



# Medicare Benefits Schedule Review Taskforce

## Report from the Diagnostic Medicine Clinical Committee

2018

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## IMPORTANT NOTES

- This report does not constitute the final position on these items, which is subject to:
  - consideration by the Minister for Health, and
  - the Government.
- The views and recommendations in this report originated from the clinical committee. Following consultation with stakeholders, the clinical committee made amendments and presented this report to the MBS Review Taskforce for its consideration.
- Any eliminations, amendments or commentary from the MBS Review Taskforce are noted in boxed comments in the body of the report:

**[Group] Recommendation [#] – Taskforce’s Advice**

[The Taskforce’s rationale behind their decision.]



# Table of Contents

<b>1. Executive summary .....</b>	<b>8</b>
<b>1.1 Mechanisms for better requesting of diagnostic tests.....</b>	<b>8</b>
<b>1.2 Item-level recommendations .....</b>	<b>9</b>
1.2.1 Vitamin B12 items.....	10
1.2.2 Iron studies items .....	10
1.2.3 Folate testing .....	10
1.2.4 Urine testing .....	11
1.2.5 Vitamin D testing .....	11
1.2.6 Prostate-specific antigen testing .....	12
1.2.7 Ankle/hind foot ultrasound .....	12
1.2.8 Shoulder ultrasound .....	12
1.2.9 Lower back imaging (CT and MRI) .....	13
1.2.10 Head imaging (CT and MRI) .....	13
<b>1.3 Non-item recommendations.....</b>	<b>13</b>
<b>1.4 Consumer engagement and impact.....</b>	<b>13</b>
Ankle/hind foot ultrasound .....	14
Shoulder ultrasound .....	14
Lower back and head imaging .....	14
Vitamin B12 items.....	15
Iron studies items .....	15
Folate testing .....	15
Urine testing .....	15
Vitamin D testing .....	16
PSA testing .....	16
<b>2. About the Medicare Benefits Schedule (MBS) Review .....</b>	<b>17</b>
<b>2.1 Medicare and the MBS .....</b>	<b>17</b>
2.1.1 What is Medicare? .....	17
<b>2.2 What is the MBS? .....</b>	<b>17</b>
<b>2.3 What is the MBS Review Taskforce? .....</b>	<b>17</b>
2.3.1 What are the goals of the Taskforce? .....	17
<b>2.4 The Taskforce's approach .....</b>	<b>18</b>



<b>3.</b>	<b><i>About the Diagnostic Medicine Clinical Committee</i></b>	<b>20</b>
3.1	Diagnostic Medicine Clinical Committee members	20
3.2	Conflicts of interest	21
3.3	Areas of responsibility of the Committee	22
3.4	Summary of the Committee's review approach	22
3.5	Limitations – Data	23
<b>4.</b>	<b><i>Mechanisms for better requesting of diagnostic tests</i></b>	<b>24</b>
4.1	Introduction	24
4.2	The nine mechanisms for better requesting	26
4.2.1	Consumer education	26
4.2.2	Requester education	27
4.2.3	Electronic clinical decision support (CDS)	27
4.2.4	Requesting pattern transparency	28
4.2.5	Requesting process	28
4.2.6	Requester restrictions	29
4.2.7	Provider feedback to requester	29
4.2.8	Provider service conditions	29
4.2.9	Payment mechanisms	29
4.3	Clinical decision support for better requesting of diagnostic services	30
4.3.1	Overview of Electronic Clinical Decision Support (CDS)	30
4.3.2	Recommendations	30
4.3.3	Illustration of Diagnostic Imaging CDS in Australia	31
4.3.4	Bridging solutions before at-scale implementation of CDS	35
<b>5.</b>	<b><i>Pathology item recommendations</i></b>	<b>37</b>
5.1	Vitamin B12 item group	38
5.1.1	Vitamin B12 items	38
5.2	Iron studies and ferritin testing item group	41
5.2.1	Items 66596 and 66593	41
5.3	Folate	47
5.3.1	Item 66840	47
5.4	Urine testing item group	50
5.4.1	Items 69300, 69333 and 73085	50
5.5	Vitamin D item group	54
5.5.1	Vitamin D items	54



<b>5.6 Prostate-specific antigen item group.....</b>	<b>59</b>
5.6.1 Items 66655, 66656, 66659 and 66660 .....	59
<b>6. Diagnostic imaging item recommendations.....</b>	<b>63</b>
<b>6.1 Ankle/hind foot ultrasound .....</b>	<b>63</b>
6.1.1 Items 55836, 55837, 55838 and 55839 .....	63
<b>6.2 Shoulder ultrasound.....</b>	<b>66</b>
6.2.1 Items 55808, 55809, 55810 and 55811 .....	66
<b>6.3 Lower back imaging.....</b>	<b>70</b>
6.3.1 Lower back items .....	70
<b>6.4 Head imaging .....</b>	<b>76</b>
6.4.1 Head imaging items .....	76
<b>7. Non-item recommendations.....</b>	<b>80</b>
7.1 ‘Diabetes care set’ item .....	80
7.2 Consumer health literacy.....	80
<b>8. Bibliography .....</b>	<b>81</b>
Appendix A - Summary for consumers .....	85
Appendix B - Glossary.....	96
Appendix C – Literature review: Interventions to improve the appropriateness and clinical utility of diagnostic investigation.....	98
Contents .....	3
Abbreviations.....	5
Executive summary .....	6
Literature search and review .....	6
Summary of results .....	7
Literature search.....	7
Included studies.....	7
Key findings.....	8
System-based interventions .....	9
Conclusion .....	13
Figures and Tables.....	39



<b>Appendices .....</b>	<b>95</b>
-------------------------	-----------

<b>Appendix 1: The full electronic search strategies used for the systematic searches.....</b>	<b>95</b>
--	-----------

Embase search for reviews investigating diagnostic imaging .....	95
Medline search for reviews investigating diagnostic imaging .....	98
Medline search for reviews investigating pathology tests .....	100
PsycINFO search for reviews investigating diagnostic imaging .....	102
PsycINFO search for reviews investigating pathology tests.....	104

<b>References .....</b>	<b>106</b>
-------------------------	------------

**Updated 5 June 2019**

## List of Tables

Table 1: Diagnostic Medicine Clinical Committee members .....	20
Table 2: Items reviewed by the Committee for inclusion in this report.....	22
Table 3: Services and benefits data for items 66538 and 66839.....	38
Table 4: Services and benefits data for items 66596 and 66593.....	41
Table 5: Services and benefits data for items 66840.....	47
Table 6: Services and benefits data for items 69300, 69333 and 73085.....	50
Table 7: Services and benefits data for items 66833, 66835, 66836, 66834 and 66837.....	54
Table 8: Services and benefits data for items 66655, 66656, 66659 and 66600.....	59
Table 9: Services and benefits data for items 55836, 55837, 55838 and 55839.....	63
Table 10: Services and benefits data for items 55808, 55809, 55810 and 55811.....	66
Table 11: Services and benefits data for lower back imaging items .....	70
Table 12: Exemplar potential imaging signposts – lower back (adults).....	74
Table 13: Services and benefits data for head imaging items .....	76
Table 14: Exemplar imaging signposts – headache (adults) .....	78



## List of Figures

Figure 1: Prioritisation matrix.....	19
Figure 2: The nine mechanisms for supporting better requesting .....	25
Figure 3: Use of the nine mechanisms across the item groups in this report .....	26
Figure 4: Recommended process for CDS implementation.....	33
Figure 5: Rates of folate co-ordering with iron and vitamin B12 .....	48



# 1. Executive summary

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The Medicare Benefits Schedule (MBS) Review Taskforce (the Taskforce) is undertaking a program of work that considers how more than 5,700 items on the MBS can be aligned with contemporary clinical evidence and practice and improve health outcomes for patients. The Taskforce will also seek to identify any services that may be unnecessary, outdated or potentially unsafe.

The Taskforce is committed to providing recommendations to the Minister for Health (the Minister) that will allow the MBS to deliver on each of these four key goals:

- Affordable and universal access
- Best practice health services
- Value for the individual patient
- Value for the health system.

The Taskforce has endorsed a methodology whereby the necessary clinical review of MBS items is undertaken by clinical committees and working groups.

The Taskforce established the Diagnostic Medicine Clinical Committee (the Committee) in March 2017 to advise on mechanisms that if implemented will support better requesting of diagnostic services. The Taskforce asked the Committee to review a set of high volume, high benefit MBS items that are predominantly requested by general practitioners (GPs). Eighteen diagnostic services involving diagnostic imaging (10 item groups) or pathology testing (eight item groups) were referred to the Committee from the General Practice and Primary Care Clinical Committee (GPPCCC). The Committee reviewed 10 priority item groups within a defined timeframe, based on rapid evidence review and clinical expertise.

The recommendations from the Committee will undergo stakeholder consultation. The Committee will consider feedback from stakeholders before providing recommendations to the Taskforce in a Review Report. The Taskforce will consider the Review Report from the Committee and stakeholder feedback before making recommendations to the Minister for consideration by Government.

## 1.1. Mechanisms for better requesting of diagnostic tests

The Committee noted the importance of providing requesters of diagnostic tests with the necessary support and enablers to facilitate better use of MBS items. The Committee agreed that there were clinical areas where the use of MBS-funded diagnostic services could be improved as per advice from the GPPCCC, and it examined mechanisms that could be used to achieve this.





To inform its recommendations, the Committee commissioned a rapid literature review to identify research on effective interventions that improve the appropriateness and clinical usefulness of diagnostic investigations requested by clinicians (Appendix C).

Through this literature review, the Committee identified and refined nine potential mechanisms to support better requesting of diagnostic services. Of the nine mechanisms, electronic clinical decision support (CDS) appeared to have the strongest evidence base for its effectiveness, whereas for the remaining mechanisms the Committee noted some influence over requesters' behaviour when applied in combination. The Committee noted that the appropriate combination of mechanisms would vary depending on the clinical issue under review. The nine mechanisms are:

- Consumer education
- Requester education
- Electronic CDS
- Requesting pattern transparency
- Requesting process
- Requester restrictions
- Provider feedback to the requester
- Provider service conditions
- Payment mechanisms

The Committee regarded CDS as a superior intervention to improve requesting of diagnostic imaging and pathology services, noting the system would give clinicians access to up-to-date clinical advice at the point of care and information on specific tests for consumer education.

## 1.2. Item-level recommendations

The Committee made multifaceted recommendations for each item included in the review, including the introduction of CDS for all items (as most of the Committee viewed this intervention as a superior mechanism with potentially the greatest influence on requester behaviour). However, it should be noted that the Committee's application of CDS to pathology items was limited, due to a lack of sufficiently widespread use of functional CDS system models for these items at the time of the review. Thus, the Committee prioritised alternative mechanisms for the pathology items but strongly supported future uptake and use of CDS.

The Committee also recognised the significant contribution of the consumer and their influence on requesting behaviour. Therefore, the Committee recommended new explanatory notes or modification of notes to provide information for both the requester and the consumer. The notes will also provide guidance on healthcare choices for consumers.

The Committee has summarised its recommendations below. The complete recommendations (and the accompanying rationales) for all items can be found in Sections 5 and 6.



### 1.3. Vitamin B12 items

The Committee made four key recommendations regarding these items.

Firstly, to match the frequency restriction that is currently in place for the serum vitamin B12 item (66838), the Committee recommended applying a 12-month frequency restriction to the quantification vitamin B12 markers item (66839), unless the previous test was abnormal and below the laboratory reference limits for vitamin B12 (in order to confirm vitamin B12 deficiency when an initial vitamin B12 result is low).

Secondly, the Committee recommended changing the explanatory notes for items 66838 and 66839 to stipulate that lethargy/tiredness alone is not an adequate or appropriate indication for any form of vitamin B12 testing.

The Committee also recommended the Department, in partnership with the Royal College of Pathologists of Australasia establish national harmonised serum vitamin B12 decision limits, although members recognised this would be difficult. The Committee also recommended providing both requester and consumer education to improve appropriate testing.

Finally, if these combined requesting processes, and requester and consumer education strategies, prove insufficient to reduce clinically ambiguous requesting for vitamin B12 testing, members then recommended the consideration of CDS for requesting of vitamin B12 testing.

### 1.4. Iron studies items

The Committee made four key recommendations for iron studies items.

Firstly, it recommended restructuring and relabelling existing iron studies and ferritin testing items into three items: an 'iron overload studies' item, an 'iron deficiency studies' item and an 'exception' item to allow testing of full iron studies when there is evidence that ferritin alone is an unreliable indicator of iron status. These changes are intended to provide clarity for clinicians about which item to use when testing for suspected iron deficiency or iron overload.

The Committee also recommended making 'iron deficiency studies' the default iron test, unless the request form indicates that the clinical suspicion is iron overload; and making iron overload studies pathologist-determinable under certain conditions.

Finally, the Committee recommended measures to support appropriate requests by educating requesters and enabling provider feedback. The outcome of these changes should be revisited 24 months after implementation to assess their effect and, if needed, to consider strengthening CDS measures for requesting of these items.

### 1.5. Folate testing

The Committee made three key recommendations for folate testing (item 66840).

Firstly, it recommended changing the item descriptor to provide clarity regarding the circumstances in which testing of folate levels should be requested, and to reduce the habitual requesting of folate testing alongside vitamin B12 testing. This recommendation included limiting the testing of folate and, if required, red cell folate testing, to those with malabsorption conditions, malnutrition or macrocytosis by including this information in the descriptor and specifying which groups of patients should be given folate supplements with



no need for testing (such as pregnant women, those planning pregnancy and those receiving methotrexate therapy) in an explanatory note.

Secondly, it recommended applying a 12-month frequency restriction to folate testing (item 66840), unless the previous test was abnormal and below the laboratory reference limits for folate (in order to confirm folate deficiency when an initial folate result is low).

The Committee also recommended establishing nationally harmonised serum folate reference limits to provide a consistent definition of what constitutes a low or equivocal serum folate result.

Finally, the Committee recommended measures to support appropriate requests by educating requesters and encouraging provider feedback. However, if these combined requesting processes and education strategies prove insufficient to change requester behaviour, then members recommended the consideration of CDS for requesting of folate testing and consideration of further requesting restrictions.

## 1.6. Urine testing

The Committee made three key recommendations for the urine testing items.

Firstly, it recommended changing the descriptor for item 69333 to specify that urine testing is only required when symptoms of a urinary tract infection are present (with the exception of specified groups of patients).

Secondly, it recommended adding an explanatory note to item 69333 to make it clear that urine microscopy and culture should not be performed in asymptomatic patients (again, with the exception of specified groups of patients) or as repeat testing to check the clearance of an infection in the absence of continuing symptoms.

The Committee also highlighted the importance of consumer education to raise awareness about the methods used to collect urine samples and the importance of minimising the possibility of contamination.

The requester and consumer education strategies should be reviewed 12 to 24 months after these changes have been implemented and if they prove insufficient to reduce requesting for urine testing, then further changes may be considered.

## 1.7. Vitamin D testing

The Committee made a number of key recommendations for vitamin D testing.

Firstly, it recommended changing the descriptor for item 66833 to clarify that testing for 25-hydroxyvitamin D should only be undertaken when the patient is at risk of both bone disease and vitamin deficiency.

Secondly, it recommended creating an explanatory note that details the various conditions and circumstances that may place a patient at risk of bone disease or vitamin D deficiency, therefore warranting testing.

Thirdly, it recommended placing a 12-month frequency restriction on the testing of 25-hydroxyvitamin D.

Fourthly, it recommended creating a new item to allow for additional vitamin D testing in patients with confirmed vitamin D deficiency and bone disease, with a three-month



frequency restrictor. A repeat test is allowed if the previous test was abnormal and below the laboratory reference limits for vitamin D (in order to confirm vitamin D deficiency when the previous vitamin D result is low).

The Committee noted that there was a need to develop a clear national standard for defining serum levels of vitamin D deficiency. The Committee recommended that this item be aligned with the national standard once developed.

The Committee also recommended measures to support appropriate requests by educating requesters and consumers. However, if requester and consumer education strategies prove insufficient to change behaviour then the Committee recommended the consideration of CDS for vitamin D testing.

Finally, the Committee recommended a rapid review of vitamin D testing, especially in regards to defined levels of deficiency and retesting intervals with the intention of making recommendations based upon current research.

## **1.8. Prostate-specific antigen testing**

The Committee's recommendations for prostate-specific antigen (PSA) testing propose item descriptor changes for the two screening items (66655 and 66659) and a frequency restriction for item 66655, that reflect current recommendations on PSA testing created by the Prostate Cancer Foundation and the Cancer Council of Australia and endorsed by the National Health and Medical Research Council (NHMRC). These recommendations would be supported by the creation of an explanatory note linking to these guidelines, as well as clinician and consumer education.

However, if requester and consumer education strategies prove insufficient to change behaviour then the Committee recommended the consideration of CDS for PSA testing.

## **1.9. Ankle/hind foot ultrasound**

The Committee made three key recommendations for the ankle/hind foot ultrasound items (55836, 55837, 55838 and 55839).

Firstly, it recommended changing the item descriptors to clarify that the only appropriate use of these items is for the assessment of suspected conditions other than acute ligament injury.

Secondly, it recommended clinician and consumer education to support these changes.

Thirdly, if the combined requesting and education strategies prove insufficient to change behaviour, then it recommended that consideration of mandatory CDS for the requesting of ankle ultrasounds be undertaken.

## **1.10. Shoulder ultrasound**

The Committee made four key recommendations for shoulder ultrasound items (55808, 55809, 55810 and 55811).

Firstly, it recommended no longer listing suspected occult fracture as a reason for requesting these items.



Secondly, it recommended restricting the claiming of these items in conjunction with shoulder X-ray items.

Thirdly, it recommended creating a new item for requesting shoulder ultrasound and X-ray at the same time, which would require the requesting clinician to provide clinical notes on the reason for requesting both items on the request form.

Finally, it recommended creating explanatory notes clarifying the appropriate pathways for shoulder imaging. These recommendations are to be supported by requester, provider and consumer education initiatives.

### **1.11. Lower back imaging (CT and MRI)**

The Committee made a multicomponent recommendation for lower back imaging items, involving the introduction of mandatory CDS, supported by requester education, audit and feedback, and patient education.

### **1.12. Head imaging (CT and MRI)**

The Committee made a multicomponent recommendation for head imaging items, involving the introduction of mandatory CDS, supported by requester education, audit and feedback, and patient education.

## **2. Non-item recommendations**

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The Committee made two non-item recommendations. Firstly, it supported the proposal to create a 'diabetes care set' item on the MBS, and recommended that the relevant organisations work together to create this item.

Secondly, the Committee strongly recommended that the Taskforce review the issue of consumer health literacy and provision of support for better consumer information (i.e. financial or clinical consent) and education relevant to MBS usage and items. Patient focussed educational material – patient information and/or decision aids - could be integrated into CDS systems which would briefly pause the requester's flow of thinking by CDS prompts. Consent for some tests being requested can also be obtained or relevant clinical information provided to improve the appropriateness of the tests requested.

### **2.1 Consumer engagement and impact**

The Committee includes experienced and committed health practitioners and two consumer representatives. This section summarises the report's key recommendations from a consumer perspective. It aims to make it easier for health consumers and members of the general public to understand and comment on the report's recommendations.

A complete list of the recommendations can be found in Appendix A, including a description in plain English of the medical service and the Committee's recommendation, as well as an explanation of why the recommendation has been made.



Consumers rarely engage with MBS item numbers unless they are following up on out-of-pocket expenses. Nevertheless, item descriptions and restrictions are an important part of healthcare accountability. The Committee's recommendations encourage agreed best practice and reflect current clinical evidence.

Both consumers and clinicians are expected to benefit from these recommendations because they address concerns regarding consumer safety and quality of care, and take steps to simplify the MBS and make it easier to use and understand. Consumer access to services was considered for each recommendation. The Committee also considered the impact of each recommendation on requester and provider groups to ensure that changes were reasonable and fair. However, if the Committee identified evidence of potential item misuse or safety concerns, recommendations were made to encourage best practice, in line with the overarching purpose of the MBS Review.

The Committee expects these recommendations to support better requesting, with the aim of ensuring that patients are provided with clinically indicated, high-quality care that reflects modern best practice.

### **Ankle/hind foot ultrasound**

The Committee considered the appropriate use of ankle ultrasound when reviewing these items and recommended that these services are provided for assessment of suspected conditions other than acute ligament injury and, with the introduction of mandatory CDS for clinicians when requesting these items should this initial restriction not prove effective for reducing inappropriate tests. The Committee expects these recommendations to have a positive effect on patients because they support consistent and evidence-based clinical best practice.

The Committee acknowledged that challenges may be faced if patients receive a suggestion from allied health professionals that ankle ultrasound should be undertaken for reasons other than assessment of suspected conditions other than acute ligament injury. The decision to restrict access to MBS funding for ankle ultrasound for purposes other than assessment of suspected conditions other than acute ligament injury aims to discourage imaging where the findings would not affect or direct the treatment pathway.

### **Shoulder ultrasound**

As part of the review of these items, the Committee considered the appropriate use of shoulder ultrasound and the circumstances in which it is clinically necessary to co-claim these items with shoulder X-ray items. The recommendations for these items include restricting co-claiming between shoulder ultrasound and X-ray items and introducing a new item for requesting both shoulder X-ray and ultrasound in specific circumstances. These changes (and a complementary explanatory note) align with current guidelines, including those from WA Health's Diagnostic Imaging Pathways (DIP) (available here: <http://imagingpathways.health.wa.gov.au/>) and the American College of Radiology's appropriate use criteria (AUC). The full impact of these changes on out-of-pocket expenses is unclear, but reducing inappropriate ordering of imaging should result in decreased gap payments for consumers.

### **Lower back and head imaging**

The Committee recommended introducing mandatory CDS for requesters of lower back and head imaging, meaning that they would be required to consult clinician-developed,



government-approved, evidence-based AUC through a CDS system prior to requesting imaging (X-ray, CT or MRI) for the lower back or head. The Committee expected these recommendations to: ensure that patients receive imaging based on consistent and evidence-based practice; reduce exposure to radiation from unnecessary X-rays and CT scans; and, have a positive impact on patient anxiety resulting from over-diagnosis. A reduction in unnecessary testing will also result in reduced out-of-pocket expenses and decreased wait times for services. However, it is crucial that access to these items is preserved in instances where the requesting clinician believes there is scope for imaging outside of the AUC. In such instances, the requesting clinician must still be able to request imaging by noting the exceptional circumstances.

While the Committee acknowledged that patients may have concerns about under-diagnosis if they are advised that a test is not suitable, and therefore not available for Medicare rebate, the recommendations are intended to ensure that patients are provided with clinically indicated, high-quality care that reflects modern best practice.

### **Vitamin B12 items**

Vitamin B12 serum and marker tests are done when investigating some causes of anaemia and neurological illness, such as dementia. Vitamin B12 marker tests should only be performed if the vitamin B12 serum test returns a low or equivocal (ambiguous) result.

Currently, patients can only receive MBS benefits for a vitamin B12 serum test once every 12 months, in line with current clinical best practice. The Committee recommends this limit also be applied to the vitamin B12 markers test, as it should only be performed after a vitamin B12 serum test and there is no benefit to more frequent testing. A repeat test is allowed if the previous test is abnormal.

The Committee also recommended that national guidelines for defining vitamin B12 deficiency, and the need for treatment or repeat testing, should be developed.

### **Iron studies items**

There are different tests that can be performed to determine whether a patient has iron deficiency or iron overload. The Committee recommended changing the descriptors for these tests to clarify under which clinical circumstances each should be used. Using the wrong set of tests can result in over-diagnosis of iron deficiency and unnecessary treatment.

### **Folate testing**

The Committees recommended that folate testing should only be performed if a clinician suspects a patient may have a malabsorption condition (a problem absorbing nutrients from food), malnutrition or macrocytosis (a type of anaemia characterised by abnormally large red blood cells). The Committee recommended changing the item descriptor for folate testing to clarify this and to limit testing to once every 12 months for results within the reference interval. A repeat test is allowed if the previous test is abnormal. The Committee also recommended specifying which groups of people should be given folate supplements straight away without testing, such as pregnant women and those receiving methotrexate therapy.

### **Urine testing**

The Committee recommended changing the item descriptor for urine testing to reflect that urine testing is mostly only required when an adult patient has symptoms of a urinary tract





infection. Additionally it is not necessary to repeat the test after treatment unless the symptoms persist or reoccur. Confining antibiotic treatment to those with symptoms is important for the best use of antibiotics.

Testing may be required for some patients without symptoms of infection:

- Pregnant women
- Children (under the age of 16 years)
- Patients undergoing urological investigations involving instrumentation, including for stone disease such as urolithiasis and nephrolithiasis
- Men undergoing transurethral resection of the prostate
- Recipients of kidney transplants
- Patients experiencing delirium with fever
- Patients undergoing haemodialysis for chronic kidney disease.

Also highlighted, was the importance of consumer education to raise awareness of the correct methods used to collect urine samples and the importance of minimising the possibility of contamination.

### **Vitamin D testing**

The Committee recommended that initial vitamin D testing be restricted to those with, or at risk of, bone disease and suspected vitamin D deficiency in order to reduce unnecessary testing while maintaining access for those who require testing to ensure that patients are provided with clinically indicated, high-quality care that reflects modern best practice.

The Committee recognised that there may be some dissatisfaction among patients with unmet expectations regarding the availability of these tests, given the popularity of vitamin D testing as a screening test among the general public. However, it noted that it has sought to preserve access for patients who clinically require testing. Patients may also be frustrated if they are required to pay for clinically requested repeat tests within a 12-month period. A repeat test is allowed if the previous test is abnormal. Clinician and provider education will be essential to minimise this, as outlined in the Committee's recommendations.

### **PSA testing**

The Committee's recommendations for PSA items focus on bringing item descriptors in line with the guidelines for PSA testing created by the Cancer Council of Australia and the Prostate Cancer Foundation of Australia, and endorsed by the NHMRC, the Royal College of Pathologists of Australasia (RCPA) and the Royal Australian College of General Practitioners (RACGP). These changes are intended to ensure that patients receive care that aligns with clinically accepted guidelines.

There may be unmet consumer expectations regarding the frequency of screenings. Clinician and consumer education will be essential to minimise this, as outlined in the Committee's recommendations.

The Committee expects these recommendations will ensure patients are provided with clinically indicated, high-quality care that reflects modern best practice.





## 3. About the Medicare Benefits Schedule (MBS) Review

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### 3.1 Medicare and the MBS

#### 3.1.1 What is Medicare?

Medicare is Australia's universal health scheme that enables all Australian residents (and some overseas visitors) to have access to a wide range of health services and medicines at little or no cost.

Introduced in 1984, Medicare has three components:

- free public hospital services for public patients
- subsidised drugs covered by the Pharmaceutical Benefits Scheme (PBS)
- subsidised health professional services listed on the MBS.

#### 3.2 What is the MBS?

The MBS is a listing of the health professional services subsidised by the Australian Government. There are more than 5,700 MBS items that provide benefits to patients for a comprehensive range of services, including consultations, diagnostic tests and operations.

#### 3.3 What is the MBS Review Taskforce?

The Government established the Taskforce as an advisory body to review all of the 5,700 MBS items to ensure they are aligned with contemporary clinical evidence and practice and improve health outcomes for patients. The Taskforce will also modernise the MBS by identifying any services that may be unnecessary, outdated or potentially unsafe. The Review is clinician-led, and there are no targets for savings attached to the Review.

##### 3.3.1 What are the goals of the Taskforce?

The Taskforce is committed to providing recommendations to the Minister that will allow the MBS to deliver on each of these four key goals:

- **Affordable and universal access**—the evidence demonstrates that the MBS supports very good access to primary care services for most Australians, particularly in urban Australia. However, despite increases in the specialist workforce over the last decade, access to many specialist services remains problematic, with some rural patients being particularly under-served.
- **Best practice health services**—one of the core objectives of the Review is to modernise the MBS, ensuring that individual items and their descriptors are consistent with contemporary best practice and the evidence base when possible. Although the Medical Services Advisory Committee (MSAC) plays a crucial role in thoroughly evaluating new services, the vast majority of existing MBS items pre-date this process and have never been reviewed.



- **Value for the individual patient**—another core objective of the Review is to have an MBS that supports the delivery of services that are appropriate to the patient’s needs, provide real clinical value and do not expose the patient to unnecessary risk or expense.
- **Value for the health system**—achieving the above elements of the vision will go a long way to achieving improved value for the health system overall. Reducing the volume of services that provide little or no clinical benefit will enable resources to be redirected to new and existing services that have proven benefit and are underused, particularly for patients who cannot readily access those services currently.

### 3.4 The Taskforce’s approach

The Taskforce is reviewing existing MBS items, with a primary focus on ensuring that individual items and usage meet the definition of best practice. Within the Taskforce’s brief, there is considerable scope to review and provide advice on all aspects that would contribute to a modern, transparent and responsive system. This includes not only making recommendations about adding new items or services to the MBS, but also about an MBS structure that could better accommodate changing health service models.

The Taskforce has made a conscious decision to be ambitious in its approach, and to seize this unique opportunity to recommend changes to modernise the MBS at all levels, from the clinical detail of individual items, to administrative rules and mechanisms, to structural, whole-of-MBS issues. The Taskforce will also develop a mechanism for an ongoing review of the MBS once the current review has concluded.

As the MBS Review is clinician-led, the Taskforce decided that clinical committees should conduct the detailed review of MBS items. The committees are broad-based in their membership, and members have been appointed in an individual capacity, rather than as representatives of any organisation.

The Taskforce asked the committees to review MBS items using a framework based on Professor Adam Elshaug’s appropriate use criteria (1). The framework consists of seven steps:

1. Develop an initial fact base for all items under consideration, drawing on the relevant data and literature.
2. Identify items that are obsolete, are of questionable clinical value<sup>1</sup>, are misused<sup>2</sup> and/or pose a risk to patient safety. This step includes prioritising items as “priority 1”, “priority 2”, or “priority 3”, using a prioritisation methodology (described in more detail below).

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<sup>1</sup> The use of an intervention that evidence suggests confers no or very little benefit on patients; or where the risk of harm exceeds the likely benefit; or, more broadly, where the added costs of the intervention do not provide proportional added benefits.

<sup>2</sup> The use of MBS services for purposes other than those intended. This includes a range of behaviours, from failing to adhere to particular item descriptors or rules through to deliberate fraud.

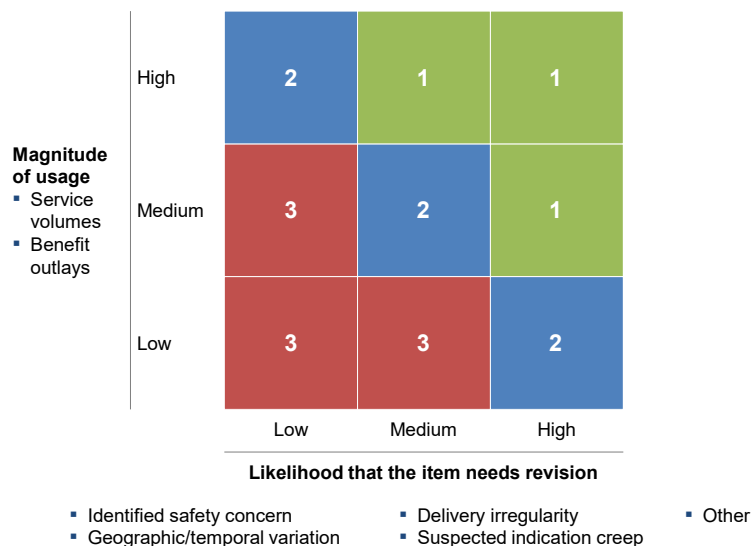


3. Identify any issues, develop hypotheses for recommendations and create a work plan (including establishing working groups, when required) to arrive at recommendations for each item.
4. Gather further data, clinical guidelines and relevant literature in order to make provisional recommendations and draft accompanying rationales, as per the work plan. This process begins with priority 1 items, continues with priority 2 items and concludes with priority 3 items. This step also involves consultation with relevant stakeholders within the committee, working groups, and relevant colleagues or Colleges. For complex cases, full appropriate use criteria were developed for the item's explanatory notes.
5. Review the provisional recommendations and the accompanying rationales, and gather further evidence as required.
6. Finalise the recommendations in preparation for broader stakeholder consultation.
7. Incorporate feedback gathered during stakeholder consultation and finalise the Review Report, which provides recommendations for the Taskforce.

All MBS items will be reviewed during the course of the MBS Review. However, given the breadth of and timeframe for the Review, each clinical committee has to develop a work plan and assign priorities, keeping in mind the objectives of the Review. Committees use a robust prioritisation methodology to focus their attention and resources on the most important items requiring review. This was determined based on a combination of two standard metrics, derived from the appropriate use criteria:

- Service volume.
- The likelihood that the item needed to be revised, determined by indicators such as identified safety concerns, geographic or temporal variation, delivery irregularity, the potential misuse of indications or other concerns raised by the clinical committee (such as inappropriate co-claiming).

**Figure 1: Prioritisation matrix**



For each item, these two metrics were ranked high, medium or low. These rankings were then combined to generate a priority ranking ranging from one to three (where priority 1 items are the highest priority and priority 3 items are the lowest priority for review), using a prioritisation matrix (Figure 1). Clinical committees use this priority ranking to organise their review of item numbers and apportion the amount of time spent on each item.



## 4. About the Diagnostic Medicine Clinical Committee

The Committee is part of the third tranche of clinical committees. It was established in 2017 to make recommendations to the Taskforce on mechanisms to support better requesting of diagnostic services. After receiving advice from the General Practice and Primary Care Clinical Committee (GPPCCC), the Taskforce asked the Committee to review a set of high volume, high benefit MBS items that are predominantly requested by GPs. The Committee reviewed ten item groups in its area of responsibility using rapid evidence review and clinical expertise.

### 4.1 Diagnostic Medicine Clinical Committee members

The Committee consists of 14 members, whose names, positions/organisations and declared conflicts of interest are listed in Table 1.

**Table 1: Diagnostic Medicine Clinical Committee members**

Name	Position/organisation	Declared conflict of interest
Professor Paul Glasziou [Chair]	Professor, Bond University; Director, Centre for Research in Evidence-Based Practice <b>MBS Taskforce Member</b>	None
Dr David Brazier	Radiologist, Royal North Shore Hospital <b>Chair, Diagnostic Imaging Clinical Committee</b>	None
Professor Anne Duggan	Gastroenterologist, John Hunter Hospital Senior Medical Advisor, Australian Commission on Safety and Quality in Health Care	None
Dr Walid Jammal	General Practitioner, Hills Family General Practice	None
Ms Alison Marcus	Consumer Representative	
Dr Elizabeth Marles	Senior Staff Specialist, General Practice & Director, Hornsby-Brooklyn GP Unit	None
Associate Professor Rachael Moorin	Manager, Health Research, Silver Chain Group; Associate Professor, Curtin University	Expert Advisor, NPS MedicineWise



Name	Position/organisation	Declared conflict of interest
Associate Professor Mark Morgan	Associate Professor, Bond University	None
Ms Geraldine Robertson	Consumer Representative, Consumer Health Forum and Breast Cancer Network Australia	None
Dr Greg Slater	Radiologist	President, Royal Australia and New Zealand College of Radiologists Shareholder, Sonic Healthcare
Associate Professor Ken Sikaris	Director of Clinical Support, Sonic Healthcare	None – note no shareholding in Sonic Healthcare
Associate Professor Peter Stewart	Director of Pathology, Sydney South West Pathology  <b>Chair, Pathology Clinical Committee</b>	Immediate past president, Royal College of Pathologists of Australasia
Dr Simon Torvaldsen	General Practitioner	Chair, Australian Medical Association (Western Australia) Council of General Practice  Owner, General Practice (which receives rent at market rate from a pathology company)
Professor Tim Usherwood	Professor, General Practice, Westmead Clinical School, University of Sydney  <b>Chair, General Practice Primary Care Clinical Committee</b>	Consultant, NPS MedicineWise

\*Conflict of interest other than being a provider of MBS items.

## 4.2 Conflicts of interest

All members of the Taskforce, clinical committees and working groups are asked to declare any conflicts of interest at the start of their involvement and reminded to update their declarations periodically. A complete list of declared conflicts of interest can be viewed in Table 1.

It is noted that the majority of the Committee members share a common conflict of interest in reviewing items that are a source of revenue for them (i.e. Committee members claim the items under review).



This conflict is inherent in a clinician-led process, and having been acknowledged by the Committee and the Taskforce, it was agreed that this should not prevent a clinician from participating in the review.

### 4.3 Areas of responsibility of the Committee

The Committee was formed to draw on the expertise of both providers and requesters of diagnostic services (pathologists, radiologists, GPs, specialists, consultant physicians, academics and consumers), with a focus on selected pathology and diagnostic imaging items. The Committee included the chairs of the GPPCCC, the Diagnostic Imaging Clinical Committee (DICC) and the Pathology Clinical Committee (PCC) to assist communication between key committees. The 75 items reviewed by the Committee are listed in Table 2 (below).

To inform its recommendations, the Committee commissioned a rapid literature review to identify research on effective interventions that improve the appropriateness and clinical utility of diagnostic investigations requested by clinicians. This report contains details of the mechanisms identified to encourage better requesting of diagnostic services, in addition to item-level recommendations that were developed based on this commissioned research for 75 items across 10 item groups referred to the Committee by the GPPCCC. In the 2015–16 financial year, these items accounted for approximately 22.1 million services. Over the past five years, service volumes for these items have grown at 10.9 per cent per year.

**Table 2: Items reviewed by the Committee for inclusion in this report**

Category	Items
Ankle/hind foot ultrasound	4
Shoulder/upper arm ultrasound	4
Lower back imaging	25
Head imaging	25
Vitamin B12 items (66838 and 66839)	2
Iron studies items (66593 and 66596)	2
Folate item (66840)	1
Urine testing items (69300, 69333 and 73085)	3
Vitamin D items	5
Prostate-specific antigen items	4
<b>Total</b>	<b>75</b>

### 4.4 Summary of the Committee's review approach

The Committee completed a review of the items in this report across seven committee meetings, during which it developed the recommendations and rationales contained in this report.

The review drew on various types of MBS data, including data on utilisation of items (services, benefits, patients, providers and growth rates); service provision (type of provider, geography of service provision); patients (demographics and services per patient); co-claiming or episodes of services (same-day claiming and claiming with specific items over time); and additional provider and patient-level data, when required.



The review also drew on data presented in the relevant literature and clinical guidelines, all of which are referenced in the report. Guidelines and literature were sourced from medical journals and other sources, such as professional societies.

The Committee has reviewed these items and made recommendations based on clinical best practice, but it recognises that the impact of these recommendations on providers may be assessed by the Pathology Business Group and the Royal Australian and New Zealand College of Radiologists, which can then provide comment to the Taskforce via the relevant Clinical Committee, Pathology or Diagnostic Imaging.

#### **4.5 Limitations – Data**

The Committee carefully considered the impact of ‘episode coning’ on its recommendations.

‘Episode coning’ is a Medicare payment rule that means only the three most expensive pathology items receive payment (and are captured in MBS data) when more than three tests are requested for a single patient on the same day, by one or more practitioners. Coning is limited to tests ordered by GPs for out-of-hospital services. Services requested for hospital in-patients or requested by specialists are not subject to coning. Pathology providers are required to perform and report on all requested items; however, the fourth and subsequent tests receive no payment.

As a result of this payment rule, MBS data does not include all pathology tests performed when more than three tests are requested at a time. The Committee discussed the issue of coning in its meetings, and took this potential limitation into account in its deliberations. For instance, the Committee noted that, in some cases, the relative mix of items included in an episode may not be fully known as less-expensive tests may be coned out (not be captured in the data). Similarly, the Committee noted in many cases requesting patterns and volumes were likely to be underestimated.



## 5. Mechanisms for better requesting of diagnostic tests

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### 5.1 Introduction

The Committee noted the importance of providing requesters of diagnostic tests with the necessary support and enablers to facilitate better use of MBS items. The Committee agreed that there were clinical areas where the use of MBS-funded diagnostic services could be improved, and it examined mechanisms that could be used to achieve this. The Committee noted at this time there are limitations to how the MBS can be used as a tool to drive a change in requesting behaviour, although the item descriptors should provide a reference for practitioners when making decisions to request diagnostic services.

To inform its recommendations, the Committee commissioned a rapid literature review to identify research on effective interventions that improve the appropriateness and clinical utility of diagnostic investigations requested by clinicians. Through this review, the Committee identified and refined nine potential mechanisms to support better requesting of diagnostic services (Figure 2).





Figure 2: The nine mechanisms for supporting better requesting

## The Committee can support better requesting through 9 mechanisms

	Mechanism	Description	Examples
Patient focus	1 Consumer Education	<ul style="list-style-type: none"> <li>Increased access to information on diagnostic testing</li> <li>Patients empowered to engage with clinicians</li> </ul>	<ul style="list-style-type: none"> <li>CHF Resource <i>Why do I even need this Test?</i></li> <li>Department of Health guidelines for Royal Australasian College of Radiologists (RANZCR) and New Zealand College of Radiologists (RANZCR) / Royal College of Pathologists Australasia patient education materials</li> </ul>
	2 Requestor Restrictions	<ul style="list-style-type: none"> <li>Eligible providers can be defined by prior mandatory training or credentialing</li> </ul>	<ul style="list-style-type: none"> <li>MRIs generally can only be requested by specialist radiologists</li> </ul>
Requestor focus	3 Requestor Education	<ul style="list-style-type: none"> <li>Increase awareness about high-value test requesting, supported by the specialist colleges, NPS Medicinewise, etc.</li> <li>The cost of diagnostic tests transparent to requestor</li> </ul>	<ul style="list-style-type: none"> <li>Publications from specialist colleges and/or media</li> <li>Mandatory continuing professional development</li> <li>Prices of test displayed on request forms (or electronic decision support)</li> </ul>
	4 Electronic Decision Support	<ul style="list-style-type: none"> <li>Provision of case-specific information/advice, at the point of care, to support clinical decision-making and high-value test selection.</li> </ul>	<ul style="list-style-type: none"> <li>Imaging Clinical Decision Rules (RANZCR), Diagnostic Imaging Pathways (WA Health)</li> </ul>
	5 Requesting Process	<ul style="list-style-type: none"> <li>Structured request</li> <li>Testing pathways</li> <li>Timing for repeat tests</li> <li>Request restrictions</li> <li>'Care sets'</li> </ul>	<ul style="list-style-type: none"> <li>Sleep study decision support tool</li> <li>Thyroid stimulating hormone (TSH) test before thyroid function test (TFT)</li> <li>Annual screening Prostate Specific Antigen</li> <li>Co-claiming of items</li> <li>Grouping of items by clinical situation</li> </ul>
	6 Provider Feedback to Requestor	<ul style="list-style-type: none"> <li>Provider directly contacts requestor to give feedback on the value of their proposed test</li> </ul>	<ul style="list-style-type: none"> <li>Footnote at bottom of request for shoulder ultrasound in elderly patients</li> </ul>
	7 Requesting Pattern Transparency	<ul style="list-style-type: none"> <li>Audits of provider behaviour (&amp; peer comparison) to spur providers to alter requesting</li> </ul>	<ul style="list-style-type: none"> <li>NPS Medicinewise reports</li> </ul>
Provider focus	8 Payment Mechanisms	<ul style="list-style-type: none"> <li>Changing payment system</li> <li>Altering payor structure</li> </ul>	<ul style="list-style-type: none"> <li>Capitation, pay for performance</li> <li>Risk sharing, differential copayments</li> </ul>
	9 Provider Service Conditions	<ul style="list-style-type: none"> <li>Provider-determinable requests</li> <li>Provider prohibited from doing certain testing</li> </ul>	<ul style="list-style-type: none"> <li>Mandatory testing pathways e.g., TSH/TFT</li> <li>Cannot do bilateral leg ultrasounds on same day service</li> </ul>

SOURCE: Committee perspective and analysis

Of the nine mechanisms, electronic CDS appeared to have the strongest evidence base for effectiveness, whereas for the remaining eight mechanisms the Committee noted some influence over requesters' behaviour when applied in combination.

After reviewing each of the nine mechanisms Committee members voted for their preferred mechanism to achieve better requesting for each item group. For diagnostic imaging items, there was a strong preference for electronic CDS with the remainder of the votes split across the other eight mechanisms. For the pathology items, Committee members' votes united around three preferred mechanisms: CDS closely followed by requester education and the requesting process. The remainder of the votes were spread across the other six mechanisms.

The recommendations in this report use various combinations of the above nine mechanisms (typically combining three to five mechanisms) to promote clinical best practice in the requesting of MBS diagnostic imaging and pathology services. The Committee's application of CDS to pathology items was limited due to a lack of sufficiently widespread use of functional CDS system models for these items at the time of the review; however, members strongly supported future uptake and use of CDS and felt a system for diagnostic imaging offered a promising opportunity to pilot the CDS mechanism.



Figure 3 details how the nine mechanisms to support better requesting of diagnostic services have been applied across the ten item groups discussed in this report. Although only six of the nine mechanisms have been used in the item recommendations in this report, the Committee believes that the three unused mechanisms may be used in future recommendations for other item groups. Specific recommendations that incorporated CDS were not made for the pathology items reviewed in this report, but the Committee considered CDS an important mechanism for supporting appropriate pathology requesting and felt it may be of value for these item groups in the future. For pathology items two other mechanisms (the requesting process and requester education) also play important roles in the recommendations in this report.

**Figure 3: Use of the nine mechanisms across the item groups in this report**

### Utilisation of the nine mechanisms across the item groups in this report

Primary recommendation
  Secondary recommendation
  Supporting recommendation

		Use of the mechanisms against the item groups reviewed								
		Consumer Education	Requestor Restrictions	Requestor Education	Electronic Clin. Decision Support (CDS)	Requesting Process	Provider Feedback to Requestor	Requesting Pattern Transparency	Payment Mechanisms	Provider Service Conditions
Items reviewed	Ankle ultrasound									
	Shoulder ultrasound									
	Lower back imaging									
	Head imaging									
	Vitamin B12									
	Iron studies									
	Folate									
	Urine									
	Vitamin D									
	PSA									

The following section describes the nine mechanisms, provides examples of each mechanism in action and summarises systematic reviews for the mechanisms (where available). Section 4.3 presents more detailed information on CDS which the Committee identified as the most effective of the nine mechanisms.

## 5.2 The nine mechanisms for better requesting

### 5.2.1 Consumer education

Consumer education is integral to efforts to support better requesting of diagnostic services because it empowers patients to engage with clinicians. The Committee suggested that consumers could be provided with increased access to information on diagnostic testing, both outside the clinical setting and through the development of resources that clinicians can directly provide to patients, such as patient decision aids (2). The Committee considered three systematic reviews (with meta-analysis of eight reviews) that investigated consumer education. These reviews demonstrated that education with a patient component can significantly improve appropriate testing. Further details can be found in **Appendix C**.



Examples of consumer education interventions include generic advice (such as the Consumer Health Forum's patient resource 'Why do I even need this test?' (3) or WA Health's DIP tools for consumers) (4), as well as information about specific tests, such as the Royal Australian and New Zealand College of Radiologists' (RANZCR) guidelines for providing patient information (for example, 'Inside Radiology') (5) or the RCPA's support of LabTestsOnline (6) and MBS explanatory notes for guidance on clinical indicators for a specific test. It is acknowledged that most consumers do not engage with the explanatory notes of the MBS; however, the notes do serve as another reference to guide healthcare decisions.

### 5.2.2 Requester education

Requester education can have limited impact when used in isolation, but it plays a crucial role in supporting other mechanisms as part of a multicomponent approach to improving requesting behaviours. Requester education can increase clinician awareness about high-value test requesting, item descriptor inclusions/exclusions and test costs, among other things. Examples of requester education initiatives include publications from specialist colleges, a mandatory continuing professional development module on diagnostic testing services, and including test prices on request forms or in electronic CDS software.

The Committee considered 10 systematic reviews that investigated clinician education interventions. Overall, seven systematic reviews and meta-analyses reported significant positive findings, and two reported significant negative findings. The strongest benefits were associated with education used in conjunction with other interventions, such as audit and feedback. Although these reviews were primarily focused on the hospital environment and evidence of effectiveness was inconsistently reported, several important points emerged from these reviews and informed the Committee's deliberations. Further detail on these points is available in **Appendix C**.

The Committee concluded educational campaigns explaining the changes to MBS items before implementation as part of multi-dimensional strategy may increase compliance, and noted that reinforcement after implementation may be provided through alternative strategies, for example CDS.

### 5.2.3 Electronic clinical decision support

Electronic CDS provides requesters with case-specific information/advice at the point of care. It supports clinical decision-making by providing signposted pathways for test selection.

Examples of CDS currently in use in Australia include the RANZCR Imaging Clinical Decision Rules (5), the DIP (4) and some hospital-based systems. In the United States, recent regulatory change has mandated the use of CDS for certain diagnostic imaging test requests. For example, the US Centres for Medicare & Medicaid Services recently ruled that from 1 January 2020, the use of CDS will be mandatory for all advanced imaging such as MRI and CT, and that payment to radiologists for these tests will become contingent on the requesting clinician providing proof that they consulted an approved CDS system (7).

The Committee considered 16 reviews that investigated CDS interventions. These reviews provided evidence that CDS interventions improve the appropriateness of health professionals' diagnostic imaging and pathology requesting. The detailed findings of these reports can be found in **Appendix C**. The Committee agreed that CDS is an area of importance, so it is discussed in more detail in Section 4.3.



The Committee held CDS as a superior intervention, especially when used as part of a multifaceted approach, because it is versatile and can be used for multiple purposes such as providing requester education, provider feedback, improving the request process and many of the other nine mechanisms. The Committee recognised that end-user acceptance of CDS and the integration of CDS into the requesting doctor's workflow are crucial for its successful implementation.

#### 5.2.4 Requesting pattern transparency

This mechanism allows requesters to understand how their requesting patterns may vary from those of their peers, and to review their own requesting decisions in the event of large or unexpected variances. For example, letters could be sent to the 10 per cent of requesters with the highest requesting rates for selected items, detailing comparisons with their peers.

The Committee considered 11 systematic reviews that investigated audit and feedback (or requesting pattern transparency) interventions. Audit and feedback generally results in small to moderate improvements in professional practice, including reductions in test ordering and inappropriate imaging. However, when clinicians were provided with feedback on their use of low-value services compared with their peers, in addition to educational materials, large reductions in laboratory testing and imaging were observed. This finding highlights the importance of multi-mechanism approaches, and it demonstrates how implementation decisions can shape the effectiveness of a mechanism. The detailed findings of these reports can be found in **Appendix C**.

#### 5.2.5 Requesting process

Changes to the requesting process include changing item descriptors and changing the ways in which tests can be requested. For example, requests may need to be structured in a specified way, mandated testing pathways may be introduced, frequency restrictions may be applied to repeat tests or 'care sets' may be introduced.

In Australia, examples of changes that have already been made to requesting processes include the sleep study decision support tool, the current testing pathway that requires thyroid stimulating hormone (TSH) testing prior to a thyroid function test (TFT), restrictions on co-claiming certain items and the grouping of items by clinical situation. In addition, there are many examples of items with frequency restrictions (meaning MBS benefits are payable once only in a defined period) throughout the MBS, for example various MRI and CT items included in the *Health Insurance (Diagnostic Imaging Services Table) Regulations*, various optometrical services and a number of pathology tests, including serum Vitamin B12 and PSA screening.

The Committee's review revealed that requesting process levers—such as modifying request or referral forms—had a significant impact on testing rates. Most studies show that changes in requesting processes have an impact on testing rates, but few studies investigate the impact that this change has on clinical outcomes. However, one study showed that changing an order form to include reflective questions decreased utilisation of imaging by 22.5 per cent, without an increase in adverse outcomes (8). Similarly, a project to reduce clinical variability in laboratory testing by increasing clinician awareness of their patterns of requesting resulted in significantly lower laboratory utilisation without negatively impacting quality outcomes (9). Further findings from the literature on changing requesting processes can be found in Appendix C.



### 5.2.6 Requester restrictions

Requester restrictions can support better requesting of diagnostic services by limiting the clinicians who can request certain tests. Mandatory training or credentialing may be needed to become an eligible requester. This mechanism is already used to restrict certain types of MRI requesting to specialists, and it is incorporated into Regulation 11 in the *Health Insurance Regulations*, which defines the diagnostic imaging services that can be requested by certain allied health professional groups. Another example in the MBS relates to the requesting of item 66835 (testing of 1, 25-dihydroxyvitamin D) which is restricted to consultant physicians and specialists managing the patient. Several other cancer related genetic tests funded through the MBS are also restricted in this manner. In Ontario, Canada, folate testing is restricted to red blood cell folate unless advised by physicians with expertise in haematological, inflammatory or gastrointestinal disorders (10).

### 5.2.7 Provider feedback to requester

This mechanism enables providers to send feedback directly to requesters on the value of the proposed test. For example, feedback notes on the clinical utility of shoulder ultrasound in elderly patients (where evidence suggests (11) that the incidence of asymptomatic rotator cuff tears is about 20 per cent) could be delivered back to the requester at the bottom of the test report. The Committee agreed that providers such as pathology laboratories and diagnostic imaging practices can influence requester behaviour and so are best placed to champion change in requesting practices.

### 5.2.8 Provider service conditions

This mechanism changes the conditions under which providers are permitted to provide tests. This includes introducing or limiting provider-determinable tests (such as the vitamin B12 marker test) or prohibiting providers from conducting certain tests in certain circumstances. In Australia, current examples of changes to provider service conditions include the introduction of mandatory testing pathways (for example, requiring TSH testing prior to TFT). Another example is MBS item 66830 for Brain Natriuretic Peptide which is currently restricted to the diagnosis of heart failure in patients presenting with dyspnoea to a hospital Emergency Department.

### 5.2.9 Payment mechanisms

Payment mechanisms include any changes to the payment system or structure that are designed to encourage a change in requesting behaviour for diagnostic services. Examples include capitation/pay for performance (where payment is linked to the achievement of certain predetermined criteria), risk-sharing (where fixed payments are made to providers regardless of the volume of services rendered) and differential co-payments.

The Committee considered three reviews that investigated pay for performance, insurer restrictions and risk-sharing. There was some limited evidence to suggest that payment systems can improve the appropriateness and clinical utility of diagnostic imaging and pathology tests requested by clinicians. However, the Committee noted that pay-for-performance interventions must be carefully stratified to minimise any risk of reduction in appropriate care. It also noted that risk-sharing has been incompletely tested for low-value care, and that further research is needed on the effectiveness of pay for performance, insurer restrictions and risk-sharing.



### 5.3 Clinical decision support (CDS) for better requesting of diagnostic services

After reviewing the evidence, the Committee agreed that CDS appeared to be the most effective of the nine mechanisms for supporting better requesting of pathology and diagnostic imaging items. For this reason, it spent a significant amount of time developing recommendations to introduce CDS for diagnostic imaging in Australia. It should be noted that the Committee's application of CDS to pathology items was limited, due to a lack of sufficiently widespread use of functional CDS system models for these items at the time of the review. Thus, the Committee prioritised alternative mechanisms for the pathology items but strongly supported future uptake and use of CDS.

The Committee felt that diagnostic imaging items offered a promising opportunity to pilot the CDS mechanism because they have relatively low service volumes but a significant impact on consumers. Additional and alternative considerations will be necessary when expanding CDS to pathology or other areas. This section of the report provides an overview of CDS and the Committee's recommendations, an illustration of how CDS may work in Australia, and a discussion of other important factors that need to be considered when introducing a CDS system.

#### 5.3.1 Overview of Electronic Clinical Decision Support

For the purposes of its review, the Committee defined CDS as 'the provision of advice at the point of care (when decisions are being made by the medical professional) that is tailored to the clinical context of the specific patient.' Among the evidence reviewed by the Committee (Appendix C), meta-analyses of heterogeneous studies suggested that CDS systems improve morbidity, preventive care services, the ordering or completion of clinical studies, and the ordering of appropriate treatment, with no significant effect on mortality or adverse events. This evidence and analysis forms the basis and rationale for the recommendations outlined in Section 4.3.2.

In recommending the introduction of mandatory CDS, the Committee's intention is to enhance high-value advanced imaging requests, reduce inappropriate overuse and misuse, and provide a source of clinical knowledge for requesting clinicians.

At present, there is no mandatory CDS in the Australian health system, although the Committee noted the existence of DIP—a WA Health initiative that provides clinical indication-based pathways for diagnostic imaging. The Committee recommended implementing a CDS system Australia-wide, with requirements for mandatory CDS attached to rebates for selected diagnostic imaging items.

#### 5.3.2 Recommendations

- The Australian Government should increasingly facilitate appropriate clinical use of MBS rebates through several mechanisms, including development of CDS.
- Australia should introduce CDS systems to support improved requesting of imaging and eventually pathology items. Mandatory CDS should be applied to selected items in the next 24 months, beginning with priority diagnostic imaging and pathology items, and expanding to pathology and other areas.





- Mandatory CDS should be limited to high priority items only. It should require clinicians to participate in the CDS process, but not mandate adherence to the CDS recommendation. There must always be a provision for clinicians to exercise clinical judgement to override CDS recommendations, provided that the reasons for doing so are recorded.
- Appropriate governance systems should be established for the development and ongoing management of the AUC and the CDS systems. Although there should be extensive cross-departmental collaboration in the development of such systems, there should also be a clear system owner. The AUC ownership and governance must be independent with adequate expertise, good clinical governance and feedback mechanisms.
- The CDS system should be seamlessly integrated with workflows including clinical software platforms and common standards will need to be developed.

It must be recognised that development and implementation of an electronic CDS is a complex process that will require significant investment of both time and expertise and should build on existing work where possible.

### 5.3.3 Illustration of Diagnostic Imaging CDS in Australia

This section expands on the above recommendations to illustrate how CDS could potentially improve requesting in the national Medicare system. It discusses how Australia could promote wider adoption of CDS in requesting, how mandatory CDS for priority items could be introduced, how such a program could be implemented effectively and how to develop AUC. It also considers the governance required for such a system.

#### Introducing an Australia-wide CDS system

When considering how to successfully promote at-scale use of CDS nationwide, the Committee discussed several significant issues, which are detailed below. (The list is not intended to be exhaustive.)

- Financial support could be offered to requesters and providers for installation of CDS to facilitate Australia-wide adoption.
- The CDS platform should be leveraged to provide clinician and consumer education. For example, it could provide information to consumers on the tests that their clinicians are considering for them.
- The Committee acknowledged current variation in the terminology used for diagnostic tests. It may be necessary to standardise terminology in the course of implementing CDS.
- The Committee recognised that clinicians' responses to the implementation of CDS will be contingent on the level of disruption to their workflow. To reduce disruption over time, a vendor-neutral interface could be created that integrates the AUC for CDS-mandatory MBS items into the Electronic Medical Record (EMR) or other CDS platforms. To achieve this, early and sustained interaction with electronic health software vendors is essential.
- When engaging with software architecture, there should be two possible starting points for requesting clinicians: the patient's clinical presentation and the requester's initial intended test.



- Development of the CDS system could allow for increased authority in the requesting of tests, with a streamlined system similar to the existing 'streamlined authority' for specific medication.
- IT support for CDS should be easily accessible for clinicians and expedient in troubleshooting any issues, especially in the trial phase.

#### **Linking MBS payments to mandatory CDS usage for select items**

The above recommendation to predicate MBS item rebates on CDS usage for select items requires careful planning and design. The Committee discussed three potential measures to illustrate how this could be enacted:

- MBS payments to providers for items where mandatory CDS is recommended could be made contingent on proof of requesters' use of CDS.
- The CDS system should be able to determine whether tests are eligible for an MBS rebate based on the clinical indications, and to advise clinicians when an MBS rebate will not be available.
- For priority items, requesters could be required to sign or complete electronic declarations confirming that they have honestly and fully complied with CDS.

#### **Development and successful implementation of CDS**

Based on its discussions, the Committee provided a number of suggestions for ensuring successful implementation of CDS. These suggestions are intended to provide guidance during the implementation phase.

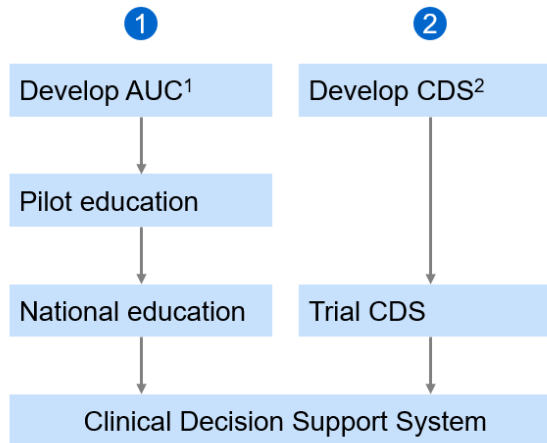
- The Committee proposed that in order to ensure timely implementation the development of mandatory CDS should take place in two phases, with development of the AUC and education efforts running parallel to the development of the CDS software system (Figure 4).





Figure 4: Recommended process for CDS implementation

## Process for development and deployment of mandatory clinical decision support



1 Appropriate use criteria  
2 Clinical decision support

- The Committee agreed that the following steps would need to be taken when establishing CDS in Australia. The steps are not listed in any particular order.
  - Institute regulatory changes that make requesters' use of CDS compulsory for specific item groups and/or clinical scenarios.
  - Engage with peak medical bodies (local group 'champions').
  - Secure funding for CDS implementation.
  - Formulate AUC for use in CDS.
  - Specify CDS design choices and create or source a vendor-neutral software platform.
  - Trial and evaluate CDS implementation (with rapid modification as needed), then implement at-scale rollout, with ongoing improvement activity based on feedback from end-users.
  - Provide education for requesters and test providers on how to use CDS, and to explain the rationale underpinning its introduction. This should be accompanied by a public campaign to inform consumers about the change. Education should commence as early as is appropriate in order to achieve better stewardship of finite healthcare resources from a national standpoint.
  - Ensure compliance by establishing monitoring and audit functions.



### Development of appropriate use criteria

The Committee agreed on the following guidance with regards to the development of AUC for initial mandatory CDS system for selected diagnostic imaging items.

- The Committee suggested that it may be helpful to use an existing database or existing AUC as a starting point for the creation of the Australian AUC. This would then need to be adapted to the Australian context by a multidisciplinary body, with representation from relevant peak medical bodies and the Department of Health.
- The Committee also suggested that the Department of Health appoint an organisation similar to the NPS Medicine Wise to assume ongoing responsibility for maintenance of the AUC. The designated third party should also play a role in coordinating input from the organisations that initially create the content, peak medical colleges (including the RACGP, RANZCR, and RCPA) and the team that created the WA Health DIP.
- Clinical rationale for clinicians requesting exceptions for mandatory items should be collected, analysed and used to review and refine the AUC on an ongoing basis.

### Governance

The Committee acknowledged the importance of governance in the implementation and ongoing execution of a CDS system and has provided the following guidance.

- The Committee agreed that the Department of Health should develop a governance structure that includes AUC oversight, as well as audit and compliance. It has been suggested that the Digital Health Authority may be an appropriate body for overseeing the CDS software structure, and that the MSAC could be suitable for determining which items require mandatory CDS.
- The governance structure should include processes for data management. The Committee agreed that data should be owned and protected by the Department of Health.
- Compliance oversight should include regular checks to identify requesters who are outliers in their requesting patterns, and to provide them with targeted feedback.
- A structure should be implemented that allows requesters to easily provide feedback to the body responsible for the CDS system.
- The Committee suggested that the governing body should oversee the CDS as a piece of critical health infrastructure and invest accordingly in fail-safes. Preventing system failure is essential to clinician buy-in.

### Other key considerations

In the Committee's numerous discussions about CDS, several other issues were deemed worthy of consideration when designing a far-reaching CDS program to improve requesting. These include:

- Remote access: The Committee noted that consideration should be given to ensuring appropriate access to CDS for requesters in remote and rural areas.
- E-health: The Committee noted that an e-health platform that allows clinicians to access information on which tests patients have previously undertaken would assist greatly in the use of CDS and the prevention of duplicate ordering.



- Potential challenges: The Committee noted the following potential challenges, which should be mitigated to ensure successful rollout of the system.
  - Stakeholder resistance due to a lack of engagement among consumers, clinical bodies and the clinicians using the CDS system.
  - Poor-quality AUC, or the choice of an existing AUC database that does not meet Australia's specific needs.
  - Failure to adequately allow for exceptions to the mandatory AUC.
  - Lack of 'beta-testing' through trial programs.
  - End-user rejection due to poor-quality software platforms and/or integration with the AUC.
  - Failure to update the AUC in response to changes in clinical practice and appropriate exceptions logged by requesters.
  - Legal considerations around AUC copyright, ownership of CDS usage data and patient data protection not being addressed.
- Expansion of CDS beyond diagnostic imaging: The Committee believes that in the long term, CDS will be appropriate beyond diagnostic imaging, potentially supporting better requesting of pathology and other services. This is consistent with the previous (2011–2016) funding agreement between the Australian Government and the pathology sector which included a requirement to begin development of decision support tools for pathology requesting (12) .
- Clinical discretion: Clinicians should be able to override the CDS system's recommendations if they provide clinical information and a rationale for their decision, which would be recorded by the system and audited for appropriateness.
- Consumer education: Any CDS system should be integrated with consumer education tools, allowing clinicians to print off or share with patient's details about the test(s) being ordered.

#### 5.3.4 Bridging solutions before at-scale implementation of CDS

- The Committee acknowledged the extensive timeline required for at-scale CDS implementation in Australia, but it noted that it is imperative that the process commences as early as possible, ideally with a two-year rollout plan.
- The Committee suggested implementing bridging solutions throughout this period with the intention of:
  - Demonstrating the feasibility of a CDS system in Australia.
  - Stress-testing development, integration and ongoing improvement protocols for both the AUC and the software delivery platforms.
  - Increasing engagement among test requesters, providers and software vendors.
- This bridging solution should be limited in its initial scope by:
  - Targeting one (or at most, two) item groups based on known low-value requesting practices, such as knee MRI and imaging for lower back pain.
  - Initially only requiring AUC to be developed for these targeted item groups.
  - Focusing on developing the standalone platform for delivering these limited AUC.
  - Limiting the geographical area (for example, to one Primary Health Network [PHN] or a group of GP practices).



- The Committee noted that any bridging solution should be designed to minimise disruption to workflow.
- An education campaign should also be commenced as soon as a decision is made to pursue CDS in Australia. This will allow requesters, providers and software vendor's time to adapt and respond. Ideally, these groups should have a minimum of one year to prepare.
- Leadership from the colleges and peak medical bodies should be engaged early in the process and equipped to become champions of this change to their respective members. This engagement should focus on the long-term goal of improving the value of imaging studies.
- The following bridging options were also discussed but were not favoured by the Committee, partly because of the disproportionate workflow disruption that clinicians would likely experience:
  - Phone call authorisation (similar to what is in place for PBS authority prescriptions).
  - Structured requests forms.



## 6. Pathology item recommendations

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### 6.1 Introduction

Between March and August 2017, the Committee considered six referred pathology item groups which accounted for 119 million services and \$335 million in benefits paid in 2015-16. Recommendations are based on rapid evidence review and the clinical expertise of the Committee.

The Committee's recommendations to the Taskforce on pathology items are that eleven items should be changed and six items should remain unchanged. These recommendations focus on encouraging best practice, modernising the MBS to reflect contemporary practice, and ensuring that MBS services provide value for the consumer and the healthcare system.

In order to achieve these goals, the Committee made multifaceted item-level recommendations involving CDS, modified requesting processes and education strategies for requesters. The Committee recognised the superiority of CDS to improve requesting of MBS diagnostic services; however, at the time of the review Committee members were not aware of any CDS system applicable to pathology items. Therefore, the Committee was limited in its capacity to delve into details of a CDS system for pathology requesting.

The Committee also recognised the significant contribution of the consumer and their influence on requesting behaviour. Therefore, the Committee recommended new explanatory notes or modification of notes to provide information for both the requester and the consumer. Whilst it is acknowledged that the majority of consumers may not engage with the explanatory notes, the notes are another reference that consumers can access to guide healthcare choices.

In addition to recommendations based on mechanisms to support better requesting of diagnostic services (as discussed in Section 4) the Committee made item-level recommendations to achieve the goals of the MBS Review Taskforce, including:

- Deleting items that are obsolete.
- Consolidating or splitting items to reflect contemporary practice.
- Modernising item descriptors to reflect best practice.
- Providing clinical guidance for appropriate use through explanatory notes.

The item-level recommendations are described below. A list of the Committee's recommendations can be found in the consumer summary table in **Appendix A**.



## 6.2 Vitamin B12 item group

### 6.2.1 Vitamin B12 items

**Table 3: Services and benefits data for items 66538 and 66839**

Item	Descriptor	Schedule fee	Services 2015/16	Benefits 2015/16	Services 5-year annual avg. growth
66838	Serum vitamin B12 test *NB: item is subject to Rule 25: for any particular patient, this item is applicable not more than once in a 12-month period	\$23.60	1,203,254	\$24,186,933	N/A
66839	Quantification of vitamin B12 markers such as holotranscobalamin or methylmalonic acid, where initial serum vitamin B12 result is low or equivocal	\$42.95	1,432,484	\$52,498,041	N/A

#### Recommendations

- a) Apply a 12-month frequency restriction to item 66839 (quantification of vitamin B12 markers) to match the restriction that is already in place for item 66838 (serum vitamin B12 test).
- b) Change the descriptor for item 66839. The proposed descriptor is as follows:  
 Quantification of vitamin B12 markers such as holotranscobalamin or methylmalonic acid, where initial serum vitamin B12 result is low or equivocal  
 \*NB: item is subject to Rule 25: for any particular patient, this item is applicable not more than once in a 12-month period unless the previous test was abnormal that is below the laboratory reference limits for Vitamin B12 (in order to confirm Vitamin B12 deficiency when an initial Vitamin B12 result is low).
- c) Add an explanatory note for items 66838 and 66839 to:
  - Reflect the amended item descriptor, stipulating that pathology laboratories that bill for quantification of vitamin B12 markers must perform this test on the same pathology episode that returned the initial low or equivocal serum vitamin B12 result.
  - Clarify that lethargy/tiredness alone is not an adequate or appropriate indication for any form of vitamin B12 testing without the presence of neuropsychiatric symptoms, certain haematological disorders or abnormal full blood examination findings, or malabsorption (13).
- In addition the Committee recommended:
  - Establishing national harmonised serum vitamin B12 decision limits (or cut-offs) to provide a consistent definition of what constitutes a low or equivocal serum vitamin B12 result, triggering the quantification of vitamin B12 markers. The Committee recognised that this would be difficult; however, it recommended that the Taskforce approach the Royal College of Pathologists of Australasia (RCPA) to establish harmonised clinical decision limits. If national harmonised decision limits for serum vitamin B12 or holotranscobalamin (HoloTC) levels have not been determined 12



months after the submission of this report, this recommendation should be reviewed, including whether pathologist-determinable testing is still appropriate.

- Providing requester education on appropriate testing frequency.
- Stipulating that pathology reports should provide to advice requesters that a full blood examination is the appropriate test to monitor patients receiving oral vitamin B12 supplementation.
- Providing consumer education on the above changes.
- Review of these items after 24 months to assess the effect of the recommendations listed above. If these combined strategies prove insufficient to change behaviour then the introduction of CDS to support better requesting of vitamin B12 tests should be considered.

## Rationale

- The Committee found that overall use of vitamin B12 testing was high. Of particular concern to the Committee was the volume of the serum tests compared to the marker tests.
- From November 2014, a two test strategy for determining vitamin B12 deficiency was introduced into the MBS. Item 66838 covers serum B12 testing and is available annually. Item 66839 covers holotranscobalamin quantification (marker testing) for patients where the initial B12 test is 'low or equivocal'. There is no annual limit and this test is pathologist determinable (i.e. a pathology test that is eligible for Medicare benefits despite not being requested by the patient's medical practitioner, but performed on the basis of information learned from an originally requested service).
- The Committee found sufficient evidence to conclude that the comparative use of serum vitamin B12 testing and vitamin B12 marker testing is not as expected.
  - In 2015–16, the number of vitamin B12 marker tests (1.4 million) exceeded the number of serum vitamin B12 tests (1.2 million) (Table 3), and was greater than the usage predicted by MSAC.
  - MBS data show that the growth in service volume for vitamin B12 marker testing is high (46 per cent per year) and does not match the trend in service volume for serum vitamin B12 testing.
  - MBS data from 2015-16 to 2016-17 indicate that approximately 30 per cent of vitamin B12 marker tests were repeated in less than 12 months.
- The Committee agreed the following factors were possibly contributing to the high usage rates for vitamin B12 marker testing:
  - Low GP awareness of the MBS annual restriction on vitamin B12 testing is likely to be contributing to frequent vitamin B12 marker testing (that is, more than once every 12 months).
  - A small group of clinicians may be directly requesting the vitamin B12 markers test for patients (even though the MBS currently indicates it is not the first-line test).
  - When clinicians incorrectly request a repeat serum vitamin B12 test less than a year after the most recent serum vitamin B12 test (with the intention of requesting another serum vitamin B12 test; item 66838), laboratories may perform the vitamin B12 marker test (item 66839), which has no annual limit. In some cases, this may be



- undertaken due to a previous 'low or equivocal' vitamin B12 result. In other cases, it may be because item 66839 is unrestricted.
- Reference limits for serum vitamin B12 tests and vitamin B12 marker tests vary and are currently independently determined by each pathology laboratory. If the cut-offs are set at too high a value, this would increase the number of 'low or equivocal' results, and consequently the number of repeat vitamin B12 marker tests.
  - The Committee agreed that the 12-month frequency restriction currently in place for serum vitamin B12 testing was also appropriate for vitamin B12 marker testing to reduce inappropriate testing, given that:
    - MSAC's intention in developing a two test strategy was for vitamin B12 marker testing to be used as a second-line test in a minority of cases (14). However, at present, MBS data show that vitamin B12 marker testing outstrips serum vitamin B12 testing (Table 3). The Committee felt that this may be partly because the vitamin B12 marker test is not subject to a frequency restriction.
    - No guidelines exist to support repeat vitamin B12 testing more frequently than annually. A review by MSAC found that there is no obvious merit in rechecking levels during vitamin B12 replacement therapy as it does not contribute to patient management (unless lack of compliance is suspected or anaemia recurs) (15). Committee members noted that some specific circumstances may require more frequent monitoring of response to treatment but considered a full blood examination (FBE) the appropriate follow-up test instead of repeat serum vitamin B12 testing.
  - The Committee was of the view that as MSAC approved the use of item 66839 for 'quantification of vitamin B12 markers such as holoTranscobalamin or methylmalonic acid when the initial serum vitamin B12 test is low or equivocal' in its 2014 decision (14), they could not recommend serum vitamin B12 testing be replaced by vitamin B12 marker testing without MSAC first conducting an updated evaluation of the vitamin B12 markers test as a first-line test - which could be triggered if important new evidence became available.
  - The recommendation that vitamin B12 marker testing be undertaken on the same pathology episode that returned the initial low or equivocal serum vitamin B12 result was made to ensure that this item is used as intended, as a second-line test when the B12 serum test has returned a low or equivocal result.
  - In line with the 2014 MSAC evaluation, there was consensus that lethargy and tiredness alone were not suitable indicators for requesting of B12 testing and that this should be expressed in the explanatory note for these items.
  - Subsequent to further consideration of stakeholder feedback and this recommendation, the Committee recommends that a repeat test is allowed if the previous test is abnormal.





## 6.3 Iron studies and ferritin testing item group

### 6.3.1 Items 66596 and 66593

Table 4: Services and benefits data for items 66596 and 66593

Item	Descriptor	Schedule fee	Services FY2015/16	Benefits FY2015/16	Services 5-year annual avg. growth
66596	Iron studies, consisting of quantitation of: (a) serum iron; and (b) transferrin or iron binding capacity; and (c) ferritin	\$32.55	5,381,062	\$149,229,387	+9.2%
66593	Ferritin - quantitation, except if requested as part of iron studies	\$18.00	588,357	\$9,020,341	+8.2%

### Recommendations

- a) Change the item name and item descriptor for item 66593. The proposed item name is 'iron deficiency studies'. The proposed item descriptor is as follows:

- Item 66593: Iron deficiency studies—ferritin—quantitation.

The proposed Explanatory Note PN.0.15 in Category 6 of the MBS is as follows:

- *Where a request includes 'iron studies', 'IS', 'Fe', or 'iron' the relevant item is 66593 (iron deficiency studies), unless the request either specifies 'iron overload study' or contains clinical notes to indicate that the test is to check for iron overload.*

*A serum ferritin alone is usually sufficient for diagnosing iron deficiency; full iron studies are only necessary when iron overload is suspected. Ferritin is the most accurate test in suspected iron deficiency; serum iron adds little other than a potential misinterpretation of low levels that may lead to a misdiagnosis of iron deficiency.*

*When inflammation or infection is present, both iron studies and ferritin are unreliable indicators of iron status.*

*Re-testing of ferritin within 3 months of commencing oral iron treatment or following iron infusion is unreliable and unnecessary.*

*If:*

- i. *Ferritin or iron studies is requested, and testing indicates low ferritin (less than 30 µg/L), then item 66593 (iron deficiency studies) should be claimed and only ferritin levels reported.*
- ii. *Ferritin or iron studies is requested, and testing indicates a ferritin level above 300 µg/L, then item 66596 should be claimed and full iron studies should be performed and reported.*
- iii. *Ferritin or iron studies is requested, and testing indicates a ferritin level between 30 µg/L and 100 µg/L, only item 66593 should be billed and only ferritin reported except where there is laboratory or clinical evidence that ferritin is an unreliable test (e.g. infection or inflammation is present) then item 665XX should be claimed and full iron studies performed and reported.*



- b) Change the item name and item descriptor for item 66596. The proposed item name is 'iron overload studies'. The proposed item descriptor is as follows:

- Item 66596: Iron overload studies, consisting of quantitation of:
  - (a) serum iron; and,
  - (b) transferrin or iron binding capacity; and,
  - (c) ferritin.

This item will be pathologist-determinable if ferritin is  $>300 \mu\text{g/L}$ .

- c) Create a new item 665XX for 'exception iron studies' to allow testing of full iron studies (i.e. item 66596; iron overload studies) when there is laboratory or clinical evidence that ferritin alone is an unreliable indicator of iron status. The proposed item descriptor is as follows:

- Item 665XX: Exception iron studies, consisting of quantitation of:
  - (a) serum iron; and
  - (b) transferrin or iron binding capacity; and
  - (c) ferritin.

This item will be pathologist-determinable if:

- i. ferritin is  $>30 \mu\text{g/L}$ ; and
- ii. there is laboratory or clinical evidence that ferritin alone is an unreliable test.

The proposed explanatory note for item 665XX would aim to clarify that the initial ferritin level determines whether further testing should be performed. If testing indicates low ferritin levels (less than  $30 \mu\text{g/L}$ ), only ferritin level would be reported and only item 66593 would be claimable. However, if testing indicates a ferritin level of more than  $30 \mu\text{g/L}$  and there is laboratory or clinical evidence of inflammation or infection to suggest ferritin alone is an unreliable indicator of iron status, the full iron studies test would be performed and the exception item should be claimable (16) (17).

The Department seek advice from stakeholders on circumstances in which ferritin may be unreliable but iron studies (transferrin, iron binding capacity) can add incremental benefit and then add these scenarios to the explanatory notes for item 665XX.

It is recommended that changes to the explanatory notes be made as soon as possible, to provide a foundation for an education campaign and any required changes to practice software.

### Measures to support appropriate requesting and implementation

- Prior to making any necessary regulation change (including amending the item names), provide an education program for requesters. It is anticipated that the program would:
  - Clearly explain why the change is occurring.



- Ensure requesters are aware that a ferritin-only item exists on the MBS and should be chosen for the investigation of suspected iron deficiency (using the new item descriptor terminology of ‘iron deficiency studies’).
- Inform clinicians that both ferritin testing and iron studies are less reliable in patients with conditions that will likely confound the results. In the Committee’s clinical opinion these conditions include acute or chronic inflammation, infections, autoimmunity, liver or kidney disease and certain malignancies (16) (17) (18) (19) (20).
- The Committee noted pathology providers and the RCPA are important partners in any education program that aims to improve the clinical value of pathology requests. The Committee recommended pathology providers offer standardised feedback to requesters that supports the desired change in requester behaviour and promotes clinically targeted ferritin and iron studies requesting. For example, feedback could be provided in the comments section of pathology reports to inform requesting clinicians that:
  - From a specific date, requests for ferritin testing and iron studies need to conform to the new iron deficiency and iron overload item descriptors respectively.
  - Ferritin testing will be performed unless the request specifies ‘iron overload study’ or clearly indicates a clinical concern for iron overload, as per the updated Explanatory Note PN.0.15.
  - When a ferritin test or iron deficiency study returns a low result, the patient can commence iron supplementation. Further re-testing would be unnecessary for at least three months or while the patient is receiving iron supplementation, whichever is longer.
  - Full panel iron studies are not necessary or appropriate for investigating suspected iron deficiency (21).
- Review these items after 24 months to assess the effect of the recommendations listed above and if the current approaches are unsuccessful to change behaviour then consider strengthening CDS measures for requesting of ferritin and iron studies items.

## Rationale

- The Committee recommended that iron deficiency studies (item 66593) should be the default iron test, unless the request form indicates that the clinical suspicion is iron overload.
- The Committee found sufficient evidence to conclude there is overuse of iron studies and hold particular concern about the relative use of full panel iron studies compared to serum ferritin testing.
  - MBS data for FY2015–16 (by date of servicing) showed that 5.37 million iron studies (item 66596) were performed; this outstrips the 0.59 million ferritin tests (item 66593) that were performed in the same period (Table 4).
  - MBS data indicate that the majority (83%) of iron studies performed in 2015–16 were at the request of GPs, while specialists were more likely (1.5×) to request a specifically ferritin test.



- This contrasts sharply with national and international practice guidelines which recommend ferritin as first-line test in the detection of iron deficiency. A literature review has shown that ferritin testing was recommended in 22 guidelines worldwide due to its high specificity and accuracy, while transferrin saturation was proposed as an alternative or complementary diagnostic test for iron deficiency by 45% of guidelines (10 of 22) (22).
- MBS data indicate iron studies are commonly co-claimed with full blood counts.
- There are many reasons why a disproportionate number of iron studies are being requested in comparison to ferritin tests. The Committee agreed that these reasons include the following:
  - Many GPs are unaware that a ferritin-only MBS item exists, and that the ferritin-only item is less expensive than iron studies.
  - There is a widespread and entrenched habit of simply requesting ‘iron studies,’ even when ferritin quantitation would be the clinically indicated test for patients with lethargy or suspected iron deficiency.
  - Some clinical management software includes iron studies as the default investigation for iron deficiency. Clinicians can also designate iron studies within the software as one of their favourite tests making it easier to request than ferritin quantitation.
  - The current explanatory note (PN.0.15) may result in inappropriate use of full panel iron studies when the requesting clinician may actually be suspicious of iron deficiency.
- The Committee agreed on the following:
  - Ferritin quantitation is the preferred test for suspected iron deficiency.
  - Guidelines recommend ferritin in the detection of iron deficiency, due to its high sensitivity and specificity (23) (24) (21) (25).
  - Low ferritin levels confirm iron deficiency.
  - There is weak evidence that treating patients with fatigue (but no proven anaemia) may be beneficial (26), but there are no guidelines for the monitoring of these patients.
  - Ferritin testing can provide useful information in patients with inflammatory conditions, if interpreted appropriately. For example, a ferritin level of 50 µg/L increases the probability of iron deficiency in a patient with inflammatory disease but not in the general population (21). In addition, higher ferritin cut-off levels can also be used to predict the presence of iron deficiency in other conditions such as chronic kidney disease and heart failure (26).
  - Despite concerted efforts by pathologists and the RCPA, low serum iron levels are frequently mistaken by non-pathologists as a sign of iron deficiency despite normal or high ferritin levels, resulting in patients being inappropriately referred to specialists for endoscopy or prescribed unjustified treatment with iron supplements.
  - In a submission to the MBS Review Blood Authority Members suggested that a request for ‘Iron studies’ should generate a ferritin level as the initial test performed and reported by the laboratory. Further iron studies (done on the same sample) should only be rebatable if the ferritin level is outside the laboratory reference ranges.



- The diagnostic ability of other biomarkers such as transferrin may be nearly equal to that of ferritin, but do not appear to add further discriminant ability once the ferritin result is available (25). However, soluble transferrin receptor may have a diagnostic advantage over ferritin because it appears less affected by the presence of inflammation. The Committee was advised of a current MSAC application to list soluble transferrin receptor on the MBS.
- Elevated ferritin levels can be investigated for iron overload if appropriate.
- Suspected iron overload is the only clinical situation where iron studies are clearly needed.
- If patients have a febrile illness, inflammation or possible acute phase response, the results of both ferritin quantitation and iron studies will be affected. As a result, iron testing should be avoided because clinical interpretation of such tests will be difficult in these patients.
- Although genetic predisposition to haemochromatosis is common, clinical disease that requires treatment is less common (about 1 in 300 in Australia) (27). The Committee held the view that screening populations for conditions of iron overload (for example, haemochromatosis) using iron-related tests was not clinically indicated. However, when haemochromatosis is suspected full iron studies (iron overload studies) should be performed.
- The above recommendations are an adaptation of the GPPCCC's proposal to the Committee to make ferritin the default test for the investigation of suspected iron deficiency, a position supported by the Blood Products Working Group and the Patient Blood Management Steering Committee National Blood Authority, 2015 (24).
- Regarding the item descriptor changes for items 66593 and 66596, the Committee agreed that:
  - Simply changing the names of the tests in the item descriptors may modify requester behaviour by intrinsically providing education regarding the selection of the appropriate test given the clinical context, and therefore should increase the requesting of ferritin testing over full iron studies, where clinically appropriate.
  - These proposed changes will address the Committee's primary concern of clinicians requesting full iron studies when ferritin alone would be more appropriate and then misinterpreting the result resulting in overtreatment for patients.
  - Suspected iron overload is the only appropriate clinical indication for full panel iron studies (to be referred to as 'iron overload studies' if the proposed item descriptors are introduced).
- Regarding the change to regulation and supporting Explanatory Note PN.0.15, the Committee agreed that:
  - The current note is misleading because it guides clinicians to use full panel iron studies as the default iron test in cases of ambiguous requests. This may be contributing to high (and potentially inappropriate) use of item 66596.
  - The proposed change should result in ferritin quantitation being performed more often and accounting for a greater proportion of iron-related tests. The ferritin result would be useful regardless of whether the patient actually has iron deficiency or iron overload. An iron overload study (currently referred to as full panel iron studies) can be requested subsequently on the same sample, if clinically needed.



- Regarding the three-month frequency restriction in cases of suspected/confirmed iron deficiency, the Committee agreed:
  - There is no clinical indication for re-testing a patient while they are receiving iron replacement or within three months of an iron infusion.
  - The three-month restriction period allows adequate time for the trial of iron replacement to replenish the patient's iron stores (20). Indeed, it is recommended that therapy be provided for three months, then stopped for two weeks, before repeat testing is performed (20). Tests performed in a shorter time period would not be a true reflection of iron status because results are likely to be artificially elevated by supplementation.
  - A full blood examination (FBE) is the appropriate test if the requesting clinician wishes to assess response to therapy in an anaemic patient (looking for increased reticulocytes).
- Regarding the recommendations that iron testing should not be requested in patients with conditions that artificially elevate ferritin, the Committee agreed:
  - RCPA guidelines (23) advise that ferritin quantitation should only be repeated when the inflammation (one cause of artificial elevation of ferritin) has resolved.
- Additional measures to reinforce the introduction of the new item descriptors (for example, those that enable ferritin quantitation to be the default test) are required because:
  - The implementation timeframe for the new item descriptors may be prolonged.
  - Requesting clinicians may not be guided by the new item descriptor terminology for the following reasons:
    - They may override iron studies recommendations offered by their electronic medical software.
    - Some may use free-text methods (for example, handwritten request forms).
    - They may ignore or forget about the change.
    - They may not update their list of favourite/commonly requested iron tests.
  - Software vendors may not fully and/or correctly implement the item descriptor updates.
- The creation of a new item (665XX) for 'exception iron studies' to allow testing of full iron studies in situations when ferritin alone is an unreliable indicator of iron status will require requesters to consider their reasons for requesting full iron studies over ferritin alone and provide evidence indicating ferritin alone may be an unreliable indicator of iron status and that there would be an incremental benefit to performing full iron studies as opposed to ferritin alone.



## 6.4 Folate

### 6.4.1 Item 66840

**Table 5: Services and benefits data for items 66840**

Item	Descriptor	Schedule fee	Services FY2015/16	Benefits FY2015/16	Services 5-year annual avg. growth
66840	Serum folate test and, if required, red cell folate test for a patient at risk of folate deficiency, including patients with malabsorption conditions, macrocytic anaemia or coeliac disease	\$23.60	736,137	\$14,667,967	N/A

Note: Until 1 November 2014, folate testing was coupled with vitamin B12 testing under a joint item number on the MBS.

#### Recommendations

- a) Change the item descriptor for item 66840 (serum folate test) to provide greater clarity. The proposed item descriptor is as follows:
  - Serum folate test and, if required, red cell folate test for patients with malabsorption conditions, or malnutrition or macrocytosis.
- b) Apply a 12-month frequency restriction to item 66840; however, repeat testing within 12 months may be allowed if the result of the previous test was outside of the 95% laboratory reference limit for folate testing (in order to confirm folate deficiency when an initial folate result is low).
- c) Add an explanatory note to item 66840 that clarifies which patients may require folate testing. The proposed explanatory note is as follows:

*Folate testing is only required for patients with macrocytosis, malnutrition or malabsorption issues such as coeliac disease and other small bowel pathology.*

*The following groups of patients should receive folate supplementation and do not require testing:*

- ☐ *Pregnant women or those planning pregnancy*
  - ☐ *Patients receiving methotrexate therapy.*
- In addition the Committee recommended:
  - Provide education to requesting clinicians that communicates details of the changed item descriptor. The Committee recommended that pathology laboratories should include a standard message encouraging appropriate folate testing on pathology reports provided to requesting clinicians. The Committee recommended the RCPA develop this message.
  - Although difficult, establish nationally harmonised serum folate reference limits to provide a consistent definition of what constitutes a low or equivocal serum folate result.

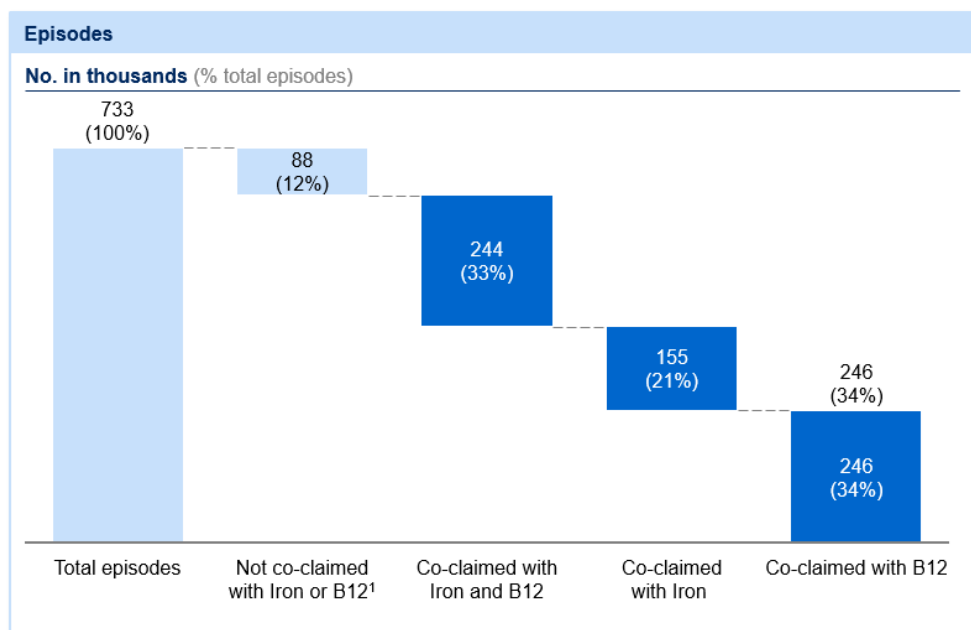


- Review the impact of the above recommendations 12 months after implementation. In the event of no/minimal change in requesting behaviour, the Committee recommended:
  - Mandating that requesting clinicians specify the reason for their request (that is, malabsorption, malnutrition or macrocytosis) through a mandatory electronic decision support system or structured pathology request form. It is acknowledged that any form of mandatory decision support must allow clinicians to request unsupported tests, however justification must be provided and such requests should be subject to audit.
  - Consideration of further requesting restrictions.

### Rationale

- The Committee found sufficient evidence to conclude that inappropriate overuse of folate testing is occurring.
  - Folate deficiency is rare in Australia (28) because of mandatory folate fortification of wheat flour (29).
  - Twenty-eight per cent of tests are conducted within 12 months of an initial test, despite there being no need for repeating folate quantification once treatment is commenced unless the patient remains symptomatic or if anaemia reoccurs (10).
  - Despite a review by MSAC and an item descriptor change in 2014, MBS data shows annual growth in folate testing continues to increase.
  - MBS data shows that 88 per cent of tests are co-claimed with either iron or vitamin B12 testing, and 67 per cent are co-claimed with vitamin B12 testing, and therefore may be requested out of habit rather than clinical necessity (Figure 5).

**Figure 5: Rates of folate co-ordering with iron and vitamin B12**



<sup>1</sup> "Iron" includes items for ferritin (66593) and iron studies (66596); B12 includes items for B12 (66838) and B12 markers (66839)

**Source:** MBS data FY 15/16. Date of servicing





- The Committee agreed on the following:
  - Breaking the connection between vitamin B12 and folate testing is essential to reduce overuse of folate testing. Except in the context of proven macrocytosis, the clinical indications for testing B12 and folate are quite different.
  - There is no clinical requirement for folate testing to be repeated within 12 months of initial testing. Patients with macrocytosis do not benefit from repeat folate testing, instead a full blood examination (FBE) including mean cell volume (MCV) adequate.
  - Once folate deficiency is confirmed, treatment should be commenced; however, repeat folate testing to monitor response to treatment is not clinically necessary and rarely contributes to patient management (10).
  - Folate testing should be limited to specific at-risk populations or when macrocytosis is proven. However, the current item restrictions which reflect this appear to have had little impact on the practices of requesting clinicians. The Committee recommended removing the phrase 'at risk of folate deficiency' from the current item descriptor because it may lead to over-testing and felt that only patients with macrocytosis or malabsorption conditions should be tested.
  - Folate supplementation is recommended for all pregnant women in the first trimester and even for those planning pregnancy making testing unnecessary.



## 6.5 Urine testing item group

### 6.5.1 Items 69300, 69333 and 73085

Table 6: Services and benefits data for items 69300, 69333 and 73085

Item	Descriptor	Schedule fee	Services FY2015/16	Benefits FY2015/16	Services 5-year annual avg. growth
69300	Microscopy of wet film material other than blood, from 1 or more sites, obtained directly from a patient (not cultures) including: a) differential cell count (if performed); or b) examination for dermatophytes; or c) dark ground illumination; or d) stained preparation or preparations using any relevant stain or stains'  1 or more tests	\$12.50	22,239	\$231,054	9.2%
69333	Urine examination (including serial examination) by any means other than simple culture by dip slide, including: a) cell count; and b) culture; and c) colony count; and d) (if performed) stained preparations; and e) (if performed) identification of cultured pathogens; and f) (if performed) antibiotic susceptibility testing; and g) (if performed) examination for pH, specific gravity, blood, protein, urobilinogen, sugar, acetone or bile salts	\$20.55	4,520,369	\$78,614,348	4.8%
73085	Microscopy of urine, whether stained or not, or catalase test  NB: Group P9 – Simple Basic Pathology Tests - These are simple basic pathology services which are included in Group P9 and may be performed by a medical practitioner in the practitioner's surgery without the need to obtain Approved Pathology Authority, Approved Pathology Practitioner or Accredited Pathology Laboratory status.	\$4.55	134,481	\$525,844	1.2%



## Recommendations

- a) Change the descriptor of item 69333 to reflect the Committee's position that the urine of asymptomatic patients should not be tested, with the exception of:
  - Pregnant women
  - Children (under the age of 16)
  - Patients undergoing urinary tract instrumentation or urological procedures, including for stone disease such as urolithiasis and nephrolithiasis
  - Men undergoing transurethral resection of the prostate
  - Recipients of renal transplants
  - Patients undergoing haemodialysis for chronic kidney disease
  - Patients with delirium with fever.
- b) Add the following text to the descriptor of item 69333:
  - This item is limited to: (a) patients who have symptoms of a urinary tract infection or: (b) pregnant women; or (c) children aged less than 16 years; or those who have (d) received a renal transplant; or (e) or those who are undergoing: (f) haemodialysis for chronic kidney disease; or (g) urinary tract instrumentation or other urological procedures, including for stone disease such as urolithiasis and nephrolithiasis; or (h) transurethral resection of the prostate. No microscopy or culture should be undertaken for patients who are asymptomatic, except those as noted above.
- c) Add an explanatory note to provide further clarification on the recommendation that the urine of asymptomatic patients should not be tested. The proposed explanatory note is as follows:
  - *Urine microscopy and culture using Item 69333 should only be undertaken for patients with symptoms of a urinary tract infection, or when clinically indicated for the following asymptomatic patients:*
    - ☐ *Pregnant women*
    - ☐ *Children (under age 16 year olds)*
    - ☐ *Patients undergoing urinary tract instrumentation or urological procedures, including for stone disease such as urolithiasis and nephrolithiasis*
    - ☐ *Men undergoing transurethral resection of the prostate*
    - ☐ *Recipients of renal transplants*
    - ☐ *Patients undergoing haemodialysis for chronic kidney disease*

*Abnormalities on urine dipstick testing are not 'symptoms' and should not of themselves lead to urine culture using MBS item 69333.*

*Urine microscopy and culture should not be performed to check clearance of infection in the absence of continuing symptoms.*



- In addition, the Committee recommended:
  - The launch of an education campaign with the aim of changing requesting habits around item 69333. The campaign should target:
    - Requesting clinicians through their respective peak post-graduate medical colleges (such as Royal Australian College of General Practitioners [RACGP], Royal Australasian College of Physicians [RACP] and Royal Australian College of Surgeons [RACS]).
    - Staff working in aged care facilities, with the message that routine urine screening in elderly patients is inappropriate and likely to cause harm. Education should include information on how to identify symptoms in elderly patients.
    - Nurses, nurse practitioners, nursing assistants and patient care assistants in all healthcare facilities.
    - Clinicians who request at rates significantly higher than the average.
  - Provide software providers with clinical indication information that can be easily and accurately transferred into codes and specific wording for GP CDS software.
  - Provide consumer education to raise awareness about the methods used to collect urine sample and the importance of minimising the possibility of contamination.
  - Review this item after 24 months to assess the effect of the recommendations listed above and if the recommended changes are unsuccessful in changing behaviour then consider further changes for the requesting of urine testing.
- Items 69300 and 73805: No change.

### Rationale

- The Committee noted that inappropriate overuse of urine testing is almost certainly occurring for the following reasons:
  - Some clinicians (both GPs and specialists) routinely request urine tests for many asymptomatic patients.
  - In aged care facilities, it is common practice to regularly screen residents' urine.
  - Health screens often include some form of urine testing.
  - Tests are at times repeated for some patients for 'proof of cure/successful treatment' which is not clinically necessary.
  - Some clinicians inappropriately investigate urinary incontinence using urine testing.
  - MBS data shows that urine examination (culture) is used 28 times more often than the microscopy item alone, and its usage is growing, while usage of the microscopy-only item declines.
  - MBS data also shows that approximately 93,000 patients (3.4 per cent of total patients receiving this test within one year), receive at least one repeat test within 7 days of the first test.
- The Committee's position is that there is no benefit to treating patients with asymptomatic bacteriuria (except for the groups of patients noted above), and therefore no reason for investigating with urine testing. This position is supported by multiple Australian and international guidelines and publications (30) (31) (32) (33).



- The Committee noted that urine culture in a patient without symptoms of a urinary tract infection may reveal asymptomatic bacteriuria. This may lead to antibiotic treatment, despite evidence showing that antibiotic treatment provides no benefit (except for the groups of patients noted above). The Committee further noted that this treatment represents poor antibiotic stewardship, posing risks to the individual patient and the community by increasing antibiotic resistance.
- The patient subgroups listed as exceptions in the new explanatory note and item descriptor for item 69333 are high-risk groups (34) (35) (36) (37) (38) (39) for whom the finding of bacteriuria—even in the apparent absence of clinical symptoms—may warrant treatment to avoid potentially serious consequences. For example, children may have structural renal or urinary tract abnormalities that may predispose them to serious infections.
- The Committee acknowledged that poor collection of the urine sample, particularly contamination by skin flora, was a factor in repeat testing which would need to be addressed through further education activities.



## 6.6 Vitamin D item group

### 6.6.1 Vitamin D items

**Table 7: Services and benefits data for items 66833, 66835, 66836, 66834 and 66837**

Item	Descriptor	Schedule fee	Services FY2015/16	Benefits FY2015/16	Services 5-year annual avg. growth
66833	<p>25-hydroxyvitamin D, quantification in serum, for the investigation of a patient who:</p> <p>(a) has signs or symptoms of osteoporosis or osteomalacia; or</p> <p>(b) has increased alkaline phosphatase and otherwise normal liver function tests; or</p> <p>(c) has hyperparathyroidism, hypo- or hypercalcaemia, or hypophosphataemia; or</p> <p>(d) is suffering from malabsorption (for example, because the patient has cystic fibrosis, short bowel syndrome, inflammatory bowel disease or untreated coeliac disease, or has had bariatric surgery); or</p> <p>(e) has deeply pigmented skin, or chronic and severe lack of sun exposure for cultural, medical, occupational or residential reasons; or</p> <p>(f) is taking medication known to decrease 25OH-D levels (for example, anticonvulsants); or</p> <p>(g) has chronic renal failure or is a renal transplant recipient; or</p> <p>(h) is less than 16 years of age and has signs or symptoms of rickets; or</p> <p>(i) is an infant whose mother has established vitamin D deficiency; or</p> <p>(j) is a exclusively breastfed baby and has at least one other risk factor mentioned in a paragraph in this item; or</p>	\$30.05	2,889,151	\$73,920,683	N/A



Item	Descriptor	Schedule fee	Services FY2015/16	Benefits FY2015/16	Services 5-year annual avg. growth
	(k) has a sibling who is less than 16 years of age and has vitamin D deficiency				
66835	1, 25-dihydroxyvitamin D - quantification in serum, if the request for the test is made by, or on advice of, the specialist or consultant physician managing the treatment of the patient	\$39.05	9,465	\$313,583	N/A
66836	1, 25-dihydroxyvitamin D-quantification in serum, if:  (a) the patient has hypercalcaemia; and  (b) the request for the test is made by a general practitioner managing the treatment of the patient	\$39.05	160	\$5,172	N/A
66834	A test described in item 66833 if rendered by a receiving APP  (Item is subject to Rule 18)	\$30.05	1,400	35,473	N/A
66837	A test described in item 66835 or 66836 if rendered by a receiving APP (Item is subject to Rule 18)	\$39.05	2,111	69,762	N/A

## Recommendations

- a) Change the descriptor for item 66833 to simplify the information regarding the clinical circumstances in which the item should be requested, and to clarify that vitamin D testing is only required for a patient who has, or is at risk of having, both vitamin D deficiency and bone disease. The proposed item descriptor is as follows:
  - 25-hydroxyvitamin D, quantification in serum for the initial investigation of a patient who has, or is at increased risk of having, both vitamin D deficiency and bone disease.
- b) Create an explanatory note for item 66833 that explains who is at risk of bone disease and vitamin D deficiency. The proposed explanatory note is as follows:

### ***At risk of bone disease:***

*(a) Has signs or is at high risk of osteoporosis or osteomalacia (such as family history); or*

*(b) Has increased alkaline phosphatase and otherwise normal liver function tests; or*



- (c) Has hyperparathyroidism, hypo- or hypercalcaemia, or hypophosphatemia; or*
- (d) Is suffering from malabsorption (for example, because the patient has cystic fibrosis, short bowel syndrome, inflammatory bowel disease or coeliac disease, or has had bariatric surgery); or*
- (e) Has chronic renal failure or is a renal transplant recipient; or*
- (f) Is less than 16 years of age and has signs or symptoms of rickets.*

**At risk of vitamin D deficiency:**

- (a) Has deeply pigmented skin, or chronic and severe lack of sun exposure for cultural, medical, occupational or residential reasons; or*
- (b) Is taking medication known to decrease 25OH-D concentrations (for example, anticonvulsants); or*
- (c) Is an infant whose mother has known vitamin D deficiency; or*
- (d) Is an exclusively breastfed baby and has at least one other risk factor mentioned in a paragraph in this item; or*
- (e) Has a sibling who is < 16 years of age and has vitamin D deficiency; or*
- (f) Has osteoporosis or osteomalacia*

*This test should not be used for general screening or fatigue.*

- c) Apply a 12-month frequency restriction to item 66833 (25-hydroxyvitamin D – quantification in serum). A repeat test can be claimed under new item 668XX if the previous test is abnormal.
- d) Create a new item (668XX) to allow for quarterly monitoring of vitamin D testing in patients with both confirmed vitamin D deficiency and bone disease. This item should have a three-month frequency restrictor. The proposed item descriptor is as follows:
  - 25-hydroxyvitamin D, quantification in serum, for the investigation of a patient who has (1) vitamin D deficiency AND (2) has, or is at high risk of, bone disease. Item is subject to rule 25 (f). \*NB: item is subject to Rule 25: for any particular patient, this item is applicable not more than once in a 12-month period unless the previous test was abnormal that is below the laboratory reference limits for Vitamin D (in order to confirm Vitamin D deficiency when a previous Vitamin D result is low).
- In addition the Committee recommended:
  - The Department seek advice from stakeholders or MSAC and systematically review the literature in order to develop clear national standards for defining vitamin D deficiency by specific serum levels which would be used to drive clinical treatment decision making and the need for repeat testing (40).
  - Provide requester education on appropriate testing frequency. The Committee recommended that this include feedback from providers to requesters noting that Medicare does not cover testing more frequently than once every 12 months (item 66833), unless claimed under new item 668XX for patients with vitamin D deficiency and bone disease.





- Provide consumer education on the above changes. Requesters should be equipped to provide patients with information about why Medicare does not cover testing more frequently than once every 12 months (item 66833), unless claimed under new item 668XX.
- The Committee acknowledged that the MSAC completed a review of vitamin D items in 2014, but it recommended a further review to gather up-to-date information on vitamin D testing requirements/necessity, with the intention of making subsequent recommendations. The Committee felt the review should include emerging clinical evidence regarding vitamin D deficiency, the role of repeat testing in its management and investigation of the following:
  - Clinical trials assessing the effect of vitamin D supplementation and repeat testing stratified by initial vitamin D blood concentrations (mild to moderate) to establish the value of supplementation and monitoring for different levels of vitamin D (41) (42).
  - Health results associated with vitamin D, including falls, fatigue, osteoporosis, osteopaenia, diabetes, autoimmune disease and malignancies.
  - Any evidence that testing within three months of starting treatment is beneficial, particularly considering annual/seasonal variations in levels.
  - Frequency of retesting if supplementation is not occurring.
- e) Review this item after 24 months to assess the effect of the recommendations listed above and if the recommended changes are unsuccessful in changing behaviour then consider the introduction of CDS for requesting of vitamin D tests.
- Items 66834, 66835, 66836 and 66837: No change.

### Rationale

- A recent MSAC review (which concluded in 2014) resulted in item descriptor and pricing changes which were intended to reduce the number of vitamin D tests conducted each year. However, the Committee found sufficient evidence to conclude that overall use of vitamin D testing is still higher than expected:
  - MBS data shows that approximately 38 per cent of MBS funded vitamin D tests were repeated in less than 12 months. Furthermore, rates of repeat testing appear to be growing from year-to-year.
  - MBS data also shows that although testing volumes initially declined following the introduction of new items with specific AUC in November 2014, testing volumes have started to stabilise and have even increased in recent months (compared to the previous year's equivalent month).
  - MBS data shows that there is higher-volume testing in females, and a peak in testing for women aged 25–39 in particular; however, the Committee believe there is no apparent need for such a spike in testing rates.
- The current literature demonstrates that vitamin D supplementation has limited clinical benefit, and only supports supplementation in at-risk patients (42) (41).
- There was consensus that the extensive list of inclusions for vitamin D testing in the current item descriptor (including non-specific clinical indicators) may be leading to confusion and over-testing of vitamin D levels.



- The Committee agreed that there is no clinical need to test vitamin D levels more than once every 12 months, unless patients have chronic kidney disease, osteoporosis, osteopaenia or rickets (43). None of the current guidelines support more frequent testing in non-risk populations.
- The clinical benefit of vitamin D supplementation appears to be limited, and the current literature only supports supplementation in at-risk patients (42) (41). Even in this subpopulation, there is no clear guidance about the specific vitamin D blood concentrations that should be targeted by supplementation (44). Furthermore, vitamin D assays can vary by as much as 10–20 per cent, even when repeating the test in the same person at the same time (45), meaning that detecting variation in the effect of vitamin D supplements can be problematic in some cases and that there is no clinical need to re-test more than once every 12 months.
- Repeat testing should not be performed unless there has been a change in the patient's risk factor profile. Despite this, MBS data indicates at least 490,000 patients received at least one repeat test within six to 12 months of an initial test in 2015-16.
- The most current systematic review shows that vitamin D possibly reduces the rate of falls but only by a very small amount. However, for those with osteoporosis, the effect of vitamin D on bone mineral density coupled with the possible effect on falls is more significant (45).



## 6.7 Prostate-specific antigen item group

### 6.7.1 Items 66655, 66656, 66659 and 66660

Table 8: Services and benefits data for items 66655, 66656, 66659 and 66660

Item	Descriptor	Schedule fee	Services FY2015/16	Benefits FY2015/16	Services 5-year annual avg. growth
66655	Prostate specific antigen - quantitation - 1 of this item in a 12 month period (Item is subject to rule 25)	\$20.15	675,488	\$11,589,143	-5.05%
66656	Prostate specific antigen - quantitation in the monitoring of previously diagnosed prostatic disease (including a test described in item 66655)	\$20.15	796,476	\$13,680,453	5.92%
66659	Prostate specific antigen - quantitation of 2 or more fractions of PSA and any derived index including (if performed) a test described in item 66656, in the follow up of a PSA result that lies at or above the age related median but below the age related, method specific 97.5% reference limit - 1 of this item in a 12 month period  (Item is subject to rule 25)	\$37.30	112,825	\$3,590,005	4.77%
66660	Prostate specific antigen - quantitation of 2 or more fractions of PSA and any derived index including (if performed) a test described in item 66656, in the follow up of a PSA result that lies at or above the age related, method specific 97.5% reference limit, but below a value of 10 µg/L - 4 of this item in a 12 month period.  (Item is subject to rule 25)	\$37.30	1,683,449	\$1,770,222	1.01%

### Recommendations

- a) **Change the frequency restriction for item 66655 to allow one PSA quantitation in a 23-month period.** This aligns with the guidelines created by the Prostate Cancer Foundation and the Cancer Council of Australia, which have been endorsed by the NHMRC (46). The proposed item descriptor is as follows:
- Prostate specific antigen – quantitation in the monitoring of previously diagnosed prostatic disease (including an abnormal test described in item 66655) (see explanatory note) – 1 of this item in a 23 month period.



- b) For item 66656, Add 97.5% to explanatory note regarding abnormal PSA (i.e. previously diagnosed prostate disease includes prostate cancer, prostatitis and premalignant conditions such as atypical small acinar proliferation. Elevated PSA levels (above the 97.5th age related upper reference limit) can be monitored using this item. This item is not to be used for monitoring of benign prostatic hypertrophy.)
- c) For item 66659, Prostate specific antigen – quantitation of 2 or more fractions of PSA and any derived index in the follow up of previous PSA result in 66655 that is greater than 3.0 µg/L and up to 5.5 µg/L. Note: a lower threshold may be applied to men with twice or more the average risk. See explanatory note.
- d) **Change the descriptor for item 66659 and clarify that this test should be requested when following up a previous PSA result (item 66655) that is greater than 3.0 µg/L and up to 5.5 µg/L** to align with the Prostate Cancer Foundation and Cancer Council of Australia guidelines. The item descriptor should also note that a lower threshold of 2.0 µg/L may apply to men with twice the average risk, and it should refer to the Prostate Cancer Foundation and Cancer Council of Australia guidelines included in the explanatory note. The proposed item descriptor is as follows:
- Prostate specific antigen – quantitation of 2 or more fractions of PSA and any derived index in the follow up of previous PSA result in 66655 that is greater than 3.0 µg/L and up to 5.5 µg/L. Note: a lower threshold of 2.0 µg/L may be applied to men with twice the average risk. See the Prostate Cancer Foundation and the Cancer Council of Australia guidelines to risk levels included in the explanatory note.
- e) **Change the descriptor for item 66660.** The proposed item descriptor is as follows:
- Prostate specific antigen – quantitation of 2 or more fractions of PSA and any derived index including (if performed) a test described in item 66656, in the follow up of a PSA result that lies
- Above 3.0 ug/L for men under 70 years of age (or lower in men with family history as described in explanatory note),
  - Below 10.0 ug/L for men under the age of 70 years (or below 5.5 ug/L for men at or above 70 years of age)
- 4 of this item in a 12 month period. (Item is subject to rule 25)
- f) **Create an explanatory note for items 66655, 66656, 66659 and 66660 to communicate that guidelines** created by the Prostate Cancer Foundation of Australia and the Cancer Council of Australia, which are endorsed by the NHMRC, the RACGP and the Urological Society of Australia and New Zealand (USANZ), **recommend offering testing from age 50 to informed men** (that is, men who have been informed of the risks and benefits of testing) **who wish to be screened for prostate cancer, and that a result over 3.0ng/mL should be followed up with a repeat PSA in one to three months, including a free-to-total PSA ratio.**



The proposed explanatory note is as follows:

- *The Prostate Cancer Foundation and the Cancer Council of Australia guidelines endorsed by the NHMRC, RACGP, USANZ for PSA testing (available here: [at http://www.prostate.org.au/awareness/for-healthcare-professionals/clinical-practice-guidelines-on-psa-testing/](http://www.prostate.org.au/awareness/for-healthcare-professionals/clinical-practice-guidelines-on-psa-testing/)) recommend that informed men wishing to undertake PSA testing for prostate cancer be offered testing from age 50 onwards and that a PSA result over 3.0 ng/mL be followed up with a repeat PSA in 1 to 3 months including a free to total PSA ratio.*
- *Different thresholds apply to younger men with a family history of prostate cancer and are detailed in the endorsed guidelines with a summary of relative risk provided below:*

Level of family history of prostate cancer	Relative risk for prostate cancer death <sup>1</sup>
<b>1 First degree relative</b>	
Father diagnosed	1.8
Father diagnosed age < 60 years	2.1
Father died	2.0
Brother diagnosed	2.8
Brother diagnosed age < 60 years	3.3
Brother died	2.8 <sup>2</sup>
<b>2 First degree relatives</b>	
Father and brother diagnosed	3.0
2 brothers diagnosed	6.3
Father and brother both died	6.9
<b>3 First degree relatives</b>	
Father and 2 brothers diagnosed	9.7
3 brothers diagnosed	8.1

- 1 **Create an explanatory note for item 66656 to clarify that ‘previously diagnosed prostatic disease’ does not include benign prostatic hypertrophy;** however, elevated (abnormal) PSA levels can be monitored using item 66656. The proposed explanatory note is as follows:
  - Previously diagnosed prostate disease includes prostate cancer, prostatitis and premalignant conditions such as atypical small acinar proliferation. Elevated PSA levels (above the 97.5<sup>th</sup> age related upper reference limit) can be monitored using this item. This item is not to be used for monitoring of benign prostatic hypertrophy.



- In addition the Committee recommended:
  - Provide requester education to ensure that all clinicians are familiar with the Prostate Cancer Foundation and Cancer Council of Australia guidelines, which have been endorsed by the NHMRC. This could be enhanced through feedback from providers to requesters.
  - Provide consumer education on the above changes.
  - If requester education strategies prove insufficient to change behaviour then the Committee recommended the consideration of CDS for PSA testing.

### Rationale

- These recommendations focus on ensuring that MBS services represent best practice and value for the consumer and the health system, in line with clinical recommendations.
- The recommended changes to item descriptors and frequency restrictions reflect current recommendations by the Prostate Cancer Foundation and Cancer Council of Australia, endorsed by the NHMRC. The Committee agreed that these recommendations reflect best clinical practice.
- There are different thresholds for younger men with a family history of prostate cancer. These are detailed in the endorsed guidelines. Due to the multitude of factors that were taken into consideration when determining these thresholds, the Committee agreed that the item descriptor should reference the guidelines, rather than attempt to capture all the factors.
- The proposed explanatory note for item 66656 is intended to provide further clarity regarding the circumstances in which this item should be used. The literature states that PSA should be monitored in patients with prostate cancer, prostatitis and premalignant conditions such as atypical small acinar proliferation (47). Elevated (abnormal) PSA levels can be monitored using item 66656.
- The Committee recommended a change to the descriptor of item 66660 to align the item with the above mentioned guidelines and the new Multiparametric Magnetic Resonance Imaging items (63541, 63542, 63543 and 63544), which suggest follow up is different for patients aged less than and over 70 years.



## 7. Diagnostic imaging item recommendations

### Introduction

Between March and August 2017, the Committee considered four referred diagnostic imaging item groups, which accounted for 1.9 million services and \$405.5 million in benefits paid in FY2015–16. Recommendations are based on evidence and the clinical expertise of the Committee. The item-level recommendations are described below.

The Committee's recommendations for public consultation include the introduction of CDS to guide the appropriate use of diagnostic imaging, as well as item-level changes. The changes focus on encouraging best practice, modernising the MBS to reflect contemporary practice, and ensuring that MBS services provide value for the consumer and the healthcare system. In addition to the non-MBS mechanisms discussed in Section 4, MBS mechanisms for achieving these goals include:

- Deleting items that are obsolete.
- Consolidating or splitting items to reflect contemporary practice.
- Modernising item descriptors to reflect best practice.
- Providing clinical guidance for appropriate use through explanatory notes.

The recommendations are organised by item group.

### 7.1 Ankle/hind foot ultrasound

#### 7.1.1 Items 55836, 55837, 55838 and 55839

**Table 9: Services and benefits data for items 55836, 55837, 55838 and 55839**

Item	Descriptor	Schedule fee	Services FY2015/16	Benefits FY2015/16	Services 5-year annual avg. growth
55836	ANKLE OR HIND FOOT, 1 or both sides, ultrasound scan of, where: (a) the service is not associated with a service to which an item in Subgroups 2 or 3 of this Group applies; and (b) the referring practitioner is not a member of a group of practitioners of which the providing practitioner is a member (R)	\$109.10	166,063	\$16,860,221	16.91%



Item	Descriptor	Schedule fee	Services FY2015/16	Benefits FY2015/16	Services 5-year annual avg. growth
55837	ANKLE OR HIND FOOT, 1 or both sides, ultrasound scan of, where: (a) the service is not associated with a service to which an item in Subgroups 2 or 3 of this Group applies; and (b) the referring practitioner is not a member of a group of practitioners of which the providing practitioner is a member (R) (NK)	\$54.55	2	\$70.00	N/A
55838	ANKLE OR HIND FOOT, 1 or both sides, ultrasound scan of, where: (a) the service is not associated with a service to which an item in Subgroups 2 or 3 of this Group applies; and (b) the patient is not referred by a medical practitioner (NR)	\$37.85	2,963	\$102,341	20.67%
55839	ANKLE OR HIND FOOT, 1 or both sides, ultrasound scan of, where: (a) the service is not associated with a service to which an item in Subgroups 2 or 3 of this Group applies; and (b) the patient is not referred by a medical practitioner (NR) (NK)	\$18.95	11	\$177	N/A

### Recommendations

- a) Change the item descriptors for items 55836, 55837, 55838 and 55839 to reflect the Committee's position that ankle ultrasound should only be used for the assessment of suspected conditions other than acute ligament injury. The proposed item descriptor is as follows:
  - ANKLE OR HIND FOOT, 1 or both sides, ultrasound scan of, where the service is provided for the assessment of suspected conditions other than acute ligament injury.
- b) Create an explanatory note detailing the AUC for ankle ultrasound, accompanied by an education campaign. The explanatory note should detail that ultrasound is not to be used when there is suspicion of ligament damage. The proposed explanatory note is as follows:
  - Ultrasound of the ankle or hind foot is only required for patients with suspected tendon or tendon sheath abnormality. Suspected ligament damage or abnormality is not a reason to request this item.
- In addition the Committee recommended:
  - If use of ankle ultrasound does not decrease during the 24 months after the change, restrict the co-requesting of ankle X-ray and ultrasound on the same day, and consider mandatory CDS.





- Deliver provider education on the appropriate imaging pathways for ankle ultrasound. The Committee noted that imaging providers play a key role in educating requesters through their ongoing communication and feedback.
- Provide requester education on appropriate pathways for ankle imaging. The Committee recommended that this include feedback to providers who request ankle ultrasound at higher rates than their peers.
- Provide consumer education on the above changes. Requesters should be equipped to provide patients with information about when ultrasound of the ankle is appropriate, and when it would not change treatment pathways.

### Rationale

- The Committee found sufficient evidence to conclude that ankle ultrasound is being inappropriately overused:
  - Use of ultrasound for ankle/hind foot injuries has been growing rapidly. Services per capita are increasing by 16 per cent annually, resulting in 18 per cent annual growth in benefits.
  - Most clinically significant acute ankle injuries can be diagnosed based on consumer history, examination and selective use of plain radiography. Deciding whether to perform imaging for acute ankle trauma can be safely guided by the Ottawa Ankle Rules (48) which do not recommend ultrasound for ankle trauma.
  - Thirty-five per cent of ankle ultrasounds occur on the same day as an ankle X-ray. The Committee does not believe that there is a clinical rationale for requesting an X-ray and an ultrasound of the ankle at the same time. There is a concern that this reflects clinical uncertainty and a lack of confidence, and that imaging is not being used as a specific and targeted diagnostic test to look for a specific result that can inform management.
  - It is the independent clinical view of this Committee that the results of ankle/hind foot ultrasound would not change the treatment pathway in instances of suspected ligament damage.
- The Committee agreed that ankle ultrasound is only clinically required when investigating Achilles tendon injury and chronic tendon pathologies.
- The Committee agreed that changing the item descriptor, creating an explanatory note and, if required, introducing mandatory CDS were appropriate actions for reducing overuse of ankle ultrasound. It noted that ultrasound of the ankle for reasons other than suspected tendon or tendon sheath damage does not change treatment pathways or injury management.



## 7.2 Shoulder ultrasound

### 7.2.1 Items 55808, 55809, 55810 and 55811

Table 10: Services and benefits data for items 55808, 55809, 55810 and 55811

Item	Descriptor	Schedule fee	Services FY2015/16	Benefits FY2015/16	Services 5-year annual avg. growth
55808	<p>Ultrasound scan of shoulder or upper arm (1 or both sides), where: (a) the service is not associated with a service to which an item in Subgroups 2 or 3 of this Group applies; and (b) <b>the referring practitioner</b> is not a member of a group of practitioners of which the providing practitioner is a member, and where the service is provided, for the assessment of one or more of the following conditions or suspected conditions:</p> <ol style="list-style-type: none"> <li>1. evaluation of injury to tendon, muscle or muscle/tendon junction; or</li> <li>2. rotator cuff tear/calcification/tendinosis (biceps, subscapular, supraspinatus, infraspinatus); or biceps subluxation; or</li> <li>3. capsulitis and bursitis; or</li> <li>4. evaluation of mass including ganglion; or</li> <li>5. occult fracture; or</li> <li>6. acromioclavicular joint pathology. (R)</li> </ol>	\$109.10	474,118	\$48,109,822	7.70%
55809	<p>Ultrasound scan of shoulder or upper arm (1 or both sides) (R) (NK)</p> <p><i>Note: Benefits are only payable when referred based on the clinical indicators outlined in the item descriptions. Benefits are not payable when referred for non-specific shoulder pain alone</i></p>	\$54.55	9	\$251	N/A
55810	<p>SHOULDER OR UPPER ARM, 1 or both sides, ultrasound scan of, where: (a) the service is not associated with a service to which an item in Subgroups 2 or 3 of this Group applies; and (b) <b>the patient is not referred by a medical practitioner</b>, and where the service is provided, for the assessment of one or more of the following conditions or suspected conditions:</p> <ol style="list-style-type: none"> <li>1. evaluation of injury to tendon, muscle or muscle/tendon junction; or</li> <li>2. rotator cuff tear/calcification/tendinosis (biceps, subscapular, supraspinatus, infraspinatus); or biceps subluxation; or</li> <li>3. capsulitis and bursitis; or</li> </ol>	\$37.85	4,648	\$160,905	15.05%



Item	Descriptor	Schedule fee	Services FY2015/16	Benefits FY2015/16	Services 5-year annual avg. growth
	4. evaluation of mass including ganglion; or 5. occult fracture; or 6. acromioclavicular joint pathology. (NR)				
55811	Ultrasound scan of shoulder or upper arm (1 or both sides) <b>(NR)</b> (NK) <i>Note: Benefits are only payable when referred based on the clinical indicators outlined in the item descriptions. Benefits are not payable when referred for non-specific shoulder pain alone.</i>	\$18.95	46	\$820	N/A

### Recommendations

- a) Change the descriptor for items 55808, 55809, 55810 and 55811 to remove 'occult fracture' as a listed condition for assessment by shoulder ultrasound.
- b) Restrict the co-claiming of all shoulder ultrasound items (55808, 55809, 55810 and 55811) to prevent claiming in conjunction with any shoulder X-ray item (57700, 57702, 57703, 57705).
- c) Create a new item (558XX) for requesting a shoulder ultrasound and a shoulder X-ray at the same time. This item should require the requesting clinician to detail on the request form the pathologies that necessitate the use of both imaging options. The proposed item descriptor is as follows:
  - *Shoulder or upper arm, one or both sides, combined ultrasound scan and radiographic examination of, if:*
    - i. *The patient is referred by a medical practitioner; and*
    - ii. *The medical practitioner is not a member of a group of practitioners of which the providing practitioner is a member; and*
    - iii. *The service is not provided in association with a service mentioned in items 55808, 55809, 55810, 55811, 57700, 57702, 57703, or 57705, and the patient has persistent significant pain and where the diagnostic imaging request form details the pathologies being investigated by the use of radiographic examination.*
- d) Create an explanatory note for items 55808, 55809, 55810 and 55811 to clarify the circumstances in which ultrasound of the shoulder is the appropriate initial investigation. This should detail the following:
  - For acute shoulder pain (present for < 7 days) of any etiology, including acute trauma, the best initial imaging is shoulder X-ray. Shoulder ultrasound should not be used as initial imaging - because acute soft-tissue pathology will often resolve with a period of rest or conservative management, and ultrasound may be more precise when the acute soft tissue swelling has resolved.



- For acute shoulder pain ultrasound can only be claimed if two conditions are fulfilled: (a) x-rays of the shoulder are non-contributory, and (b) the ultrasound is being used for the conditions or suspected conditions listed in the item descriptor.
- e) Create an explanatory note for the new item (558XX) to clarify the circumstance in which both ultrasound and x-ray of the shoulder are the appropriate initial investigations. This should detail the following:
  - For sub-acute pain (present for 7-10 days) the combination of x-ray and ultrasound for shoulder is permissible where (i) no previous imaging has been undertaken for this episode of symptoms and (ii) where examination shows:
    - 1) Pain with elevation and/or internal rotation; or
    - 2) Weakness of elevation and external rotation.
- In addition the Committee recommended:
  - Deliver provider education on the appropriate imaging pathways for chronic and acute shoulder presentations. The Committee noted that imaging providers play a key role in educating requesters through their ongoing communication and feedback.
  - Provide requester education on the appropriate imaging pathways for chronic and acute shoulder presentations. The Committee recommended that this include feedback to providers who request shoulder ultrasound or the new combined shoulder ultrasound and X-ray item at higher rates than their peers.
  - Provide consumer education on the above changes. Requesters should be equipped to provide patients with information about when imaging of the shoulder is appropriate, and when it would not change treatment pathways.

### Rationale

- The Committee agreed that there is sufficient evidence to conclude that shoulder ultrasound is being inappropriately overused:
  - Use of shoulder ultrasound has been growing rapidly, with a 9.4 per cent annual growth in benefits, driven primarily by 7.4 per cent annual growth in services per capita.
  - BEACH data shows that from 2002–05 to 2009–12, there was a 37 per cent increase (from 32.5 to 44.5 imaging orders per 100 shoulder problems) in the imaging ordering rate for all shoulder problems, suggesting a tendency to image more in the management of a patient who presents with a shoulder complaint or syndrome. The same data shows that the increase stems mostly from a significant increase in the rate of ultrasound orders, from 17.6 to 28.9 per 100 shoulder problems (49). Most clinically significant acute shoulder damage can be diagnosed based on consumer history, examination and selective use of plain radiography.
  - Forty-six per cent of shoulder ultrasounds occur on the same day as a shoulder X-ray. The Committee is of the opinion that the clinical circumstances in which both are required would not be present in almost 50 per cent of presentations.
  - There is large variation (2.2 times) in services per population across jurisdictions.



- The Committee agreed that indiscriminate imaging is possibly contributing to the high usage rates for shoulder ultrasound. In particular, there was concern that same-day shoulder ultrasound and X-ray (on the same consumer) reflect clinical uncertainty and lack of confidence, and that imaging is not being used as a specific and targeted diagnostic test to look for a specific result that can inform management.
- There is no requirement for routine co-requesting of shoulder X-ray and ultrasound in the instance of acute shoulder pain. Acute soft-tissue pathology will often resolve with a period of rest or conservative management. Additionally, ultrasound may be more precise when acute soft tissue swelling has resolved.
- The explanatory note for item 558XX is in line with WA Health's DIP imaging pathways and the Committee agreed that this represented best clinical practice.
- Ultrasound is of limited clinical utility in the diagnosis of occult fractures. CT is the preferred imaging pathway in adults, and MRI is the preferred pathway in paediatric patients.
- There is concern that unnecessary imaging, particularly in the case of shoulder ultrasound, is resulting in over-diagnosis of asymptomatic rotator cuff tears.



## 7.3 Lower back imaging

### 7.3.1 Lower back items

**Table 11: Services and benefits data for lower back imaging items**

Item	Descriptor	Schedule fee	Services FY2015/16	Benefits FY2015/16	Services 5-year annual avg. growth
58109	SPINE SACROCOCCYGEAL (R)	\$47.00	832,192	19,377	4.03%
58112	Spine, two examinations of the kind referred to in items 58100, 58103, 58106 and 58109 (R)	\$97.25	11,562,257	127,069	-0.55%
58115	Spine, three examinations of the kind mentioned in items 58100, 58103, 58106 and 58109 (R)	\$110.00	2,642,795	25,396	4.74%
58120	Spine, four regions, cervical, thoracic, lumbosacral and sacrococcygeal (R), if the service to which item 58120 or 58121 applies has not been performed on the same patient within the same calendar year	\$110.00	1,851,438	17,752	5.33%
58121	Spine, three examinations of the kind mentioned in items 58100, 58103, 58106 and 58109 (R), if the service to which item 58120 or 58121 applies has not been performed on the same patient within the same calendar year	\$110.00	10,500,320	100,728	-8.42%
59700	DISCOGRAPHY, each disc, with or without preliminary plain films and with preparation and contrast injection - (R)	\$96.55	110,342	1,503	-2.51%
59724	COMPUTED TOMOGRAPHY - scan of spine, 1 or more regions with intrathecal contrast medium, including the preparation for intrathecal injection of contrast medium and any associated plain X-rays, not being a service to which item 59724 applies (R) (K) (Anaes.)	\$326.20	72,738	409	-4.58%
63151	MAGNETIC RESONANCE IMAGING performed under the professional supervision of an eligible provider at an eligible location where the patient is referred by a specialist or by a consultant physician - scan of one region or two contiguous regions of the spine for: - infection (R) (Contrast) (Anaes.)	\$358.40	3,558	\$1,180,420	13.32%



Item	Descriptor	Schedule fee	Services FY2015/16	Benefits FY2015/16	Services 5-year annual avg. growth
63201	MAGNETIC RESONANCE IMAGING performed under the professional supervision of an eligible provider at an eligible location where the patient is referred by a specialist or by a consultant physician - scan of three contiguous regions or two non-contiguous regions of the spine for: - infection (R) (Contrast)	\$448.00	1,269	\$518,657	10.25%
63154	MAGNETIC RESONANCE IMAGING performed under the professional supervision of an eligible provider at an eligible location where the patient is referred by a specialist or by a consultant physician - scan of one region or two contiguous regions of the spine for: - tumour (R) (Contrast) (Anaes.)	\$358.40	6,859	\$2,346,335	6.21%
63204	MAGNETIC RESONANCE IMAGING performed under the professional supervision of an eligible provider at an eligible location where the patient is referred by a specialist or by a consultant physician - scan of three contiguous regions or two non-contiguous regions of the spine for: - tumour (R) (Contrast) (Anaes.)	\$448.00	7,253	\$3,100,757	6.31%
63164	MAGNETIC RESONANCE IMAGING performed under the professional supervision of an eligible provider at an eligible location where the patient is referred by a specialist or by a consultant physician - scan of one region or two contiguous regions of the spine for: - congenital malformation of the spinal cord or the cauda equina or the meninges (R) (Contrast) (Anaes.)	\$358.40	823	\$284,907	-0.43%



Item	Descriptor	Schedule fee	Services FY2015/16	Benefits FY2015/16	Services 5-year annual avg. growth
63222	MAGNETIC RESONANCE IMAGING performed under the professional supervision of an eligible provider at an eligible location where the patient is referred by a specialist or by a consultant physician - scan of three contiguous regions or two non contiguous regions of the spine for: - congenital malformation of the spinal cord or the cauda equina or the meninges (R) (Contrast) (Anaes.)	\$448.00	1,997	\$868,181	4.96%
63176	MAGNETIC RESONANCE IMAGING performed under the professional supervision of an eligible provider at an eligible location where the patient is referred by a specialist or by a consultant physician - scan of one region or two contiguous regions of the spine for: - sciatica (R) (Contrast) (Anaes.)	\$358.40	52,469	\$18,089,029	3.75%
63234	MAGNETIC RESONANCE IMAGING performed under the professional supervision of an eligible provider at an eligible location where the patient is referred by a specialist or by a consultant physician - scan of three contiguous regions or two non-contiguous regions of the spine for: - sciatica (R) (Contrast) (Anaes.)	\$448.00	2,483	\$1,064,088	5.54%
63179	MAGNETIC RESONANCE IMAGING performed under the professional supervision of an eligible provider at an eligible location where the patient is referred by a specialist or by a consultant physician - scan of one region or two contiguous regions of the spine for: - spinal canal stenosis (R) (Contrast) (Anaes.)	\$358.40	19,358	\$6,724,202	6.82%





Item	Descriptor	Schedule fee	Services FY2015/16	Benefits FY2015/16	Services 5-year annual avg. growth
63237	MAGNETIC RESONANCE IMAGING performed under the professional supervision of an eligible provider at an eligible location where the patient is referred by a specialist or by a consultant physician - scan of three contiguous regions or two non-contiguous regions of the spine for: - spinal canal stenosis (R) (Contrast) (Anaes.)	\$448.00	4,113	\$1,754,148	9.97%
63167	MAGNETIC RESONANCE IMAGING performed under the professional supervision of an eligible provider at an eligible location where the patient is referred by a specialist or by a consultant physician - scan of one region or two contiguous regions of the spine for: - myelopathy (R) (Contrast) (Anaes.)	\$358.40	7,909	\$2,751,843	2.50%
63225	MAGNETIC RESONANCE IMAGING performed under the professional supervision of an eligible provider at an eligible location where the patient is referred by a specialist or by a consultant physician - scan of three contiguous regions or two non-contiguous regions of the spine for: - myelopathy (R) (Contrast) (Anaes.)	\$448.00	3,510	\$1,515,753	7.85%

## Recommendations

- Implement a multicomponent intervention to improve requesting practices for lower back imaging. This should focus on mandated use of CDS for lower back imaging, implemented alongside other mechanisms to increase the collective impact on requester behaviour. Specific mechanisms that lend themselves to synergies with CDS include:
  - Requester education.
  - Audit and feedback on requesting patterns.
  - Patient education focused on the inappropriateness of early imaging of non-specific lower back pain, and what patients can and should expect as part of a comprehensive medical examination for back pain when they see a clinician.
- Link eligibility for MBS rebates for lower back imaging to mandatory use of CDS.
- Work with clinical experts to develop clinical signposts for lower back imaging as part of the design and implementation of a mandatory CDS system. Table 12 provides examples of potential signposts for lower back imaging.

**Table 12: Exemplar potential imaging signposts – lower back (adults)**

Clinical scenario	Imaging guide (first line)
Low back pain duration <4 weeks – no neurological symptoms or signs.	<ul style="list-style-type: none"> <li>Consider C-reactive protein (CRP).</li> <li>Consider X-ray if history or strong suspicion of cancer or possibility of vertebral compression fracture.</li> <li>MRI if risk or suspicion of spinal infection (CT if MRI contraindicated or not available).</li> </ul>
Low back pain duration >4 weeks with no improvements and no neurological symptoms or signs.	<ul style="list-style-type: none"> <li>Consider CRP or Erythrocyte sedimentation rate (ESR).</li> <li>Consider X-ray if possibility of cancer, ankylosing spondylitis or spondylolisthesis.</li> </ul>
Signs or symptoms of radiculopathy	<ul style="list-style-type: none"> <li>MRI if persists &gt;4 weeks (CT if MRI contraindicated or not available).</li> <li>MRI for severe radiculopathy not improving in 1 week.</li> </ul>
Signs or symptoms of cauda equine syndrome or other spinal cord compression.	<ul style="list-style-type: none"> <li>Urgent referral</li> <li>MRI</li> </ul>
Symptoms or signs of spinal stenosis	<ul style="list-style-type: none"> <li>MRI</li> </ul>
Trauma to lumbosacral spine	<ul style="list-style-type: none"> <li>X-ray/CT/MRI as clinically indicated</li> </ul>
<b>Note:</b> These signposts are suggestions only. The final signposts are intended to be developed by clinical experts based on an evidence review as a part of the design and implementation of the CDS system.	

### Rationale

- The Committee found sufficient evidence to conclude that inappropriate imaging is occurring for lower back pain presentations. Factors contributing to this include:
  - Patients' expectations that their treating clinician will make a diagnostic imaging request.
  - A potential lack of consumer awareness regarding the possible harms associated with overuse of imaging tests. Such as:
    - Over-diagnosis and the identification of radiological findings that are not clinically significant, which can result in unnecessary tests or treatment.
    - Radiation exposure through X-ray and CT modalities.
- The use of mandatory CDS can assist GPs in reassuring patients that best practice is being followed, because patients may view CDS as an 'objective' third party. This may be particularly useful when the appropriate clinical recommendation is not to request imaging (for example, during the acute presentation of non-specific lower back pain).
- The Committee noted that existing evidence does not demonstrate that MRI has a large clinical advantage over CT for detecting significant lower back pathology. The DICC's report (50) on lower back pain did not find a statistically significant difference between the two modalities.



- Correct imaging pathways for lower back pain are essential. Early imaging in non-specific lower back pain does not improve clinical outcomes (51), and delayed imaging has been found to be a low-risk approach. In such circumstances:
  - Imaging risks over-diagnosis (52) due to the possible detection of clinically insignificant anomalies (which may exacerbate patient anxiety, rather than provide reassurance).
  - Imaging may carry associated risks of harm from radiation<sup>9</sup> (for example, where the imaging modality is CT) and incurs costs for the patient and the community.
  - Alternatives to imaging are available. Thorough clinical assessment, referral to allied health professionals and medical management is often an appropriate first-line approach.
  - Requester and patient education provide key opportunities to support appropriate requesting practices (as they did when tackling the over-prescribing of antibiotics).
- A systematic review (53) revealed that CDS is an effective intervention for reducing inappropriate lower back imaging.



## 7.4 Head imaging

### 7.4.1 Head imaging items

**Table 13: Services and benefits data for head imaging items**

Item	Descriptor	Schedule fee	Services FY2015/16	Benefits FY2015/16	Services 5-year annual avg. growth
56001	CT scan of brain without IV contrast (R) (K)	\$195.05	300,636	\$52,697,201	3.20%
56007	CT scan of brain with IV contrast and with any scans of the brain prior to IV contrast injection, when undertaken (R) (K)	\$250.0	78,387	\$18,012,847	0.78%
56010	CT scan of pituitary fossa with or without IV contrast and with or without brain scan when undertaken (R) (K)	\$252.10	1,627	\$386,206	-10.24%
56013	CT scan of orbits with or without IV contrast and with or without brain scan when undertaken (R) (K)	\$250.00	7,662	\$1,791,128	-2.99%
56016	CT scan of petrous bones in axial and coronal planes in 1 mm or 2 mm sections, with or without IV contrast, with or without scan of brain (R) (K)	\$290.00	44,131	\$12,029,168	3.43%
56030	CT scan of facial bones, paranasal sinuses or both, with scan of brain, without IV contrast (R) (K)	\$225.00	25,208	\$5,252,291	3.21%
56036	CT scan of facial bones, paranasal sinuses or both, with scan of brain, with IV contrast, where: (a) a scan without IV contrast has been undertaken; and (b) the service is required because the result of the scan mentioned in paragraph (a) is abnormal (R) (K)	\$336.80	3,694	\$1,156,017	-0.82%
63507	MAGNETIC RESONANCE IMAGING Referral by a medical practitioner (excluding a specialist or consultant physician) for a scan of head (of a patient <16years) for any of the following: - unexplained seizure(s), unexplained headache where significant pathology is suspected, paranasal sinus pathology which has not responded to conservative therapy (R) (Contrast)	\$403.20	8,656	\$3,463,970	N/A
63551	MAGNETIC RESONANCE IMAGING Referral by a medical practitioner (excluding a specialist or consultant physician) for a scan of head for a patient 16 years or older for any of the following: unexplained seizure(s) or unexplained chronic headache with suspected intracranial pathology (R) (Contrast)	\$403.20	92,083	\$36,633,332	N/A



Item	Descriptor	Schedule fee	Services FY2015/16	Benefits FY2015/16	Services 5-year annual avg. growth
63001	MAGNETIC RESONANCE IMAGING (including Magnetic Resonance Angiography if performed), performed under the professional supervision of an eligible provider at an eligible location where the patient is referred by a specialist or by a consultant physician - scan of head for:  - tumour of the brain or meninges (R) (Contrast)	\$403.20	73,763	\$28,619,744	6.17%
63004	- inflammation of the brain or meninges (R) (Contrast)	\$403.20	4,950	\$1,914,878	11.19%
63007	- skull base or orbital tumour (R)	\$403.20	25,927	\$10,108,219	10.29%
63010	- stereotactic scan of brain, for the sole purpose to plan for stereotactic neurosurgery (R)	\$336.00	2,735	\$789,351	3.74%
63040	- Acoustic neuroma (R) (Contrast)	\$336.00	22,917	\$7,485,456	2.83%
63043	- Pituitary tumour (R) (Contrast)	\$358.40	12,836	\$4,474,771	6.02%
63046	- Toxic or metabolic or ischaemic encephalopathy (R) (Contrast)	\$403.20	15,986	\$6,214,273	12.12%
63049	- Demyelinating disease of the brain (R) (Contrast)	\$403.20	21,553	\$8,423,757	11.70%
63052	- Congenital malformation of the brain or meninges (R) (Contrast)	\$403.20	4,506	\$1,759,683	0.63%
63055	- venous sinus thrombosis (R) (Contrast)	\$403.20	1,993	\$752,530	6.86%
63058	- head trauma (R) (Contrast)	\$403.20	1,595	\$610,590	3.22%
63061	- epilepsy (R) (Contrast)	\$403.20	9,758	\$3,808,452	1.83%
63064	- stroke (R)	\$403.20	25,968	\$9,652,868	9.51%
63067	- carotid or vertebral artery dissection (R) (Contrast)	\$403.20	680	\$252,475	8.27%
63070	- intracranial aneurysm (R) (Contrast)	\$403.20	6,596	2,614,651	9.86%
63073	- intracranial arteriovenous malformation (R) (Contrast)	\$403.20	1,374	539,626	1.60%



## Recommendations

- Implement a multicomponent intervention to improve requesting practices for head imaging. This should focus on mandated use of CDS, implemented alongside other mechanisms in order to increase the collective impact on requester behaviour. Specific mechanisms that lend themselves to synergies with CDS include:
  - Requester education.
  - Audit and feedback on requesting patterns.
  - Patient education focused on the inappropriateness of early imaging for head pain, and what patients can and should expect as part of a comprehensive medical examination for head pain when they see a clinician.
- Work with clinical experts to develop clinical signposts as part of the design and implementation of a mandatory CDS system. Table 14 provides examples of potential signposts for imaging when a patient presents with a headache.

**Table 14: Exemplar imaging signposts – headache (adults)<sup>3</sup>**

Clinical scenario	Imaging guide (first line)
New, sudden onset headache reaching maximum intensity within minutes	<ul style="list-style-type: none"> <li>● Urgent referral or urgent CT</li> </ul>
New onset headache	<ul style="list-style-type: none"> <li>● Consider ESR and CRP if aged &gt;50 years.</li> <li>● Watch and wait with referral for MRI if change in mental state, symptoms of raised intracranial pressure (ICP), neurological signs, or space occupying liaison (CT if MRI is contraindicated or unavailable).</li> </ul>
Chronic (continuing) headache	<ul style="list-style-type: none"> <li>● Watch and wait with referral for MRI if change in mental state, symptoms of raised ICP or neurological signs (CT if MRI is contraindicated or unavailable).</li> </ul>
Recurrent headache	<ul style="list-style-type: none"> <li>● Watch and wait with referral for MRI if change in mental state, symptoms of raised ICP or neurological signs (CT if MRI is contraindicated or unavailable).</li> </ul>
<b>Note:</b> These signposts are suggestions only. The final signposts are intended to be developed by clinical experts based on an evidence review as a part of the design and implementation of the CDS system.	

<sup>3</sup> Based on clinical presentations with headache



- Mandate the use of formal request forms as a short-term bridging measure until a comprehensive CDS solution can be formally introduced.
- Specify in the AUC for head imaging that paediatric head imaging should be performed using the MRI modality whenever possible. Use of CT should be minimised in children, except in exceptional situations such as the following:
  - The child has ferromagnetic implants (MRI contraindication).
  - The child has claustrophobia (MRI contraindication).
  - The child is unable to remain still for the required duration to complete an MRI scan of satisfactory quality.
  - A condition/diagnosis is suspected for which CT would provide better imaging quality and/or greater clinical utility (for example, CT is the preferred modality for suspected subdural haemorrhage).
  - It is an emergency, and waiting for MRI imaging would result in a delay that compromises patient outcomes.

### Rationale

- The introduction of a GP-requested paediatric MRI item (63507) has coincided with a modest gradual decline in brain CTs ordered for the paediatric population. However, there has only been a small reduction in the growth of brain CTs ordered for the adult population since the introduction of a GP-requested adult MRI item (63551).
- In the first 12 months following the introduction of the GP-requested adult MRI brain item, there was a 33 per cent increase in total MRI brain services (both specialist and non-specialist), but there was no corresponding reduction in CT brain services. The Committee is therefore concerned that there may be low-value use of brain MRIs in the adult population, and it may be necessary to consider clearer AUC.
- MRI is expensive and risks over-diagnosis (a safety issue). Use should therefore be limited to cases where affording increased access to patients in primary care outweighs the concern of over-diagnosis (and low-value use).
- The Committee agreed that mandatory CDS is the most appropriate mechanism for changing requesting behaviours regarding head imaging. The Committee acknowledged that a considered approach to implementation is required, ensuring that CDS is integrated into requesting clinicians' clinical software in order to minimise disruption to their workflow.



## 8. Non-item recommendations

### 8.1 'Diabetes care set' item

#### Recommendations

- The Committee endorsed the proposal to develop an MBS item encompassing the key tests required for the care of patients with diabetes.
- The Committee recommended that relevant organisations work together to develop this care set.

#### Rationale

- The Committee recognised that an annual cycle of care is required for the management of diabetes, and that it therefore makes clinical sense to develop a care set.

### 8.2 Consumer health literacy

#### Recommendations

- The Committee recommended that the Taskforce review the issue of consumer health literacy, with the aim of developing a communication mechanism designed to provide more information to consumers on referred diagnostic testing. This should include generic information about testing (that is, financial impacts, preparations and adverse effects), as well as information about the value of specific tests. Examples of current communication efforts include [labtestsonline.org.au](http://labtestsonline.org.au), the Consumers Health Forum, Inside Radiology, DIP (Western Australia), and the Choosing Wisely website and factsheets.
- The Committee supports the proposals developed by the Health Technology Assessment Consumer Consultative Committee (HTACCC). These proposals rely on one of the nine mechanisms for improving requesting practices (consumer education) that the Committee is currently exploring.

#### Rationale

- The Committee noted that GPs have minimal information on diagnostic testing to provide to consumers.
- The Committee agreed that consumer education is critical to improving requesting practices.





## 9. Bibliography

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1. **Elshaug A, et al.** Over 150 potentially low-value health care practices: an Australian study. *Med J Aust.* 2012, pp. 556-560.
2. **Stacey D, Legare F, Lewis K, et al.** Decision aids for people facing health treatment or screening decisions. *Cochrane Database of Systematic Reviews.* 2017.
3. **Consumer Health Forum.** Why do I even need this test? A Diagnostic Imaging and Informed Consent Consumer Resource. [Online]  
[https://chf.org.au/sites/default/files/diagnostic-imaging-factsheet\\_web\\_1.pdf](https://chf.org.au/sites/default/files/diagnostic-imaging-factsheet_web_1.pdf).
4. **Western Australian Department of Health.** Diagnostic Imaging Pathways. [Online]  
<http://www.imagingpathways.health.wa.gov.au>.
5. **Royal Australian and New Zealand College of Radiologists.** Inside radiology. [Online]  
<https://www.insideradiology.com.au/>.
6. **Australasian Association of Clinical Biochemists.** Lab Tests Online Australasia. [Online]  
<https://www.labtestsonline.org.au>.
7. **Centers for Medicare & Medicaid Services.** Medicare Program; Revisions to Payment Policies Under the Physician Fee Schedule and Other Revisions to Part B for CY 2019; Medicare Shared Savings Program Requirements; Quality Payment Program; and Medicaid Promoting Interoperability Program. Available at:  
<https://www.federalregister.gov/documents/2018/07/27/2018-14985/medicare-program-revisions-to-payment-policies-under-the-physician-fee-schedule-and-other-revisions>. 2018.
8. **Stammen LA, Stalmeijer RE, Paternotte E, et al.** Training physicians to provide high-value, cost-conscious care: a systematic review. *JAMA* . 2015. Vol. 314. 2384–400.
9. **Mora A, Krug BS, Grigonis AM, et al.** Optimizing laboratory test utilization in long-term acute care hospitals. *Proc (Bayl Univ Med Cent)*. 2017. Vol. 30, 1. 26-29.
10. **Australian Government Department of Health.** *MBS Reviews Folate Testing Report*. Canberra : Department of Health, 2014.
11. **Yamamoto A, Takagishi K, Osawa T, et al.** Prevalence and risk factors of a rotator cuff tear in the general population. *J Shoulder Elbow Surg*. 2010, Vol. 19, 1, pp. 116-120.



12. **Australian Government.** Pathology funding agreement between the Australian Government and the Australian Association of Pathology Practices and the Royal College of Pathologists of Australasia and the National Coalition of Public Pathology. 2011.
13. **Royal College of Pathologists of Australasia.** Position Statement: Vitamin B12 and Folate testing – Use and interpretation. 2015.
14. **Medical Services Advisory Committee.** 61st MSAC Meeting 3-4 April 2014: Review of Vitamin B12 Testing. 2014.
15. **Australian Government, Department of Health.** MBS Reviews Vitamin B12 Testing Report. 2014.
16. **Pasricha S-RS, Flecknoe-Brown SC, Allen KJ, et al.** Diagnosis and management of iron deficiency anaemia: a clinical update. *Med J Aust.* 2010. Vol. 193 , 9. 525-532.
17. **Baird-Gunning J, Bromley J.** Correcting iron deficiency. *Aust Prescr.* 2016. Vol. 39, 6. 193–199.
18. **Dignass, A, Farrag, K and Stein, J.** Limitations of Serum Ferritin in Diagnosing Iron Deficiency in Inflammatory Conditions. *Int J Chronic Dis.* 2018. Vol. 2018. doi: 10.1155/2018/9394060.
19. **Royal College of Pathologists of Australasia and Australian Doctor.** Interpreting serum ferritin. *Common sense pathology.* Oct 2013.
20. **Gastroenterological Society of Australia.** *Iron Deficiency: clinical update.* Oct 2015.
21. **Guyatt GH, Oxman AD, Ali M, et al.** Laboratory diagnosis of iron-deficiency anemia: an overview. *Journal of General Internal Medicine.* 145-153, 1992.
22. **Peyrin-Biroulet L, Williet N, Cacoub P.** Guidelines on the diagnosis and treatment of iron deficiency across indications: a systematic review. *American Journal of Clinical Nutrition.* 1585-94, 2015, Vol. 102, 6.
23. **Royal College of Pathologists of Australasia.** Iron Studies Standardised Reporting Protocol. 2013.
24. **Patient Blood Management Steering Committee, National Blood Authority.** *Submission to the MBS Review Taskforce on Blood Related MBS Item Numbers.* 2015.
25. **Guyatt, G.** Transferrin as a predictor of iron deficiency. *American Journal of Medicine.* 453, 1992.
26. **Camaschella, C.** Iron-Deficiency Anemia. *New England Journal of Medicine.* 1832-43, 2015, Vol. 372.



27. **Leggett BA, Halliday JW, Brown NN, et al.** Prevalence of haemochromatosis amongst asymptomatic Australians. *Br J Haematol.* 1990. Vol. 74, 4. 525-30.
28. **Australian Bureau of Statistics.** Australian Health Survey: Biomedical Results for Nutrients, 2011-12 . 2013.
29. **Brown RD, Langshaw MR, Uhr EJ, et al.** The impact of mandatory fortification of flour with folic acid on the blood folate levels of an Australian population. *Medical Journal of Australia.* 65-67, 2011.
30. **Royal Australian College of General Practitioners.** *Medical care of older persons in residential aged care facilities - Urinary Tract Infections.* 4th ed. 2006.
31. **Lin K, Fajardo K.** Screening for Asymptomatic Bacteriuria in Adults: Evidence for the U.S. Preventive Services Task Force Reaffirmation Recommendation Statement. *Annals of Internal Medicine.* W-20, 2008.
32. **Australian Society for Infectious Diseases.** *Tests, treatments and procedures clinicians and consumers should question.* 2016.
33. **Nicolle L, Bradley S, Colgan R, et al.** Infectious Diseases Society America Guidelines for the Diagnosis and Treatment of Asymptomatic Bacteriuria in Adults. *Clinical Infectious Diseases.* 2005.
34. **Oikonomou KG, Alhaddad A.** The Diagnostic Value of Urinalysis in Hemodialysis Patients with Fever, Sepsis or Suspected Urinary Tract Infection. *Journal of Clinical and Diagnostic Research.* 2016.
35. **Oikonomou KG, Alhaddad A.** Isolation Rate and Clinical Significance of Uropathogens in Positive Urine Cultures of Hemodialysis Patients. *Journal of Global Infectious Disease.* 2017.
36. **Nicolle LE.** The Paradigm Shift to Non-Treatment of Asymptomatic Bacteriuria. *Pathogens.* 2016.
37. **Schwaderer AL, Wolfe AJ.** The association between bacteria and urinary stones. *Annals of Translational Medicine.* 2017.
38. **Yacoub R, Akl NK.** Urinary Tract Infections and Asymptomatic Bacteriuria in Renal Transplant Recipients. *Journal of Global Infectious Diseases.* 2011.
39. **Nicolle LE.** Asymptomatic bacteriuria. *Current Opinion in Infectious Diseases.* 90-96.
40. **Nowson CA, McGrath JJ, Ebeling PR, et al.** Vitamin D and health in adults in Australia and New Zealand: a position statement. *Med J Aust.* 2012. Vol. 196, 11. 686-687.



41. **Avenell M, Mak J, O'Connell D.** Vitamin D and vitamin D analogues for preventing fractures in post-menopausal women and older men. 2014.
42. **Bolland M, Avenell A, Grey A.** Should adults take vitamin D supplements to prevent disease? *BMJ*. 2016.
43. **National Institute for Health and Care Excellence (NICE).** Vitamin D guideline. 2014.
44. **Bjelakovic G, Gluud L, Nikolova D, et al.** Vitamin D supplementation for prevention of mortality in adults. 2014.
45. **Allan GM, Cranston L, Lindblad A, et al.** Vitamin D: A Narrative Review Examining the Evidence for Ten Beliefs. *Journal of General Internal Medicine*. 780-91, 2016.
46. **Prostate Cancer Foundation of Australia and Cancer Council Australia.** *Clinical practice guidelines PSA Testing and Early Management of Test-Detected Prostate Cancer*. Sydney : Cancer Council Australia, 2016.
47. **Srirangam V, Rai BP, Abroaf A, et al.** Atypical Small Acinar Proliferation and High Grade Prostatic Intraepithelial Neoplasia: Should We Be Concerned? An Observational Cohort Study with a Minimum Follow-Up of 3 Years. *Curr Urol*. 2017. Vol. 10, 4. 199-205.
48. **Yao K, Haque T.** The Ottawa knee rules - a useful clinical decision tool. *Aust Fam Physician*. 2012.
49. **Britt H, Miller G, Valenti L, et al.** *Evaluation of imaging ordering by general practitioners in Australia 2002-03 to 2011-12*. Sydney : Sydney University Press, 2014.
50. **MBS Review Taskforce Diagnostic Imaging Clinical Committee.** *First report of the Diagnostic Imaging Clinical Committee - Low Back Pain*. 2017.
51. **Chou R, Fu R, Carrino J, et al.** Imaging strategies for low-back pain; systematic review and meta-analysis. *The Lancet*. 2009, Vol. 373, pp. 463-472.
52. **Srinivas SV, Deyo RA, Berger ZD.** Application of 'less is more' to low back pain. *Arch Intern Med*. July 2012, Vol. 172, 13, pp. 1016-20.
53. **Jenkins HJ, Hancock MJ, French SD, et al.** Effectiveness of interventions designed to reduce the use of imaging for low-back pain: a systematic review. *CMAJ*. 2015, Vol. 187, 6, pp. 401-408.



## Appendix A - Summary for consumers

This table describes the medical service and the recommendations of the clinical experts, and it explains why each recommendation has been made.

### Recommendations for Vitamin B12 testing (items 66838 and 66839)

Item	What it does	Committee recommendation	What would be different	Why
Item 66838 (serum vitamin B12 test) and item 66839 (quantification of vitamin B12 markers)	<p>Vitamin B12 is important for nerve and brain function, and it is needed for blood cells to form properly.</p> <p>These blood tests check the amount of vitamin B12 in your blood, either directly or through other biological substances that can indicate vitamin B12 levels (known as markers).</p> <p>The serum test is the first-line test for checking vitamin B12 levels. The vitamin B12 marker test is used only when the serum test produces an abnormal result.</p>	<p>Limit testing to once every 12 months per patient for item 66839, as already exists for item 66838, however if the previous test was abnormal and below the laboratory reference limits for B12 a repeat test can be performed.</p> <p>Stipulate that pathology laboratories perform the vitamin B12 marker test on the same blood samples that had a low or ambiguous serum vitamin B12 result.</p> <p>Note in the explanatory note that lethargy/tiredness alone is not an appropriate indication for vitamin B12 testing.</p> <p>Establish national vitamin B12 decision limits to provide a consistent definition of 'low' vitamin B12 results.</p> <p>Provide requester and consumer education on the appropriate use of vitamin B12 testing.</p> <p>Encourage provider feedback to requestors that a full blood examination is the appropriate test to monitor patients receiving vitamin B12 therapy.</p> <p>Consider the introduction of CDS for requesting of vitamin B12 testing if the above strategies do not change requesting behaviour.</p>	<p>Clinicians would only be able to request item 66839 once every 12 months per patient unless the previous test was abnormal.</p> <p>Updated item descriptors would be clearer and would reflect appropriate use of the items.</p> <p>A nationally agreed definition of a 'low' vitamin B12 result would provide consistency when analysing and reporting test results.</p> <p>Clinicians would request a full blood examination instead of vitamin B12 testing to monitor response to treatment.</p> <p>Both clinicians and consumers would have a clearer understanding of the appropriate use of these tests.</p>	<p>This recommendation aims to update these item numbers to reflect best clinical practice and encourage appropriate use.</p> <p>Clearer item descriptors and a nationally agreed definition of a 'low' vitamin B12 result would provide better clinical guidance for clinicians and reduce unnecessary testing and appointments for patients. It would also mean consistency of reporting for vitamin B12 levels.</p>



## Recommendations for Iron studies and ferritin testing (items 66593 and 66596)

Item	What it does	Committee recommendation	What would be different	Why
Item 66593 (ferritin testing) and item 66596 (iron studies)	<p>Ferritin is a protein that stores iron in your cells: the iron is released when iron levels in the blood are low.</p> <p>Ferritin testing measures the amount of ferritin in your body. A low ferritin level indicates low iron stores.</p> <p>Iron studies measure the amount of iron in your blood for a fuller investigation, for example to test for an overload of iron.</p>	<p>Change the item names and descriptors of both items to intrinsically provide education on the selection of the appropriate test for each patient.</p> <p>Create a new item for exception iron studies to allow testing of full iron studies when there is evidence that ferritin alone is an unreliable indicator of iron status (e.g. inflammation or infection are present).</p> <p>Make item 66593 the default iron test, unless the request form indicates iron overload is suspected.</p> <p>Limit testing to once every three months per patient for item 66593, however if the previous test was abnormal and below the laboratory reference limits for iron studies and ferritin testing a repeat test can be performed.</p> <p>Support these changes with an education program and by encouraging pathology providers to give feedback to requesters to explain the proposed changes.</p> <p>Consider strengthening CDS measures for requesting of ferritin and iron testing if the above strategies do not change requesting behaviour.</p>	<p>The descriptor for item 66593 would be changed to 'iron deficiency studies' and the descriptor for item 66596 would be changed to 'iron overload studies'.</p> <p>A new item would be created to allow testing of full iron studies when there is evidence that ferritin alone is an unreliable indicator of iron status (e.g. inflammation or infection are present).</p> <p>Ferritin (iron deficiency studies) testing would become the default iron test, unless the request form indicates iron overload is suspected.</p> <p>Clinicians would be limited to requesting item 66593 once every three months per patient unless the previous test was abnormal.</p> <p>Clinicians would have a clearer understanding of the appropriate use of these tests.</p>	<p>The Committee agreed that there is sufficient evidence that full panel iron studies are overused, and that most iron-related tests are requested to check for iron deficiency. Use of full panel iron studies can result in over diagnosis of iron deficiency and unnecessary treatment. Ferritin testing is the appropriate first-line test for iron deficiency.</p> <p>The Committee agreed that many GPs are unaware that the ferritin-only MBS item exists, and that full iron studies are only appropriate when there is suspicion of an iron overload.</p> <p>This recommendation focuses on simplifying the item numbers to reflect best clinical practice for patients and limit over-testing.</p> <p>The three-month limit would ensure that patients are allowed appropriate time for iron replacement treatment to take effect and reduce unnecessary testing.</p>



## Recommendations for Folate testing (item 66840)

Item	What it does	Committee recommendation	What would be different	Why
66840 (Serum folate testing)	<p>Folate is a B group vitamin that helps to produce red blood cells and make and repair DNA. It is also important for our immune system. In pregnancy it helps prevent birth defects.</p> <p>Serum folate testing measures the amount of folate in your blood.</p>	<p>Change the item descriptor to clarify that folate testing is only appropriate for patients with malabsorption conditions (poor uptake from their diet), malnutrition or macrocytosis (enlarged red blood cells).</p> <p>Limit testing to once every 12-months per patient, unless the previous test was abnormal and is below the laboratory reference limits for folate (in order to confirm folate deficiency when an initial folate result is low).</p> <p>Change the explanatory note to clarify who may require folate testing and which groups of patients should be supplemented with folate and do not require testing.</p> <p>Educate requesters regarding details of changed item descriptor.</p> <p>Establish folate reference limits to provide a consistent definition of 'low' folate results.</p> <p>If the above strategies do not change requesting behaviour, require requesters to specify the reason for their request of folate testing (via mandatory CDS or a structured pathology request form) or consider introducing further requesting restrictions.</p>	<p>The item descriptor would no longer list 'folate deficiency' or 'coeliac disease' as reasons for testing.</p> <p>Clinicians would be limited to requesting item 66840 once every 12 months per patient unless the previous test was abnormal.</p> <p>Updated explanatory notes would clarify that folate testing is only required for patients with macrocytosis, malabsorption conditions or malnutrition.</p> <p>Clinicians would have a clearer understanding of the appropriate use of these tests.</p>	<p>The Committee felt that there is sufficient evidence that folate testing is overused. MBS data indicate that 28 per cent of tests are conducted within 12 months of an initial test and 88 per cent of testing was co-claimed with either iron or vitamin B12 testing.</p> <p>The Committee noted that current item restrictions have had little impact on requesting practices and believed that there is no clinical requirement for folate testing to be repeated within 12 months of the initial test. This recommendation focuses on updating the item number to reflect best clinical practice for patients and encourage appropriate use.</p> <p>The Committee noted that listing 'malabsorption conditions' encompasses those with coeliac disease.</p>



## Recommendations for Urine testing (items 69300, 69333 and 73085)

Item	What it does	Committee recommendation	What would be different	Why
Items 69300, 69333 and 73085	Urine testing is usually performed to find bacteria in the urine. These bacteria can cause an infection.	<p>Change the descriptor and add explanatory notes to item 69333 to specify that urine testing is only required when symptoms of a urinary tract infection are present (with the exception of specified groups of patients).</p> <p>No changes are recommended to items 69300 and 73085.</p> <p>Provide requester (including clinicians, aged care and other healthcare facilities staff) and consumer education on the appropriate use of vitamin B12 testing.</p> <p>Consider the introduction of CDS for requesting of vitamin B12 testing if the above strategies do not change requesting behaviour.</p>	<p>The proposed item descriptor and explanatory notes for item 69333 would clarify that urine testing should not be requested for patients who are not experiencing or showing symptoms, unless the patient is in a high-risk group.</p> <p>Patients would no longer have to undergo unnecessary tests.</p> <p>High risk groups include: pregnant women; children aged less than 16; recipients of renal transplants; those undergoing urinary tract instrumentation (such as catheterisation) or urological procedures, including for diagnosed with stone disease; and, those undergoing haemodialysis for chronic kidney disease.</p> <p>Both clinicians and consumers would have a clearer understanding of the appropriate use of these tests.</p>	<p>The Committee agreed that urine testing is overused, most likely as a result of common practices such as including urine testing in health screens or the regular testing of residents' urine in aged care facilities.</p> <p>Urine testing should only be done when the patient has symptoms of infection. There are exceptions for high risk patents such as pregnant women, children under 16 and patients undergoing urinary investigation.</p> <p>This recommendation focuses on encouraging appropriate use of urine testing and to reflect best clinical practice for patients by limiting over-testing and the subsequent over-prescribing of antibiotics, except in high-risk patient groups.</p> <p>The antibiotic treatment of asymptomatic bacteriuria (bacteria found in urine) provides no benefits except for the groups of high risk patients noted previously.</p> <p>This recommendation will reduce unnecessary exposure to antibiotics, which may pose further risk to patient wellbeing and the wellbeing of the broader community by increasing antibiotic resistance.</p>





## Recommendations for Vitamin D testing (items 66833, 66834, 66835, 66836 and 66837)

Item	What it does	Committee recommendation	What would be different	Why
Items 66833, 66834, 66835, 66836 and 66837	<p>Vitamin D is a hormone that controls calcium levels in the blood. It is needed for strong bones and muscles and overall health.</p> <p>Vitamin D testing is performed to determine the level of vitamin D stores in a patient's body.</p> <p>The total 25-hydroxyvitamin D level is the appropriate indicator of the body's vitamin D stores.</p>	<p>Change the item descriptor for item 66833 and add an explanatory note to clarify when and why patients should be tested.</p> <p>Limit testing to once every 12 months per person for item 66833 (25-hydroxyvitamin D), unless the previous test was abnormal that is below the laboratory reference limits for Vitamin D.</p> <p>Create a new item (668XX) for regular vitamin D testing in patients with a confirmed vitamin D deficiency and bone disease. Testing will be limited to once every three months. A repeat test is allowed if the previous test was abnormal.</p> <p>A rapid review of vitamin D testing will be undertaken to review the most current research.</p> <p>Develop national standards for defining vitamin D deficiency by specific serum levels to drive clinical treatment decision making and the need for repeat testing.</p> <p>Provide requester and consumer education on the appropriate use of vitamin B12 testing.</p> <p>Consider the introduction of CDS for requesting of vitamin D testing if the above strategies do not change requesting behaviour.</p> <p>No changes are recommended for items 66834, 66835, 66836 and 66837.</p>	<p>The proposed item descriptor for item 66833 would clarify that a vitamin D test should only be ordered for patients who have, or are at increased risk of having, low levels of vitamin D or bone disease.</p> <p>The updated explanatory notes would clarify who is at risk of bone disease or vitamin D deficiency.</p> <p>MBS rebates would only be paid for one item 66833 test every 12 months per patient unless the previous test was abnormal.</p> <p>Patients with a confirmed deficiency and osteoporosis, osteopenia or rickets who may need additional testing can access a test every three months using the new item for regular vitamin D testing. A repeat test is allowed if the previous test is abnormal.</p>	<p>The Committee agreed that vitamin D testing is overused, most likely due to a lack of clarity in the item descriptor, and because the test is ordered as part of general routine screening.</p> <p>This recommendation focuses on updating the item to reflect best clinical practice for consumers by encouraging appropriate use.</p> <p>The Committee noted that with the exception of people with chronic kidney disease, rickets or osteoporosis/osteopenia, there is no clinical need to test vitamin D levels more than once every 12 months unless the previous test shows an abnormality.</p> <p>A great deal of research is being conducted each year on the value of vitamin D testing. The Committee has recommended a rapid review of this research in order to inform further recommendations on vitamin D testing.</p>

## Recommendations for PSA testing (items 66655, 66656, 66659 and 66660)



Item	What it does	Committee recommendation	What would be different	Why
Items 66655, 66656, 66659 and 66660	Prostate-specific antigen (PSA) is a protein produced exclusively by prostate cells. There is a simple blood test to measure your PSA level.	<p>Limit testing to once every 23 months per person for item 66655.</p> <p>Change the descriptor for item 66659 to clarify when this test should be undertaken to reflect current guidelines on PSA testing.</p> <p>Add an explanatory note for all PSA items to provide a link to the National Health and Medical Research Council (NHMRC)-endorsed PSA testing guidelines and provide a summary of relative risk for prostate cancer death.</p> <p>Create an explanatory note for item 66656 to clarify what is meant by 'previously diagnosed prostatic disease' in the item descriptor.</p> <p>Provide requester and consumer education on the appropriate use of PSA testing.</p> <p>Consider the introduction of CDS for requesting of PSA testing if the above strategies do not change requesting behaviour.</p>	<p>MBS rebates would only be paid for one item 66655 test every 23 months per patient.</p> <p>MBS rebates for item 66659 would only be paid for tests taken following a result from item 66655 between 3.0 ug/L and 5.5 ug/L; however, lower threshold of 2.0 ug/L may apply to men with twice the average risk, as defined by the Cancer Council guidelines.</p>	These changes bring the MBS items for PSA testing in line with guidelines created by the Cancer Council of Australia and the Prostate Cancer Foundation of Australia. These guidelines have been endorsed by the NHMRC the Royal Australian College of General Practitioners (RACGP) and the Royal College of Pathologists of Australasia (RCPA).



### Recommendations for Ankle/hind foot ultrasound (items 55846, 55837, 55838 and 55839)

Item	What it does	Committee recommendations	What would be different	Why
Items 55846, 55837, 55838 and 55839 for ultrasound of the ankle/hind foot	<p>These items provide a rebate for ultrasounds conducted on the ankle and back of the foot.</p> <p>An ultrasound creates a real-time picture of inside the body using sound waves. It can be used for screening, diagnosis or to assist with treatment.</p>	<p>Change the item descriptors for all four items to reflect the Committee's position that ultrasound of this area should only be used for the assessment of suspected conditions other than acute ligament injury.</p> <p>Create an explanatory note to clarify that ultrasound should not be used when the treating clinician suspects ligament damage.</p> <p>Provide requester and consumer education on the appropriate use of ankle imaging.</p> <p>Encourage provider feedback to requesters on appropriate use of ankle imaging.</p> <p>Introduce mandated CDS for the requesting of ankle ultrasound if the initial recommendations do not change requesting behaviour. This means that clinicians will be provided with evidence-based imaging recommendations based on the symptoms of the presenting patient.</p>	<p>Patients would only be eligible for Medicare rebates when their clinician requests ultrasounds of the assessment of conditions other than acute ligament injury.</p>	<p>This recommendation aims to update these items to reflect best clinical practice and encourage appropriate use of these items.</p> <p>Most clinically significant acute (severe and sudden) ankle injuries can be diagnosed based on patient history, examination and the use of X-ray if required.</p> <p>The large number of ankle ultrasounds being claimed on the same day as ankle X-rays indicates that clinicians are not using ultrasound as a specific and targeted test to look for a specific result that will change the way the patient is treated.</p> <p>The Committee agreed that ankle ultrasound is only needed when the treating clinician is investigating Achilles tendon injury or other ongoing tendon conditions.</p>



## Recommendations for Shoulder ultrasound (items 55808, 55809, 55810 and 55811)

Item	What it does	Committee recommendation	What would be different	Why
Items 55808, 55809, 55810 and 55811 for ultrasound of the shoulder or upper arm	<p>These items provide a rebate for ultrasounds conducted on the shoulder and upper arm.</p> <p>An ultrasound creates a real-time picture of inside the body using sound waves. It can be used for screening, diagnosis or to assist with treatment.</p>	<p>Change the item descriptors for all four items to remove 'occult fracture' (a fracture that does not appear on an X-ray) as a reason for requesting ultrasound of this region.</p> <p>Restrict the claiming of shoulder ultrasound items in conjunction with shoulder X-ray items.</p> <p>Create a new item for requesting shoulder ultrasound and X-ray at the same time.</p> <p>Create explanatory notes to provide clarification on when shoulder ultrasound should be requested, and when both shoulder ultrasound and X-ray should be requested.</p> <p>Provide requester and consumer education on the appropriate use of shoulder imaging.</p> <p>Encourage provider feedback to requesters on appropriate use of shoulder imaging.</p> <p>Introduce mandated CDS for the requesting of ankle ultrasound if the initial recommendations do not change requesting behaviour. This means that clinicians will be provided with evidence-based imaging recommendations based on the symptoms of the presenting patient.</p>	<p>Suspected occult fracture would no longer be a reason to request a shoulder ultrasound.</p> <p>When requesting a shoulder ultrasound and X-ray at the same time, clinicians would need to use the new MBS item and provide reasons for why both tests are required on the request form.</p>	<p>Ultrasound is of limited value in the diagnosis of occult fractures. CT is preferred in adult patients, and MRI is preferred in paediatric patients.</p> <p>The changes are intended to ensure that the most appropriate imaging study is used for each patient.</p>



**Recommendations for Lower back imaging (items 56223, 56226, 56233, 56234, 56237, 56238, 56106, 56108, 58109, 58112, 58115, 58120, 58121, 59700, 59724, 63151, 63154, 63164, 63167, 63176, 63179, 63201, 63204, 63222, 63225, 63234 and 63237)**

Item	What it does	Committee recommendation	What would be different	Why
Items relating to CT and MRI imaging of the lower back: item numbers 56223, 56226, 56233, 56234, 56237, 56238, 56106, 56108, 58109, 58112, 58115, 58120, 58121, 59700, 59724, 63151, 63154, 63164, 63167, 63176, 63179, 63201, 63204, 63222, 63225, 63234 and 63237.	Imaging of the lower back (by CT or MRI) is performed to help the clinician make a diagnosis.	<p>Introduce mandatory CDS for clinicians who request lower back imaging. This means clinicians will have to check whether lower back imaging is appropriate for their patient (based on their symptoms) using a CDS system before requesting the test.</p> <p>Work with a team of clinical experts and specialists to develop criteria for the best use of lower back imaging as part of the development and rollout of a CDS system.</p> <p>Provide more education for clinicians on appropriate imaging choices.</p> <p>Feedback to clinicians who are requesting lower back imaging at higher rates than their peers.</p> <p>Education to patients about why early imaging of non-specific lower back pain is not appropriate, and what they can and should expect as part of a comprehensive medical examination for back pain.</p>	Clinicians would be required to consult clinician-developed, government-approved, evidence-based appropriate use criteria through a CDS system before requesting imaging (CT or MRI) for the lower back.	<p>The Committee noted that there is sufficient evidence that inappropriate imaging of the lower back is occurring. The factors contributing to this include:</p> <p>The comparative use of CT to MRI in Australia.</p> <p>An expectation among patients with lower back pain that their treating clinician will request imaging.</p> <p>A possible lack of awareness among patients about the potential harms associated with overuse of imaging tests. These include radiation exposure through CT, as well as unnecessary tests and treatment that can result from over-diagnosis.</p> <p>Research indicates that early imaging for non-specific lower back pain does not improve clinical outcomes, and that delayed imaging is a low-risk approach.</p> <p>Alternatives to imaging include clinical assessment, referral to allied health professionals (such as physiotherapists) or medical management.</p>



**Recommendations for Head imaging (items 56001, 56007, 56010, 56013, 56016, 56030, 56036, 63001, 63004, 63007, 63010, 63040, 63043, 63046, 63049, 63052, 63055, 63058, 63061, 63064, 63067, 63070, 63073, 63507 and 63551)**



Item	What it does	Committee recommendation	What would be different	Why
Items relating to imaging of the head, including CT and MRI of this area: item numbers: 56001, 56007, 56010, 56013, 56016, 56030, 56036, 63001, 63004, 63007, 63010, 63040, 63043, 63046, 63049, 63052, 63055, 63058, 63061, 63064, 63067, 63070, 63073, 63507 and 63551	Imaging of the head by CT or MRI in order to make a diagnosis.	<p>Introduce mandatory CDS for clinicians who request head imaging. This means clinicians will have to check whether head imaging is appropriate for their patient (based on their symptoms) using this system before requesting the test.</p> <p>Work with a team of clinical experts and specialists to develop criteria for the best use of head imaging as part of the development and rollout of this CDS system.</p> <p>In addition to a CDS, the Committee also recommended providing:</p> <p>More education for clinicians on appropriate imaging choices.</p> <p>Feedback to clinicians who are requesting head imaging at higher rates than their peers.</p> <p>Education to patients about what they can and should expect as part of a comprehensive medical examination when they have signs and symptoms that may indicate head imaging.</p>	Clinicians would be required to consult clinician-developed, government-approved, evidence-based appropriate use criteria through a CDS system before requesting imaging (CT or MRI) of the head.	<p>The Committee noted that there is sufficient evidence that inappropriate imaging of the head is occurring. A GP-requested head MRI item for adults was introduced in order to decrease the number of brain CTs ordered. However, in the 12 months following the introduction of this item, there was a 33 per cent increase in total MRI brain services and no corresponding decrease in CT brain services.</p> <p>Inappropriate use of MRI can lead to over-diagnosis and further unnecessary tests, which all carry risks. The use of MRI should therefore be limited to cases where the value of imaging outweighs concerns about over-diagnosis.</p>

## Appendix B - Glossary

Term	Description
AUC	Appropriate use criteria
CAGR	Compound annual growth rate, or the average annual growth rate over a specified time period.
CDS	Clinical decision support
Change	When referring to an item, 'change' describes when the item and/or its services will be affected by the recommendations. This could result from a range of recommendations, such as: (i) specific recommendations that affect the services provided by changing item descriptors or explanatory notes; (ii) the consolidation of item numbers; and (iii) splitting item numbers (for example, splitting the current services provided across two or more items).
CT	Computed tomography
DICC	Diagnostic Imaging Clinical Committee
DIP	Diagnostic Imaging Pathways
EMR	Electronic Medical Record
FY	Financial year
GP	General practitioner
GPPCCC	General Practice and Primary Care Clinical Committee
High-value care	Services of proven efficacy reflecting current best medical practice, or for which the potential benefit to consumers exceeds the risk and costs.
HTACCC	Health Technology Assessment Consumer Consultative Committee
Inappropriate use / misuse	The use of MBS services for purposes other than those intended. This includes a range of behaviours, from failing to adhere to particular item descriptors or rules through to deliberate fraud.
Low-value care	Services that evidence suggests confer no or very little benefit on consumers; or for which the risk of harm exceeds the likely benefit; or, more broadly, where the added costs of services do not provide proportional added benefits.
MBS	Medicare Benefits Schedule
MBS item	An administrative object listed in the MBS and used for the purposes of claiming and paying Medicare benefits, consisting of an item



Term	Description
	number, service descriptor and supporting information, schedule fee and Medicare benefits.
MBS service	The actual medical consultation, procedure or test to which the relevant MBS item refers.
Misuse (of MBS item)	The use of MBS services for purposes other than those intended. This includes a range of behaviours, from failing to adhere to particular item descriptors or rules through to deliberate fraud.
MRI	Magnetic resonance imaging
MSAC	Medical Services Advisory Committee
NHMRC	National Health and Medicine Research Council
No change or leave unchanged	Describes when the services provided under these items will not be changed or affected by the recommendations. This does not rule out small changes in item descriptors (for example, references to other items, which may have changed as a result of the MBS Review or prior reviews).
Obsolete services / items	Services that should no longer be performed because they do not represent current clinical best practice and have been superseded by superior tests or procedures.
PBS	Pharmaceutical Benefits Scheme
PCC	Pathology Clinical Committee
PHN	Primary Health Network
PSA	Prostate-specific antigen
RACGP	Royal Australian College of General Practitioners
RANZCR	Royal Australian and New Zealand College of Radiologists
RCPA	Royal College of Pathologists Australasia
The Committee	The Diagnostic Medicine Clinical Committee of the MBS Review
The Taskforce	The MBS Review Taskforce
Total benefits	Total benefits paid in FY2015–16 unless otherwise specified.
TSH	Thyroid stimulating hormone
TST	Thyroid function test
USANZ	Urological Society of Australia and New Zealand

## **Appendix C – Literature review: Interventions to improve the appropriateness and clinical utility of diagnostic investigation**

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## A Review for the Medicare Review Taskforce

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# Interventions to improve the appropriateness and clinical utility of diagnostic investigations

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March 2017

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- Independent, not-for-profit and evidence based, NPS enables better decisions about medicines and medical tests. We are funded by the Australian Government Department of Health and Ageing.

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# Contents

<b>Abbreviations.....</b>	<b>5</b>
<b>Executive summary .....</b>	<b>6</b>
<b>Literature search and review .....</b>	<b>6</b>
Literature search.....	7
Included studies.....	7
Key findings.....	8
System-based interventions .....	9
<b>1. Introduction .....</b>	<b>15</b>
<b>2. Methods.....</b>	<b>16</b>
2.1. Eligibility criteria.....	16
2.2. Information sources.....	16
2.3. Literature searches .....	17
2.4. Included studies.....	17
2.5. Review selection and data collection .....	17
<b>3. Results.....</b>	<b>19</b>
3.1. Search results .....	19
3.2. Methodological quality .....	19
3.3. Intervention strategies.....	19
3.4. Clinical decision support (CDS) .....	20
3.4.1. Alerts, prompts or reminders.....	21
3.4.2. CPOE and CDSS.....	21
3.4.3. System-based interventions.....	23
3.4.4. Utility score ratings, health information exchanges and clinical team decision support.....	23
3.4.5. Guideline dissemination or implementation tools.....	23
3.4.6. Price display .....	24
3.4.7. Summary of findings .....	24
3.5. Education .....	26
3.5.1. Traditional educational .....	26
3.5.2. Education and audit and feedback.....	27
3.5.3. Interactive educational .....	27
3.5.4. Multicomponent interventions.....	28
3.5.5. Interventions including a patient-mediated component .....	29
3.5.6. Outcomes for interventions aiming to increase or decrease a clinical behaviour .....	29
3.5.7. Summary of findings .....	30
3.6. Audit and feedback.....	31

3.6.1.	Summary of findings .....	32
<b>3.7.</b>	<b>Payment systems.....</b>	<b>32</b>
3.7.1.	Pay-for-performance.....	32
3.7.2.	Other payment systems .....	33
3.7.3.	Summary of findings .....	33
<b>3.8.</b>	<b>Quality improvement.....</b>	<b>33</b>
3.8.1.	Modifications or restrictions to referral or order forms .....	34
3.8.2.	Summary of findings .....	34
<b>4.</b>	<b>Discussion.....</b>	<b>36</b>
4.1.	Conclusions .....	37
	<b>Figures and Tables.....</b>	<b>39</b>
	<b>Appendices.....</b>	<b>95</b>
	<b>Appendix 1: The full electronic search strategies used for the systematic searches .....</b>	<b>95</b>
	Embase search for reviews investigating diagnostic imaging.....	95
	Medline search for reviews investigating diagnostic imaging .....	98
	Medline search for reviews investigating pathology tests .....	100
	PsycINFO search for reviews investigating diagnostic imaging .....	102
	PsycINFO search for reviews investigating pathology tests .....	104
	<b>References .....</b>	<b>106</b>

## Abbreviations

BMD	bone mineral density
CBC	complete blood count
CDSS	clinical decision support systems
CI	confidence interval
CPOE	computerised physician order entry
C-RCT	cluster randomised controlled trial
CRP	C-reactive protein
CT	computed tomography
ESR	erythrocyte sedimentation rate
GP	general practitioner
Hb	haemoglobin
HbA <sub>1c</sub>	glycated haemoglobin
HIE	health information exchange
ICU	intensive care unit
INR	international normalised ratio
IQR	interquartile range
IRR	incident rate ratio
ITS	interrupted time series
LDH	lactate dehydrogenase
LDL	low-density lipoprotein
MRI	magnetic resonance imaging
OCS	order communications systems
OR	odds ratio
RCT	randomised controlled trial
RD	risk difference
RF	rheumatoid factor
RR	risk ratio
SD	standard deviation
STAT (L. <i>statum</i> )	immediate
TSH	thyroid-stimulating hormone
TTE	transthoracic echocardiograms
UAE	unit of analysis error

## Executive summary

To inform discussion at the meeting of the Medicare Review Taskforce, a rapid literature review was undertaken to answer the question, 'What interventions improve the appropriateness and clinical utility of diagnostic investigations requested by medical practitioners?' The key findings of the literature review are summarised in this executive summary.

### Literature search and review

A systematic search of the literature was conducted using pre-defined eligibility criteria. However, this review was not intended to be a formal systematic review.

Studies were eligible for inclusion if they were systematic reviews or meta-analyses from Australia, the UK and Ireland, the US and Canada that were published in the last 10 years. Only articles published in English language were considered for inclusion. We did not include lower levels of evidence or grey literature.

Studies had to include medical practitioners who request or utilise diagnostic interventions. Interventions were broadly grouped into one or more of the following categories of interest:

- Audit and feedback.
- Clinical decision support (CDS).
- Education.
- Payment systems.
- Quality improvement.

Studies had to investigate an outcome before and after one of the above intervention categories. Outcomes were broadly grouped into the following categories of interest:

- Clinical utility (including positive and negative predictive value).
- Rates of diagnostic imaging/pathology tests, or rates of their requests or referrals.
- Rates of medicine prescribing after diagnostic imaging/pathology tests.
- Rates of invasive treatments or procedures.
- Health outcomes (morbidity, mortality, quality of life).
- Rates of inappropriate requesting for diagnostic imaging/pathology tests.
- Costs or cost effectiveness.

Studies were identified by systematically searching the online libraries of Medline, Embase and PsycINFO, and supplemented with searches of the Cochrane Library, Health Systems Evidence, PubMed and Google Scholar. All searches were conducted in February or March 2017.

Eligibility assessment was performed independently in an unblinded standardised manner by two reviewers, data were extracted by two reviewers, and the AMSTAR Checklist was used to assess the quality of the included reviews.



## Summary of results

### *Literature search*

The search of Medline, Embase and PsycINFO provided a total of 90 citations, and the additional searches provided 96 citations. After removal of 29 duplicate publications, a further 107 articles were removed after reviewing their abstracts against the pre-specified eligibility criteria.

The full text of the remaining 50 articles was screened against the eligibility criteria in more detail and a further 31 articles were removed, resulting in the final 19 articles included in this review.

### *Included studies*

A brief overview of the 19 included articles is provided in **Table 2. Summary of included studies**.

The reviews varied in quality, with AMSTAR scores ranging from 2 to 10 (median 6).

The included reviews varied considerably in focus, and fell into one of three general categories:

- Broad reviews (for example, on all types of educational interventions).
- Reviews of specific settings (for example, primary care).
- Reviews of specific behaviours (for example, laboratory test ordering).

### *Number of included studies by intervention*

A range of intervention strategies was identified. However, many distinctly different strategies were sometimes considered together under broad headings (for example, 'education'), while similar strategies were considered separately (for example, 'education + feedback + system change').

Of the included reviews that met the eligibility criteria:

- 16 investigated CDS interventions.[1-16]
- 10 investigated educational interventions.[1,3,4,6,10,11,15-18]
- 11 investigated audit and feedback interventions.[1,3,4,6,10,11,14-18]
- 3 investigated payment systems.[1,11,17]
- 5 investigated methods for quality improvement.[3,4,10,17,19]

### *Details of investigated interventions*

CDS interventions that were investigated included:

- Alerts, prompts or reminders.[1,6,10,16]
- Computerised physician order entry (CPOE) or clinical decision support systems (CDSS).[2,4,7,8,12,13]
- Utility score ratings.[1]
- Health information exchange (HIE).[1]
- Clinical team decision support.[1]
- Guideline dissemination[10] or implementation tools.[5]
- Price display.[3,9,14]

Educational interventions that were investigated included physician strategies and combinations of both physician and patient-mediated strategies.[1,3,4,6,10,11,15-18] Payment systems that were investigated included pay-for-performance, insurer restrictions and risk sharing.[1,11,17] All methods

for quality improvement that were investigated included modifications or restrictions to referral or order forms.[3,4,10,17,19]

## **Key findings**

### *Clinical decision support*

Overall, based on the number of reviews that conducted a meta-analysis and the number of relevant articles included within each review, CPOE or CDSS appeared to be the CDS intervention with the greatest body of evidence. However, it has been difficult to make direct comparisons between interventions.

There was substantial heterogeneity between studies, which resulted in a low number of meta-analyses and led to a high proportion of reviews that narratively summarised the results of individual studies. In addition, there was variation in the way outcomes were described, overall effect sizes were often not summarised, and some review authors only reported the proportion of included studies that showed a particular outcome.

In total, relevant results from only three meta-analyses were available, one for alerts, prompts or reminders,[16] and two for CPOE or CDSS.[2,4] Also pertinent to the interpretation of the findings is that the meta-analyses performed by Chaudhuri et al. (2016) and Tzortziou Brown et al. (2016) each only included two studies.

Overall, each type of CDS intervention demonstrated improvements in at least one of the assessed outcomes, including:

- improved rates or ordering of laboratory or diagnostic tests (alerts, reminders, CDSS, system-based interventions, administrative interventions, price display)[3,6,11,13,15,16]
- improved rates or ordering of imaging (reminders, utility scores, CDSS, administrative interventions)[6,7,10,20]
- improved medicine prescribing rates (alerts)[16]
- increased compliance with guidelines or recommended treatment criteria (prompts, CPOE with CDSS, utility scores, guideline dissemination tools)[1,5,8]
- reduced rates or ordering of redundant or inappropriate laboratory tests (alerts, CDSS)[1]
- reduced rates or ordering of redundant or inappropriate imaging (CDSS)[4]
- increased completion of a recommended preventive care service, clinical study or prescription (CDSS)[2]
- improved overall practitioner performance (CDSS)[12]
- reduced rates of low-utility imaging (utility scores used with CPOE)[20]
- reduced cost of tests or imaging (price display, CDSS).[7,9,14]

### *CPOE and CDSS*

Although their meta-analysis was not specific to studies investigating diagnostic imaging or pathology tests, 'diagnosis' and 'laboratory test ordering' were described as 'topics' evaluated in studies included in each of the analyses below. Comparators included usual care or no CDSS, direct comparison against the same CDSS with additional features, or comparison of the same CDSS for different conditions.[2]

Both commercially and locally developed CDSS improved health care process measures related to:[2]

- ordering or completing recommended preventive care services (high evidence strength, 25 studies in the meta-analysis): odds ratio (OR) 1.42 (95% CI 1.27 to 1.58)

- ordering or completing recommended clinical studies (moderate evidence strength, 20 studies in the meta-analysis): OR 1.72 (95% CI 1.47 to 2.00)
- ordering or prescribing recommended treatments (high evidence strength, 46 studies in the meta-analysis): OR 1.57 (95% CI 1.35 to 1.82).

The impact of CPOE on pathology or medical imaging services was investigated in two separate reviews by Georgiou et al. (2007, 2011). Implementation of CPOE resulted in a reduction in:[7,8]

- rates of redundant pathology tests (27% with intervention versus 51% with controls)
- utilisation rates for portable chest X-rays (reduction of 18.6 orders/day)
- growth rates for the use of CT, MRI and ultrasound examinations (decrease of 2.75%, 1.2% and 1.3%, respectively)
- rates of low-yield CT, MR and nuclear medicine examinations (5.4% to 1.9%).
- radiology orders not conforming to guidelines (33.2% to 26.9%).

Reducing the proliferation of common items in laboratory utilisation which have become used excessively through two factors, bundling (such as coagulation panels and liver function tests) and automated repetition, was the focus of several included studies. Unbundling of tests on request forms was shown to contribute to a relative reduction in test ordering of 34.5%. [11,17]

### **System-based interventions**

Two reviews grouped changes to test ordering processes and computer order entry systems as 'system-based interventions'. Neither review conducted a meta-analysis. [11,15]

In the review by Kobewka et al. (2015), it was noted that the removal of automated repetition from ordering systems can have a significant impact decreasing laboratory utilisation, with reductions in product testing of up to 48.3%.

### **Utility score ratings, health information exchange and clinical team decision support**

Based on the results of separate studies, Colla et al. (2016) described that the use of utility scores can:[1]

- reduce the rate of growth of CT and MRI use from 12% to 7% and 1%, respectively
- reduce low-utility radiology examinations from 6% to 2% when used with a CPOE.

Department-level non-payer-based utilisation management decreased the number of inappropriate outpatient imaging orders that were scheduled and performed from 5.4% to 1.9%. An administrative intervention to restrict available emergency laboratory tests and commonly repeated orders (coupled with educational feedback measures) reduced the number of laboratory tests ordered per year by 19%. Requiring clinical justification for repeat CT orders decreased the number of repeat orders by 23%. [1]

A separate study concluded that HIE can reduce duplicate imaging for back pain and increase the odds of guideline adherence by 33%. [1]

### **Guideline dissemination or implementation tools**

Guideline implementation tools were investigated in one review, and guideline dissemination in another. Each review only included one relevant study. In summary:

- adherence to guidelines for appropriate ordering of thyroid function tests increased from 62.0% to 77.9% after implementation of a memorandum pocket card and a test request form that indicated inappropriate tests. [5]

- postal guideline dissemination decreased imaging referrals by general practitioners by 7.7% in the first month after the intervention, however the effect was not statistically significant or sustained over time.[10]

### *Price display*

Price display was investigated in four reviews.[3,9,12,14] In two reviews meta-analyses were not performed due to study heterogeneity[9,14] and only a single relevant study was included in the third review.[3] Overall, price display was associated with reductions in cost and/or the number of tests ordered.[3,9,14]

### *Reminders and alerts*

The implementation of reminders and alerts can substantially affect inappropriate test orders.[1,6,10,16]

Prompts alerting physicians to non-compliance with guidelines was shown to improve compliance with guidelines across a range of studies and settings, including neonatal intensive care units (reduction in transfusions from 65% to 90%).[1] Alerts were also effective to discontinue low-value care, such as the use of electronic health record prompts to decrease or discontinue standing or repeat test orders after 72 hours, significantly reducing testing, or discontinue redundant testing.[1] This also applied to imaging studies, where decreases in radiology examinations were noted after prompts and reminders were implemented.[6,10]

### *Education*

Overall, educational interventions demonstrated improvements in at least one of the assessed outcomes, including:

- improvement in compliance and behavioural change (multicomponent intervention strategies; in 5/7 reviews)[1,3,11,15,17]
- improved rates of diagnostic imaging tests or laboratory test ordering (traditional education)[1,3,4,6,11,17]
- interactive small group strategies with problem solving and feedback can lead to modest improvements in test ordering in primary care.[3]
- small improvements in rates of diagnostic imaging tests or laboratory test ordering (education with audit and feedback)[6,15,16]
- reduction of inappropriate test use (multicomponent interventions)[1,3,6,15,17]
- improvement in guideline-consistent GP behaviour (interventions including a patient-mediated component)[11,16]
- improvement in patient outcomes (referrals to physiotherapy, medicine prescribing rates, interactive educational, interventions including a patient-mediated component).[6,10,16]

Many interventions cited in the included reviews were poorly defined or did not include data, thereby precluding analysis. No conclusion can be drawn as to whether the direction of the targeted behaviour (that is, increasing or decreasing a behaviour) can affect the effectiveness of an intervention.

No review reported an optimal length of educational programs in terms of either number of sessions, frequency, or total time.

Educational interventions with potential for improving diagnostic imaging and laboratory test ordering included those with an audit–feedback component, multi-component interventions, and combined physician–patient-mediated strategies.

Less-effective strategies included didactic education and passive dissemination strategies such as providing educational materials to clinicians in printed form.

It was noted that the threshold of intervention intensity necessary to affect clinician behaviour in areas where there are substantial barriers to change may need to be higher.[6] The need for ongoing reinforcement of interventions to maintain effectiveness was also acknowledged.[11]

Multicomponent intervention strategies resulted in significant improvements in compliance and behavioural change in most reviews (5/7).[1,3,11,15,17] A range of strategy combinations was described, although there was no conclusive evidence of any relationship between the number of components and strategy effectiveness.

### *Audit and feedback*

Audit and feedback generally leads to small-to-moderate improvements in professional practice, including reductions in test ordering and inappropriate imaging.[1,11,17] However, many interventions cited in the included reviews were poorly defined or did not include data, thereby precluding analysis.

Additionally, interventions were multifaceted; hence, their effects were dependent on the particular combination of strategies used.

Multiple and repeated strategies are most likely necessary to maintain an effect.

Overall, when clinicians were provided feedback on their use of low-value services compared with their peers, in addition to educational materials, large reductions in laboratory testing and imaging were observed.[1,11] One review emphasised the role of feedback in successful learning, noting that facilitation of reflective practice, such as providing feedback from mentors and educators or asking reflective questions regarding decisions related to laboratory ordering or prescribing to give trainees insight into their past and current behaviour was key to accomplishing lasting practice change.[17]

### *Payment systems*

Pay-for-performance substantially reduced laboratory test utilisation.[1,11] Third-party review and prepaid insurance plans reduced the utilisation of imaging, diagnostic or laboratory tests.[1] Education on the utility and cost of testing combined with fines for overuse reduced rates of laboratory test ordering.[17]

However, these results were only derived from a limited number of reviews, and each of these only provided a narrative report of individual studies.[1,11,17]

Overall, pay-for-performance interventions must be carefully stratified to minimise risk of reductions to appropriate care; risk sharing has been incompletely tested for low-value care; and further research is needed on the effectiveness of pay-for-performance, insurer restrictions, and risk-sharing.[1]

### *Quality improvement*

All of the five included reviews investigated modifications or restrictions to referral or order forms.[3,4,10,17,19]

The main body of evidence was derived from three reviews, which did not conduct meta-analyses and instead reported the results of individual studies.[10,17,19] Imaging was reduced by 22.5%–36.8% after modification to a referral or order form,[10,17] whereas request rates for laboratory tests decreased by between 2% and 100% after modification of order forms.[19]

Most data in the review by were derived from one study, by Thomas et al. (2015), which highlighted the limitations of the findings: the rationale for choosing specific tests was often not explained, most studies targeted a few tests for several months, and the tests and test volumes differed widely across studies.[19]

This review noted there was a reduction in request rates for laboratory tests after modification of order forms to:[19]

- remove separate individual tests from groups of tests (2% to 58% reduction, depending on the test)
- reduce the total number of tests included on an order form (17% to 79% reduction, depending on the test and study)
- deny family physicians the option to order certain tests (100% reduction)
- justify costs over a specified value (61% reduction)
- re-organise tests into screening, tests to assess the extent of a problem, and tests to fully evaluate a problem (2% reduction, 3 months after the intervention).

## Conclusion

Continuing medical education is necessary for physician knowledge and methods that could be described as traditional, such as didactic conferences or printed materials, are important to affect physician knowledge or attitude. However, the most successful interventions combined education with peer review, feedback, and administrative (order entry) changes.[3,11] Multi-component educational intervention strategies may result in significant improvements in compliance and behavioural change. Targeted education for junior trainees in teaching hospital settings or via senior educators and physicians can be an effective strategy to improve appropriate care and reduce waste.[11,17]

Small group strategies with problem solving and feedback can lead to modest improvements in test ordering in primary care. No inference can be made as to timing of strategies within multi-component interventions, that is for example, whether education should precede administrative or other changes, and what is the optimal time frame for subsequent audit and feedback. Sequential or longitudinal components may be more effective.

Top-down administrative changes or 'enabling' strategies are effective, with evidence to suggest that CDS interventions improve the appropriateness of diagnostic imaging and pathology tests requested by health professionals, with CPOE or CDSS appearing to have the greatest body of evidence. Modifying systems such as order entry can change physician behaviour, encouraging greater interaction with the decision support system, resulting in fewer low-yield orders. Modifications or restrictions to test order forms may improve the appropriateness of diagnostic imaging and pathology tests. Reminders and alerts embedded into the process of care can substantially affect inappropriate test orders.

Although price display has not consistently shown to be effective, cost-awareness strategies are easy to implement and less time and labour intensive than active education, and are hence worthy of consideration.

Audit and feedback generally leads to small-to-moderate improvements in professional practice; comparison with peers can lead to effective behaviour change. Chart review and feedback about practice have been shown to be effective in reducing laboratory utilisation, and reducing unnecessary blood transfusions. Interventions that employed physician audit and feedback were associated with significantly lower odds of inappropriate cardiac testing, particularly in hospital settings. However, strategies based on addressing clinical problems and associated tests can be effective in primary care.[3] In this review, decreases in unnecessary laboratory tests were not accompanied by decreases in clinically indicated appropriate testing.

This literature review has a number of limitations, which should be considered when interpreting the findings.

This was a rapid review with a broad scope. As a result, only systematic reviews were considered for inclusion, sources of grey literature were not searched and data from the included reviews were not re-analysed. Therefore, this literature review has largely relied on the reporting, analysis and interpretation of the authors of the included reviews and some relevant studies may not have been included.

In addition, it was not possible to perform a detailed analysis of interventions to determine which individual components lead to the greatest improvements in outcomes, and this review did not investigate whether greater improvements in outcomes would occur with data derived specifically from large-scale or accredited data or educational or programs. Terminology is inconsistent across the literature, particularly with what is considered an educational intervention. Many educational interventions with an interactive component (such as case discussions, practice sessions, and didactic activities that permit peer discussion and case-based learning also included other educational strategies) also commonly included strategies such as guideline dissemination, and were considered multi-component for this reason. This is not to say that these particular educational efforts are not

worthwhile. It is readily apparent that education, while necessary, is insufficient alone and must be combined with other modalities to be effective.

Baseline rates of inappropriate testing were low in some included studies; improving on low levels of inappropriate testing with some simple interventions may be unlikely.

Some of the interventions have questionable generalisability; opportunities for reducing overuse locally, based on local driving and restraining forces, may determine what is clinically and financially feasible and meaningful.

No conclusions can be made as to the impact of stakeholders, including end users, or perceived needs of end users, from this review. Involvement of end users from the outset in the design and implementation of interventions may significantly ensure buy-in.



## 1. Introduction

In March 2017 the Australian Government Department of Health engaged NPS MedicineWise to undertake a brief literature review examining the body of evidence on interventions that aim to improve the requesting of pathology testing and diagnostic imaging services.

Research question was:

- What interventions improve the appropriateness and clinical utility of diagnostic investigations requested by medical practitioners?

The purpose of the literature report was to inform the discussion at the next meeting of the Medicare Review Taskforce.

## 2. Methods

This literature review was restricted to a search for systematic reviews or economic costing studies. Although a systematic search of the literature was conducted using pre-defined eligibility criteria, this review was not intended to be a formal systematic review.

### 2.1. Eligibility criteria

**Types of studies:** Systematic reviews or economic costing studies from Australia, the UK and Ireland, the US and Canada that were published in the last 10 years. Only articles published in English language were considered for inclusion.

**Types of participants:** Studies had to include medical practitioners who request or utilise diagnostic interventions, with a focus on diagnostic imaging or pathology tests.

**Types of intervention:** An intervention had to modify (improve) diagnostic imaging or laboratory testing. Studies had to investigate interventions that could be broadly grouped into one or more of the following categories of interest:

- Audit and feedback.
- CDS.
- Education.
- Payment systems.
- Quality improvement.

**Types of comparator:** All types of comparator were considered, and were reported as described in the eligible studies.

**Types of outcome:** Studies had to investigate an outcome before and after one of the above intervention categories. Outcomes were broadly grouped into the following categories of interest:

- Clinical utility (including positive and negative predictive value).
- Rates of diagnostic imaging/pathology tests, or rates of their requests or referrals.
- Rates of medicine prescribing after diagnostic imaging/pathology tests.
- Rates of invasive treatments or procedures.
- Health outcomes (morbidity, mortality, quality of life).
- Rates of inappropriate requesting for diagnostic imaging/pathology tests.
- Costs or cost effectiveness.

### 2.2. Information sources

Studies were identified by systematically searching the online libraries of Medline ([www.medline.com](http://www.medline.com)), Embase ([www.embase.com](http://www.embase.com)) and PsycINFO ([www.apa.org/pubs/databases/psycinfo](http://www.apa.org/pubs/databases/psycinfo)). The systematic searches were supplemented with searches of the Cochrane Library ([www.cochranelibrary.com](http://www.cochranelibrary.com)) and Health Systems Evidence ([www.healthsystemsevidence.org](http://www.healthsystemsevidence.org)).

Hand searching of reference lists for key articles was conducted to search for articles not previously identified. These searches were further supplemented by selective searches using the 'similar articles' function of PubMed ([www.ncbi.nlm.nih.gov/pubmed](http://www.ncbi.nlm.nih.gov/pubmed)) and Google Scholar (<http://scholar.google.com.au>).

## 2.3. Literature searches

Literature review search terms and concepts are summarised in Table 1 below. The full electronic search strategies used for the systematic searches are summarised in Appendix 1. All searches were conducted in February or March 2017.

**Table 1: Literature review search terms and concepts**

Concepts (sub-concepts)	Search terms (keywords and subject headings)
Pathology testing	Diagnostic tests routine, medical tests, blood tests, pathology clinical, haematological test s, clinical laboratory techniques
Diagnostic imaging	Diagnostic tests routine, imaging, ultrasound, MRI, CT scan, tomography, magnetic resonance imaging, X-ray, ultrasonography
Interventions	Interventions, education medical continuing, clinical audit, decision support techniques, quality improvement, decision support systems clinical, guideline adherence, practice guidelines, practice guidelines as topic, practice pattern feedback, feedback, inservice training, general practitioner's education
Setting (Primary care or hospital)	Primary healthcare, GPs, family practice, general practice, general practitioners, physicians family, practice patterns, quality of healthcare, healthcare costs, unnecessary procedures Hospital care, tertiary healthcare, hospital admission

## 2.4. Included studies

Articles were included if they were as described below.

- Systematic reviews: when relevant literature had been identified by means of structured search of bibliographical and other databases, where transparent methodological criteria were used to exclude papers that did not meet an explicit methodological benchmark, and which presented rigorous conclusions about outcomes.
- Meta-analyses: as for systematic reviews, including the use of statistical methods to summarise the results of included studies.

## 2.5. Review selection and data collection

Eligibility assessment was performed independently in an unblinded standardised manner by two reviewers. Disagreements between reviewers were resolved by consensus.

First, abstracts were reviewed for eligibility. All abstracts reporting on the effect of an intervention on diagnostic imaging laboratory utilisation were selected for full text review. Full text articles were then assessed to determine if the study met the specified eligibility criteria. Included reviews had to quantify test utilisation with and without the intervention, with a change identified, preferably calculated, and reported.

Data were extracted by two reviewers. When available, relevant data on the participants, interventions, comparators and outcomes (PICO) were extracted and summarised. Summary measures and data analyses were recorded as described within the eligible reviews. No additional data analyses were conducted.

The AMSTAR Checklist (A Measurement Tool to Assess Systematic Reviews: [https://amstar.ca/Amstar\\_Checklist.php](https://amstar.ca/Amstar_Checklist.php)) was used to assess the quality of the included systematic reviews.

## 3. Results

### 3.1. Search results

In total, 19 systematic reviews were identified for inclusion in this literature review. The search of Medline, Embase and PsycINFO provided a total of 90 citations, and the additional searches provided 96 citations. After removal of duplicate publications, a further 107 articles were removed because, after reviewing their abstracts, it appeared that they would not meet the pre-specified eligibility criteria for this review (see Appendix 1. Search strategy for database searches, and Figure 1. Flow chart of information through the literature search).

The full text of the remaining 50 articles was screened against the eligibility criteria in more detail and a further 31 articles were removed, resulting in the final 19 articles included in this review.

Several studies (identified as key studies) were included in more than one review, resulting in double counting and a convergence of findings across some of the interventions. There was also considerable overlap resulting from inconsistent definitions of interventions included in the systematic reviews.

### 3.2. Methodological quality

The reviews varied in quality, with AMSTAR scores ranging from 2 to 10 (median 6; Table 2). Several AMSTAR items were infrequently reported in the included reviews:

- An a priori design (five reviews).
- Disclosing conflict of interest for individual studies (no reviews).
- Including a list of included and excluded studies (6 reviews).
- Assessing the likelihood of publication bias (6 reviews).

This may in fact reflect journal word limits or publication space limitations rather than poor design. A lack of reporting for publication bias most likely reflected the heterogeneity of the included studies.

### 3.3. Intervention strategies

A range of intervention strategies was identified. However, many distinctly different strategies were sometimes considered together under broad headings (for example, 'education', while similar strategies were considered separately (for example, 'education + feedback + system change'). Due to this variation in methodology, some combinations of strategies within given interventions were collapsed into broader headings. The range of definitions may also have accounted for the variation in reported effectiveness between seemingly similar approaches. Results of each type of intervention are presented in Tables 3–6; results of key studies for each intervention are listed, as well as the general findings of each review.

The included reviews varied considerably in focus, and fell into one of three general categories:

- Broad reviews (for example, on all types of educational interventions).
- Reviews of specific settings (for example, primary care).
- Reviews of specific behaviours (for example, laboratory test ordering).

#### *Intervention classification*

Interventions used to affect physician diagnostic imaging or laboratory ordering practices were categorised into one or more of the following non-exclusive categories, based on Effective Practice and Organisation of Care (EPOC) taxonomy (<http://epoc.cochrane.org/epoc-taxonomy>):

- *Educational interventions* in which appropriate test ordering (including the distribution of guidelines) was taught to physicians.
- *CDSS* involving:
  - CPOE systems with rules disallowing test ordering in specific circumstances
  - an interactive computer system that forces physicians to integrate previous knowledge about the patient and/or the medical literature into the test-ordering process
  - alerts, prompts and reminders
  - utility score ratings in which the appropriateness of imaging requests are rate
  - health information exchange (HIE) in which information is mobilised electronically across organisations
  - clinical team decision support
  - guideline dissemination
  - price display.
- *Audit and feedback interventions* in which physicians were presented with statement of their test utilisation compared with their previous utilisation or peer utilisation, or the total costs of the tests they ordered.
- *System-based interventions* involving one-time, permanent changes to test-ordering processes (including order form modifications).
- *Quality improvement*, which was predominantly modifications or restrictions to referral or order forms.
- *Payment systems* in which physicians received rewards or punishments for certain test ordering practices.

### 3.4. Clinical decision support (CDS)

A total of 16 reviews that met the eligibility criteria investigated CDS interventions.[1-16]

The key findings on CDS interventions from these reviews are summarised in Table 3. CDS interventions that were investigated included:

- alerts, prompts or reminders[1,6,10,16]
- CPOE or CDSS[2,4,7,8,12,13]
- utility score ratings[1]
- HIE[1]
- clinical team decision support[1]
- guideline dissemination[10] or implementation tools[5]
- price display.[3,9,14]

Overall, CDS interventions improved the appropriateness and clinical utility of diagnostic imaging and pathology tests requested by health professionals, with each type of intervention investigated leading to improvements in at least one of the assessed outcomes.

Two reviews investigated ‘system-based interventions’.[11,15] In one review this was described as one-time, permanent changes to test ordering processes, including order form modifications, computer order entry systems with rules disallowing test ordering in specific circumstances, and CDSS in which an interactive computer system forces physicians to integrate previous knowledge about the patient and/or the medical literature into the test ordering process.[11]

In the second review, system-based interventions were described more briefly as order form modifications and computerised CDSS.[15]

Although results below have been categorised by intervention, there was some overlap. For example, a CDSS can include alerts, reminders or recommendations.

### **3.4.1. Alerts, prompts or reminders**

Alerts, prompts or reminders were investigated in four reviews.[1,6,10,16] Only the review by Tzortziou et al. (2016) included an analysis of pooled results.[16]

In a meta-analysis of two studies, alerts for general practitioners (including a patient-specific letter or electronic reminder message) led to improved bone mineral density testing rates (risk ratio 4.75, 95% confidence interval [CI] 3.62 to 6.24; 3047 participants) and osteoporosis medicine prescribing rates (risk ratio 1.52, 95% CI 1.26 to 1.84; 3047 participants).[16]

However, the certainty of evidence was downgraded due to the fact that only two studies were included, due to the relatively low number of patients and events in one review, and also due to the considerable statistical heterogeneity observed.[16]

The three other reviews showed that alerts, prompts or reminders can improve compliance with guidelines, or reduce rates of testing, repeat testing or redundant testing.[1,6,10,16]

From values that were reported in the individual studies:

- Prompts alerting non-compliance with guidelines increased compliance with guidelines from 65% to 90%.[1]
- Alerts decreased inappropriate redundant ordering from 54% to 15% in one study, and by 21% or 24% relative to baseline in another study.[1]
- Reminders improved bone mineral density test ordering by 7.1%, and reduced lumbar imaging by 22.5% to 47% (depending on the study).[6,10]

Both Jenkins et al. (2015) and French et al. (2010), described that no meta-analysis was performed due to study heterogeneity.[6,10]

French et al. (2015) demonstrated differences in the effectiveness of interventions for the appropriate use of imaging, depending on the indication. Reminder (and organisational interventions) had most potential for improving imaging use in osteoporosis, but interventions for low back pain showed variable effects.[6]

### **3.4.2. CPOE and CDSS**

Six reviews investigated CPOE or CDSS.[2,4,7,8,12,13] A meta-analysis was conducted in two reviews,[2,4] and three reviews described that a meta-analysis was not performed due to heterogeneity.[7,12,13]

In Bright et al. (2012), commercially and locally developed CDSS improved healthcare process measures related to performing preventive services, ordering clinical studies and prescribing therapies.[2]

Although their meta-analysis was not specific to studies investigating diagnostic imaging or pathology tests, 'diagnosis' and 'laboratory test ordering' were described as 'topics' evaluated in studies included in each of the analyses below.[2]

- Recommended preventive care service ordered or completed (high evidence strength, 25 studies in the meta-analysis): odds ratio (OR) 1.42 (95% CI 1.27 to 1.58) favouring CDSS.
- Recommended clinical study ordered or completed (moderate evidence strength, 20 studies in the meta-analysis): OR 1.72 (95% CI 1.47 to 2.00) favouring CDSS.

- Recommended treatment ordered or prescribed (high evidence strength, 46 studies in the meta-analysis): OR 1.57 (95% CI 1.35 to 1.82) favouring CDSS.

The review by Chaudhuri et al. (2016) included two studies that investigated the use of point-of-care decision support tools for cardiac imaging. However, only one of the two studies used a computer-based process as its primary intervention.[4]

Stratifying by the use decision support tools demonstrated that initiatives using these interventions were associated with significantly (OR 0.35, 95% CI 0.22 to 0.56) and consistently (heterogeneity,  $I^2$  within group 22%) lower odds of inappropriate testing, but the observed benefit did not significantly differ from initiatives, such as education or audit and feedback, that did not incorporate decision support tools.[4]

In their review, Roshanov et al. (2011) assessed whether computerised CDSS were able to improve diagnostic test ordering, disease monitoring, or treatment monitoring. They focused exclusively on diagnostic testing measures and defined these broadly to include performing physical examinations (for example, eye and foot exams), blood pressure measurements, and ordering laboratory, imaging, and functional tests.[13]

Overall, 18/33 (55%) included studies reported improvements in diagnostic testing after implementation of the CDSS. Four of the systems explicitly attempted to reduce test ordering rates and all succeeded. Effect sizes were not summarised for the included studies.[13]

Two relevant questions were asked in the review by Main et al.(2010):[12]

- ‘What is the impact of CDSS in order communication systems (OCS) for diagnostic, screening or monitoring test ordering compared with OCS without CDSS on process outcomes, patient outcomes and adverse events/safety?’
- What is known about the cost-effectiveness of CDSS in diagnostic, screening or monitoring test OCS compared with OCS without CDSS?

Taking into account primary and secondary outcomes, CDSS significantly improved practitioner performance in 15/24 studies (62.5%), including:[12]

- 1/3 studies assessing cost display
- 1/2 studies assessing display of previous test results
- 6/10 studies assessing use of reminders
- 2/7 studies assessing display of recommendations.

Only two included reviews investigated the cost-effectiveness of CDSS. A Dutch study reported a mean cost decrease of 3% for blood test orders compared with a 2% increase in control clinics, whereas a Spanish study reported a significant increase in the cost of laboratory tests after CDSS implementation.[12]

The impact of CPOE on pathology or medical imaging services was investigated in two separate reviews by Georgiou et al. (2007, 2011). Implementation of CPOE resulted in a reduction in:[7,8]

- pathology test volumes and costs (7/11 and 4/5 studies, respectively)
- rates of redundant pathology tests (27% with intervention versus 51% with controls)
- utilisation rates for portable chest X-rays (reduction of 18.6 orders/day)
- growth rates for the use of CT, MRI and ultrasound examinations (decrease of 2.75%, 1.2% and 1.3%, respectively)
- rates of low-yield CT, MR and nuclear medicine examinations (5.4% to 1.9%).
- radiology orders not conforming to guidelines (33.2% to 26.9%).



In addition, four studies showed that CPOE systems with computerised decision support improved compliance with guideline advice.[8]

### **3.4.3. System-based interventions**

Two reviews grouped changes to test ordering processes and computer order entry systems as 'system-based interventions'. Neither review conducted a meta-analysis; Kobewka et al. (2015) described that this was due to study heterogeneity.[11,15]

Kobewka et al. (2015) included 109 studies that investigated 119 interventions aimed at reducing laboratory test utilisation. Of 119 interventions, 54 (45.4%) had a system-based component.[11]

The overall median relative reduction (RR) in test utilisation was 22.2% (interquartile range [IQR] 3.6 to 68.3). The percentage relative reduction in test utilisation was statistically significantly decreased versus controls, with 36 out of 54 interventions (median RR 19.6, IQR 10.4 to 36.1).[11]

Thomas et al. (2015) included 10 studies that investigated system-based interventions, which usually consisted of computer-assisted decision making. The unweighted average desired change in testing for 26 outcomes in the intervention group compared with the control group was 14.9%.[15]

### **3.4.4. Utility score ratings, health information exchanges and clinical team decision support**

These findings are all derived from the narrative review by Colla et al. (2016). Based on the results of three separate studies, Colla et al. (2016) described that the use of utility scores can:[1]

- reduce the rate of growth of CT and MRI use from 12% to 7% and 1%, respectively
- increase compliance with appropriateness criteria for head CT and head and spine MRI
- reduce low-utility radiology examinations from 6% to 2% when used with a CPOE.

Colla et al. (2016) found that administrative interventions decreased the number of inappropriate outpatient imaging orders that were scheduled and performed from 5.4% to 1.9% and reduced the number of laboratory tests ordered per year by 19%. Requiring clinical justification for repeat CT orders decreased the number of repeat orders by 23%.[1]

A separate study was used to conclude that HIE can reduce duplicate imaging for back pain and increase the odds of guideline adherence by 33%.[1]

However, Colla et al. (2016) acknowledged that their review was limited by potential publication bias, and a focus on the effect of a policy or intervention on acute or low-value care.[1]

### **3.4.5. Guideline dissemination or implementation tools**

Guideline implementation tools were investigated in one review, and guideline dissemination in another. Each review only included one relevant study.

The review by Flodgren et al. (2016) specifically investigated the implementation of tools developed and disseminated by guideline producers after publication of clinical practice guidelines.[5]

In the single relevant included study, adherence to guidelines for appropriate ordering of thyroid function tests increased from 62.0% to 77.9% after implementation of a memorandum pocket card and a test request form that indicated inappropriate tests. The included study was determined to have complete outcome data, and adequate randomisation sequence and allocation concealment.[5]

The review by Jenkins et al. (2015), was more general and focused on the effectiveness of interventions designed to reduce the use of imaging for low back pain. A single included study investigated the effect of postal guideline dissemination on the number of imaging referrals made by general practitioners. Although imaging referrals decreased by 7.7% in the first month after the intervention, the effect was not statistically significant or sustained over time.[10]

### 3.4.6. Price display

Price display was investigated in four reviews.{Cadogan, 2015 #109;Goetz, 2015 #39;Silvestri, 2016 #84;Main, 2010 #45} In two reviews a meta-analysis was not performed due to study heterogeneity,[9,14] and only a single relevant study was included in the third review.[3]

Overall, price display was associated with reductions in cost and/or the number of tests ordered, although the results may be limited by study heterogeneity and need for higher levels of evidence, and effects on cost may only be modest.[3,9,14]

Silvestri et al. (2016) included studies that showed the price of laboratory tests, imaging studies or medicines to providers in real-time during the ordering process and evaluated the impact on provider ordering.[14]

Thirteen studies reported the numeric impact of price display on aggregate order costs, and nine demonstrated a statistically significant decrease in order costs with effect sizes ranging from 10.7% to 62.8%. Eight studies reported the numeric impact of price display on aggregate order volume, and three demonstrated a statistically significant decrease in order volume with effect sizes ranging from 14.2% to 25.5%.[14]

Goetz et al. (2015) included 17 studies that investigated the effect of price display on radiology and laboratory test ordering, or medicine choice. In most studies, price information changed ordering and prescribing behaviour. However, effect sizes were not summarised.[9]

Of nine clinically based interventions that examined test ordering, seven showed statistically significant reductions in cost and/or the number of tests ordered. Significant reductions in cost were also shown in two of the three clinical studies that investigated medicine expenditures. The authors stated that awareness of price may have led to the ordering of less expensive, rather than fewer, tests.[9]

Cadogan et al. (2015) included one relevant study. After price display there was a 1% to 2.6% reduction in the volume of tests ordered for 5/27 different laboratory tests (estimated reduction of 0.4/1000 and 5.6/1000 visits per month). Although significant, the reduction was small and principally for low-cost tests.[3]

Findings by Main et al. (2010) were equivocal. The authors concluded that the display of test costs may be differentially effective in reducing the number of test orders and their corresponding costs according to baseline ordering rates, and that the effect of displaying test charges may be relatively transient.{Main, 2010 #45}

### 3.4.7. Summary of findings

The included reviews provided evidence to suggest that CDS interventions improve the appropriateness of diagnostic imaging and pathology tests requested by health professionals.

Overall, each type of CDS intervention demonstrated improvements in at least one of the assessed outcomes, including:

- improved rates or ordering of laboratory or diagnostic tests (alerts, reminders, CDSS, system-based interventions, administrative interventions, price display)[3,6,11,13,15,16]
- improved rates or ordering of imaging (reminders, utility scores, CDSS, administrative interventions)[6,7,10,20]
- improved medicine prescribing rates (alerts)[16]
- increased compliance with guidelines or recommended treatment criteria (prompts, CPOE with CDSS, utility scores, guideline dissemination tools)[1,5,8]
- reduced rates or ordering of redundant or inappropriate laboratory tests (alerts, CDSS)[1]
- reduced rates or ordering of redundant or inappropriate imaging (CDSS)[4]

- increased completion of a recommended preventive care service, clinical study or prescription (CDSS)[2]
- improved overall practitioner performance (CDSS)[12]
- reduced rates of low-utility imaging (utility scores used with CPOE)[20]
- reduced cost of tests or imaging (price display, CDSS).[7,9,14]

Overall, based on the number of reviews that conducted a meta-analysis and the number of relevant articles included within each review, CPOE or CDSS appears to be the CDS intervention with the greatest body of evidence. However, it has been difficult to make direct comparisons between interventions.

As acknowledged in many of the included reviews, there was substantial heterogeneity between studies, which resulted in a low number of meta-analyses and led to a high proportion of reviews that narratively summarised the results of individual studies. In addition, there was variation in the way outcomes were described, overall effect sizes were often not summarised, and some review authors only reported the proportion of included studies that showed a particular outcome.

In total, relevant results from only three meta-analyses were available, one for alerts, prompts or reminders,[16] and two for CPOE or CDSS.[2,4] However, only two studies were included in the meta-analyses performed by Chaudhuri et al. (2016) and Tzortziou Brown et al. (2016).

In addition, the meta-analysis by Tzortziou Brown et al. (2016) was downgraded due to the heterogeneity and the small number included patients and events, and a detailed explanation of the CDS intervention was not provided in the meta-analysis conducted by Chaudhuri et al. (2016).[4,16]

The meta-analysis by Bright et al. (2010) included a large number of studies with moderate–high evidence strength to show that CDSS can improve preventive care services, ordering or completing clinical studies, and ordering the appropriate treatment. However, this review did not specifically investigate pathology tests or diagnostic imaging. Instead, these investigations were ‘topics’ incorporated within the included studies.[2] Authors concluded that both commercially and locally developed CDSS are effective at improving healthcare process measures across diverse settings, but evidence for clinical, economic, workload, and efficiency outcomes remains sparse.[2]

There was consistent and substantial heterogeneity between included studies. The relevance of data in the retrieved meta-analyses should also be questioned, due to the low number of included studies, low strength of evidence, or lack of specific data for pathology testing or diagnostic imaging in the only comprehensive meta-analysis that included a high number of studies with moderate–high-strength evidence.

The heterogeneity between studies, low number of meta-analyses, high proportion of reviews that did not present overall effect sizes for a particular intervention, and differences in the way outcomes or interventions were reported or described made direct comparisons between interventions difficult. However, overall, CPOE or CDSS appeared to be the CDS intervention with the greatest body of evidence, and these interventions led to improvement for the greatest number of outcomes.

Limited data are available on the cost-effectiveness of CDSS plus order communication systems compared with order communications systems alone, and it is unclear whether the use of CDSS, either for curtailing unnecessary or redundant tests, or increasing the appropriateness of tests and their timing, has any potential impact on healthcare outcomes that are relevant to patients.[12]

Additionally, Roshanov et al. (2011) stated that, to better inform development and implementation of computerised CDSS, studies should describe in more detail potentially important factors such as system design, user interface, local context and implementation strategy, and evaluate impact on user satisfaction and workflow, costs and unintended consequences.[13]

In interpreting the findings of this review, a number of other practical factors should also be considered, as highlighted by the authors of the reviews below.

Colla et al (2016) highlighted practical aspects that may need to be considered when implementing alerts or reminders. The review concluded that appropriateness scores and alerts integrated directly into electronic health records can reduce redundant testing and inappropriate care. However, physicians can experience alert fatigue, which introduces challenges such as overriding potentially critical notifications.[1]

French et al. (2010) highlighted the need to consider specific indications. They concluded that patient-mediated, reminder, and organisational interventions had most potential for improving imaging use in osteoporosis, but interventions for low back pain showed variable effects, and no firm conclusions could be made for other musculoskeletal conditions.[6]

Regarding price display, Goetz et al. (2015) suggested that awareness of price may lead to the ordering of less expensive, rather than fewer, tests.[9] Additionally, Cadogan et al. (2015) included a study that showed that price display may lead to price reduction in low-cost tests rather than high-cost tests.[3]

### 3.5. Education

A total of 10 reviews that met the eligibility criteria investigated educational interventions.[1,3,4,6,10,11,15-18] The key findings on educational interventions from these reviews are summarised in Table 4.

Educational interventions that were investigated included physician strategies and combinations of both physician and patient-mediated strategies.

#### 3.5.1. Traditional educational

‘Traditional’ strategies typically incorporated passive education and information dissemination such as didactic lectures, seminars, educational emails and flyers and distribution of educational materials, and were reported by 10 reviews.[1,3,4,6,10,11,15,16,18]

Evidence of effectiveness was inconsistently reported for both imaging and ordering of laboratory tests. Details of the intervention were often insufficiently described. Most included studies were before-after with no time series analysis.

Reviews that reported positive findings overall:

- A meta-analysis of two studies by Chaudhuri et al. (2016) found that the odds of inappropriate cardiac testing were marginally improved after use of lectures (OR 0.89, 95% CI 0.61 to 1.29).[4]
- A systematic review by Kobewka et al. (2015) found that interventions with an educational component (including but not exclusively traditional educational) had the highest median relative reduction in test ordering volume at 34.5% (IQR 16.5 to 49.0).[11] Six studies in this review of traditional educational interventions such as lectures and distributed materials all had positive findings, with reductions in testing ranging from 22% to 60% after the intervention. Interventions that were exclusively educational had a median relative reduction in test ordering of 30.6% (16.5 to 48.5). However, the vast majority of included studies targeted physicians and were set in teaching hospitals. Only 10 out of 109 included studies addressed primary care physicians and family doctors.
- Colla et al. (2016) found that passive educational interventions, those with a narrow scope, or those with only one educational tactic are often less successful at reducing low-value care.[1]
- Stammen et al. (2015) found that lectures and educational sessions could lead to reductions in test ordering, especially if a cost-containment element was included, but did not provide any analysis.[17]
- A systematic review by Cadogan et al. (2015) included two studies of educational lectures that found a small reduction in test ordering at 1 year follow-up (by 5%), and an improvement in laboratory testing orders at 4 months post intervention (of 64%; no analysis provided).[3]

Reviews that reported negative findings overall:

- The review by Thomas et al. (2016) included an individual study of an educational intervention to increase lipid testing, which found a small increase (1.4%) in cholesterol testing in the control group after a 3-hour lecture with guidelines.[15]
- The reviews by French et al.[6] and Tzortziou-Brown[16] found that the distribution of educational materials had no impact on the ordering of diagnostic imaging for back pain, or limb and joint X-rays. One small study found that educational materials provided to GPs from surgeons after a BMD test may lead to an improvement in the rates of osteoporosis medicine prescribing (74% compared with 26%, large risk difference of 48%) by GPs.[16]

The review by French et al. (2010) found that for all interventions with a distributional educational component, the median absolute effect size was 3.8 (IQR –0.2 to 27.7) compared with 15.0 (IQR 10.6 to 18.1) for those without.[6]

Only one review provided cost data.[17] Interventions with distributed educational materials consistently demonstrated cost savings as a result of fewer test orders, with reported savings ranging from 16% to 22%.

### **3.5.2. Education and audit and feedback**

When the major intervention was continuing medical education with an audit–feedback component, reviews found:

- The combination of educational guidelines and audit–feedback may result in a slight reduction in spinal radiology requests.[6] However, in a key study found by two reviews, the distribution of educational materials with audit–feedback resulted in little or no reduction in GP radiology referrals overall.[6,16]
- A continuing medical education plan with a feedback component to improve test ordering for lipids found a 1% increase in improvement in the control group.[15]

### **3.5.3. Interactive educational**

Educational outreach, also known as academic detailing, is defined as the use of a trained person who meets with providers in their practice settings to give information with the intent of changing the provider’s practice.[6] This typically consisted of practice visits by educators, the provision of promotional material, and subsequent reminders or educational follow-up. Workshops and educational meetings were also included in this group if they had an evaluation process component.

Individual studies evaluating reduction in imaging requests and laboratory test ordering showed little or no change in ordering outcomes. Overall, educational sessions, workshops and guidelines may result in some positive changes in GP behaviour and patient-related outcomes. However, these interventions showed no improvements in GP prescribing.

Key studies reviewed found no evidence of effectiveness for face-to-face education sessions, including guideline dissemination and implementation strategies for reducing unnecessary imaging for low back pain.[6,10,16] One included study reported no change in GP behaviour with regard to ordering X-rays, issuing sickness certificates and prescribing opioids.[10]

Another study found academic detailing (two sessions) with educational material (DVD) plus guideline and a follow-up session 3 months afterwards (distribution of educational material) demonstrated temporary, slight reduction in the number of ultrasound requests, but little or no change in the number of X-ray requests.[16] A study to increase testing after dispensing of angiotensin-converting enzyme inhibitors or angiotensin-II receptor blockers (ACEIs/ARBs), diuretics or digoxin found no increase in follow-up testing after prescribing digoxin, a 3.3% increase in testing after prescribing ACEIs/ARBs, and a 4.9% increase after prescribing a diuretic.[15]

A study by Légaré et al. (2016) found that outreach may improve efficient use of laboratory tests in primary care; however, the level of evidence was quite low and the quality was poor.[18]

Patient outcomes were reported by one study covered by three reviews.[6,10,16] After adjustment for cluster variance this study found a 12.2% (95% CI 2.8% to 21.6%) increase in the number of patients in the intervention group being referred to physiotherapy or to educational programs at the back clinic. The increase in these referrals was considered to be a positive effect of the intervention.

### **3.5.4. Multicomponent interventions**

Multicomponent intervention strategies resulted in significant improvements in compliance and behavioural change in most reviews (5/7).[1,3,11,15,17] A range of strategy combinations was described, although there was no conclusive evidence of any relationship between the number of components and strategy effectiveness.

Colla et al. (2016) concluded that the effectiveness of education interventions to reduce low-value care varies depending on the intensity of the education program.[1] The authors concluded that multicomponent educational interventions, although costly and time-consuming, are more effective at reducing utilisation and targeted inappropriate use than passive educational interventions, those with a narrow scope, or those with only one educational tactic are often less successful at reducing low-value care.[1]

This was supported by Kobewka et al. (2015) who found that 30 interventions (25.2%) used multiple strategies; these multifaceted interventions had larger reductions in test use with a median relative reduction in test volume of 32.7% (IQR 15.1 to 47.5) versus 21.4% (IQR 9.5 to 33.3) for interventions that were classified into a single category.[11]

In contrast, the review by French et al. (2010) found no relationship between effect size and number of components in the interventions (Kruskal–Wallis test,  $p = 0.48$ ). Quantile regression analysis also indicated that there was no evidence of an increased effect size by increasing the number of components (coefficient  $-2.51$ , 95% CI  $-11.58$  to  $6.56$ ,  $p = 0.57$ ).

Key studies of different format interventions included:

- A hospital-based intervention in which monthly usage statements were distributed to physicians, in combination with guidelines on appropriate testing; some tests were cancelled if inappropriate, which reduced unnecessary tests by 62.1%.[11]
- A hospital-based intervention in which published guidelines on test ordering were distributed. A maximum number of tests per patient was instituted and test ordering was reviewed by a consultant, resulting in a 37.1% reduction in a number of specified tests.[11]
- An educational lecture about excessive and inappropriate testing was combined with feedback about ordering practices from a senior physician; tests were unbundled on the request form. This decreased all blood tests by 34.5%.[11]
- An educational intervention including a lecture on appropriate use criteria, a pocket card, and biweekly e-mail feedback on ordering behaviour which resulted in significantly lower inappropriate echocardiography use. Pre–post intervention had 26% reduction in number of transthoracic echocardiograms (TTE) ordered per day ( $p < 0.001$ ); proportion of inappropriate TTE was significantly lower (5% versus 13%;  $p < 0.001$ ) and proportion of appropriate TTE was significantly higher (93% versus 84%;  $p < 0.001$ ).[1]
- Feedback on compliance with national guidelines followed by small group discussions on clinical problems, which were shown to significantly decrease inappropriate ordering (as defined by guidelines) with a 5% to 12% reduction in testing in physician groups after problem-solving strategies.[3,6,15]



- A pre–post intervention consisting of an education, flyer, email, and cost impact information, which led to a reduction in number of overall tests ordered (4.14 versus 3.79 per patient per day;  $p = 0.001$ ), plus a cost reduction of \$6.33 per patient per day.[17]

### 3.5.5. *Interventions including a patient-mediated component*

Three reviews had a patient-mediated component aiming to educate the person on the condition and remind them to see their GP to discuss its management. The reviews typically included educational material, a GP-reminder system informing the participant's clinician on the patient's increased risk either via a patient-specific letter or an electronic reminder.

In the review by Tzortziou et al. (2016) most the studies reported improvements in GP behaviour and, more specifically, increases in bone mineral density (BMD) testing and osteoporosis medicine prescribing rates, with several studies showing moderate to large effects in investigation rates (for BMD testing) and four showing moderate to large effects in the prescribing rates for osteoporosis medicine.[16] A meta-analysis showed that a GP-alerting system for a patient's increased risk of osteoporosis combined with a patient-directed intervention (including patient education and a reminder to see their GP) improved GP behaviour with regard to diagnostic BMD testing and osteoporosis medicine prescribing (RR 4.44, 95% CI 3.54 to 5.55; three studies; 3386 participants) and for BMD and osteoporosis medicine (RR 1.71, 95% CI 1.50 to 1.94; five studies; 4223 participants).

A meta-analysis of two studies in the review showed that GP alerting on its own also probably improves osteoporosis guideline-consistent GP behaviour (RR 4.75, 95% CI 3.62 to 6.24; 3047 participants) for BMD and osteoporosis medicine (RR 1.52, 95% CI 1.26 to 1.84; 3047 participants) and that adding the patient-directed component probably does not lead to a greater effect (RR 0.94, 95% CI 0.81 to 1.09; 2995 participants) for BMD and osteoporosis medicine (RR 0.93, 95% CI 0.79 to 1.10; 2995 participants).[16]

The review by French et al. (2010) provided contrary findings. Four comparisons reported a significant improvement in BMD test ordering, with results ranging from 3.8% to 44.8% absolute change post intervention. Across all interventions (for musculoskeletal conditions) with a patient-mediated component, the median absolute effect size was 12.80 (IQR 3.8 to 27.7) compared with –0.90 (IQR –1.9 to 17.3) for interventions without a patient-mediated component.[6]

The authors concluded that interventions for managing musculoskeletal disorders that included a patient-mediated component tended to show larger effects than interventions that did not include these components. The inclusion of a patient-mediated educational component may be effective if patient counselling is also added.

The final review included one study only, which was covered in the reviews mentioned above, showing no effect for changes on rates of lumbar X-rays, CT or MRI.[10] However, this study reported patient referrals to physiotherapy or specialist, but found no difference between the intervention and non-interventions groups (RR 0.8, 95% CI 0.6 to 1.1 and RR 1.2, 95% CI 0.8 to 1.8; no effect size reported).[10]

### 3.5.6. *Outcomes for interventions aiming to increase or decrease a clinical behaviour*

Among reviews that evaluated and reported the effect size of interventions aiming to either increase or decrease a specific practice or behaviour, results in one review overall found that it was easier to increase a targeted practice rather than decrease it (median effect size for comparisons targeting a decreased use of imaging –2.4 [IQR –8.0 to 0.0] compared with +10.6 [IQR 0.7 to 34.0] for comparisons that targeted an increased use of imaging).[6]

However, a second review found that the direction of the targeted behaviour (that is, increasing or decreasing a behaviour) did not affect the effectiveness of an intervention (median effect size for comparisons aiming to increase a behaviour of 5 [IQR 0.6 to 12.6] compared with 1.1 [IQR –1.1 to 3] for comparisons that aimed to decrease an existing behaviour).[16] Thomas et al. (2016) reported an

average decrease of 18% in six studies aiming to decrease test ordering, but did not provide an estimate for studies aiming to increase testing.[15]

### 3.5.7. *Summary of findings*

Overall, each type of educational intervention demonstrated improvements in at least one of the assessed outcomes, including:

- multicomponent intervention strategies, which resulted in significant improvements in compliance and behavioural change in most reviews (5/7)[1,3,11,15,17]
- improved rates of diagnostic imaging tests or laboratory test ordering (traditional education)[1,3,4,6,11,17]
- small improvements in rates of diagnostic imaging tests or laboratory test ordering (education with audit and feedback)[6,15,16]
- reduction of inappropriate test use (multicomponent interventions)[1,3,6,15,17]
- improvement in guideline-consistent GP behaviour (interventions including a patient-mediated component)[16]
- improvements in patient outcomes (referrals to physiotherapy, medicine prescribing rates, interactive educational, interventions including a patient-mediated component).[6,10,16]

No conclusion can be drawn as to whether the direction of the targeted behaviour (that is, increasing or decreasing a behaviour) can affect the effectiveness of an intervention.

The effectiveness of educational interventions, broadly, is contentious. Clinician education can be an effective tool to improve the quality of diagnostic imaging requests and laboratory testing, particularly when used in conjunction with other interventions such as audit and feedback.

Many interventions cited in reviews were poorly defined or did not include data, precluding analysis. In the review by Kobewka et al. (2015) half of the interventions were not described adequately enough to be replicated, with a high risk of contamination between experimental and control groups, results were reported incorrectly (per institution/physician instead of per patient), and 90% had no time series analysis.[11]

While we included only key studies reporting significant positive effects, the number may be greater, as many studies reporting positive findings did not report significance.

Additionally, potential unit of analysis errors were commonly reported.[6,16] In many cluster RCT (C-RCT) studies the practitioner was randomised but during the statistical analyses individual patient data were analysed as if there was no clustering within practitioner. C-RCT studies that do not account for clustering during analysis have 'unit of analysis errors', increasing the chances of spuriously significant findings and misleading conclusions.[21]

Conflicting findings were found as to the degree that time and intensity of educational strategies may influence effectiveness, with a large number of included studies reporting short pre–post intervention findings; no review reported an optimal length of educational programs in terms of either number of sessions, frequency, or total time.

The sustainability of education-based strategies is often questioned in the literature.[11] However, follow-up of long-term effects of education programs found it can be achieved with regular re-enforcement, although not captured in this review.[3] Moreover, the literature suggests provider education is inexpensive and feasible for widespread delivery; the few included studies providing cost data consistently reported cost savings.[17] However, no study stated whether savings offset costs of implementation, or consequences of test volume reduction on patient outcomes. Few studies reported patient outcomes and overall found that interventions had little impact on medicine prescribing rates.



According to this review, educational interventions with potential for effectiveness in improving diagnostic imaging and laboratory test ordering include those with an audit–feedback component, multicomponent interventions, and combined physician–patient-mediated strategies, although there was little clarity regarding the most effective mix of elements in multicomponent strategies. Less-effective strategies included didactic education and passive dissemination strategies such as providing educational materials to clinicians in printed form. There was no research into costs of implementation, or relative costs to benefits.

### 3.6. Audit and feedback

A total of 11 reviews that met the eligibility criteria investigated audit and feedback interventions.[1,3,4,6,10,11,14-18] The key findings from these reviews are summarised in Table 5.

Only one meta-analysis of audit and feedback was included in the reviews. This showed that the presence of a physician audit and feedback mechanism was associated with lower odds of inappropriate testing (OR 0.36, 95% CI 0.31 to 0.41,  $p < 0.001$ ), whereas studies that lacked this process had no significant effect on inappropriate testing (OR 0.89, 95% CI 0.61 to 1.29,  $p = 0.51$ ;  $p$  value for difference  $< 0.001$ ).[4]

Systematic reviews of audit and feedback provided the following mixed findings:

- the percentage relative reductions in test ordering interventions were statistically significantly decreased versus controls, with 18 out of 51 interventions with an audit/feedback component (median RR 23.2, IQR 13.8 to 34.5).[11] For exclusively audit and feedback interventions, the median RR (IQR) was 18.4 (2.1 to 24.8). For exclusively cost display, the median RR (IQR) was 18.4 (2.1 to 28.8).
- interventions that used practitioner audit and feedback, or practitioner education or guideline dissemination had variable results and did not significantly reduce imaging rates.[10]
- the effectiveness of interventions was closely tied to the use of physician audit and feedback mechanisms; two included studies used feedback alone (one showed a 5% increase, one a 27% desired decrease); eight education and feedback (average increase in desired direction greater than the control of 4.9%), one system change and feedback (increases of 5% to 44%), three education and system change and feedback (average 7.7% increase).[15]

Overall, the other reviews reported that when clinicians were provided feedback on their use of low-value services compared with their peers, in addition to educational materials, large reductions in laboratory testing and imaging were observed.[1,11] An RCT study included in the review by Kobewka et al. (2015) investigated ordering by medical students and residents after an intervention involving a manual outlining rational test ordering supplemented with feedback on laboratory usage and costs incurred. Their usage compared with peers reduced test ordering by 40.9%. A similar study targeting residents with education, audit and individual feedback on test ordering for high users found a reduction in all laboratory test of 21.0%.[11] One review emphasised the role of feedback in successful learning, noting that facilitation of reflective practice, such as providing feedback from mentors and educators or asking reflective questions regarding decisions related to laboratory ordering or prescribing to give trainees insight into their past and current behaviour was key to accomplishing lasting practice change.[17]

There was insufficient data for included studies to perform meta-analysis in two reviews, which showed that providing GP feedback combined with guidelines on the total number of investigations requested may result in a slight reduction in the number of radiology requests.[6,16], and an improvement in medicine prescribing rates.[16]

However, according to Colla et al. (2016), based on one study that showed that while over-utilisation decreased, underutilisation increased, volumes of test orders may be being reduced regardless of value.[1] In a review examining the impact of cost display on provider ordering, Silvestri et al. (2016) found that combining written education regarding costs with feedback regarding laboratory use

seemed to decreased test utilisation compared with audit and feedback alone (unadjusted difference 22.3%, high risk of bias; no p-value reported; one study, no analysis reported).[14] The authors concluded that although there is insufficient evidence on which to base strong conclusions, review results suggested that provider price display likely reduces order costs to a modest degree. This was supported by a study of audit and feedback combined with educational support, which found a 22% post-intervention reduction in test ordering and subsequent costs.[17]

There was little discussion of the impact of frequency of intervention delivery, with most studies being pre–post interventions that did not use time series analysis to determine the longer-term outcomes. The review by Kobewka et al. (2015) included a discussion of sustainability of results, stating that multiple reminders and repeated meetings were necessary to maintain the change in behaviour.[11] Infrequent reporting of post-intervention results was noted by one other review, where a period of reduction in test ordering during an intervention was followed by a return to baseline.[1,17] One other review considered frequency of feedback[17] although without analysis, and suggested that both frequency and timing may be important factors in the effectiveness of interventions.

### **3.6.1. Summary of findings**

Audit and feedback generally leads to small-to-moderate improvements in professional practice, including reductions in test ordering and inappropriate imaging.[1,11,17]

Improvements in correct test ordering has consequent cost reductions.[11,17]

A meta-analysis demonstrated lower odds of inappropriate diagnostic imaging tests.[4]

However, many interventions cited in reviews were poorly defined or did not include data, precluding analysis. In the review by Kobewka et al. (2015) half the interventions were not described adequately enough to be replicated, with a high risk of contamination between experimental and control groups, results reported incorrectly (per institution/physician instead of per patient), and 90% had no time series analysis.[11]

Additionally, the interventions in this review were multifaceted; hence, their effects were dependent on the particular combination of strategies used. Most studies were pre–post and did not include any time series analysis, which brings into question the sustainability of any intervention and the validity of results. Multiple and repeated strategies are most likely necessary to maintain an effect, increasing resources and hence costs. Many of the interventions have questionable generalisability; there is a wide range of relative reductions among included studies due to heterogeneity at every level.

## **3.7. Payment systems**

A total of three reviews that met the eligibility criteria investigated payment systems. The reviews investigated pay-for-performance, insurer restrictions and risk sharing.[1,11,17]

### **3.7.1. Pay-for-performance**

Two reviews investigated pay-for-performance.[1,11]

Kobewka et al. (2015) investigated the influence of educational, audit and feedback, system-based, and incentive and penalty interventions to reduce laboratory test utilisation.[11]

They included one relevant study for payment systems, in which medical residents received money if their laboratory use decreased after a 1-hour lecture on laboratory costs. After the intervention, there was a significant reduction in the number of radiology and blood tests performed (relative reduction of 5.8).[11]

The review by Colla et al. (2016) refers to a ‘notable example’ of pay-for-performance.[1] The example is a program in which medical residents were paid for improved adherence to guidelines that supported the avoidance of five laboratory tests. The targeted tests were ranked in the top 13

performed at the hospital but were deemed least likely to be abnormal or influence patient management (low-value care). The program resulted in a 47% decrease in target test utilisation. [1]

Colla et al. (2016) also described another study in which a \$150 gift card rewarded to medical residents was able to reduce laboratory test utilisation, but the change was not maintained after the study period.[1]

### **3.7.2. Other payment systems**

The review by Colla et al. (2016) described insurer restrictions and risk sharing arrangements.[1] The results from three separate studies were summarised, which showed that third-party review decreased electroencephalogram use, troponin test requests, and imaging for neurological deficit disorders before use of physical therapy. A further study was used to summarise that prepaid insurance plans can decrease the utilisation of diagnostic tests.[1]

Stammen et al. (2015) investigated the circumstances under which the delivery of high-value, cost-conscious care is learned, with a goal of informing development of effective educational interventions. They included one relevant study, which investigated payment system rules and other financial levers.[17]

Education on the utility and cost of testing and fines for overuse led to significant absolute reduction in rate of C-reactive protein test ordering (17.6%,  $p < 0.001$ ) among the target population of medical students, residents and practising physicians. Although the study was rated to have a lower quality of rigour, it was deemed to have a higher quality of relevance.[17]

### **3.7.3. Summary of findings**

A total of three reviews investigated pay-for-performance, insurer restrictions and risk sharing.[1,11,17] There were no meta-analyses and results were summarised for individual included studies.

All reviews that described pay-for-performance targeted medical residents. The incentives substantially reduced laboratory test utilisation, although one study showed that the intervention was not maintained after the study period.[1,11]

Third-party review and prepaid insurance plans were able to reduce the utilisation of imaging, diagnostic and laboratory tests,[1] and education on the utility and cost of testing combined with fines for overuse also led to reduced rates of laboratory test ordering.[17]

There was some limited evidence to suggest that payment systems can improve the appropriateness and clinical utility of diagnostic imaging and pathology tests requested by health professionals.

Overall, pay-for-performance substantially reduced laboratory test utilisation,[1,11] third-party review and prepaid insurance plans reduced the utilisation of imaging, diagnostic or laboratory tests,[1] and education on the utility and cost of testing combined with fines for overuse reduced rates of laboratory test ordering.[17]

However, these results were only derived from three included reviews, and each of these only provided a narrative report of individual studies.[1,11,17]

Pay-for-performance interventions must be carefully stratified to minimise risk of reductions to appropriate care; risk sharing has been incompletely tested for low-value care; and further research is needed on the effectiveness of pay-for-performance, insurer restrictions, and risk-sharing.[1]

## **3.8. Quality improvement**

A total of five reviews that met the eligibility criteria investigated methods for quality improvement. All five investigated modifications or restrictions to referral or order forms.[3,4,10,17,19] The key findings from these reviews are summarised in Table 6.

### **3.8.1. Modifications or restrictions to referral or order forms**

Jenkins et al. (2015) included one study that investigated the effect of restricting indications for lumbosacral spine radiography in patients with acute back symptoms. CDS involving a modified referral form reduced imaging by 36.8%. [10]

In the review by Stammen et al. (2015), results from a single study showed that changing an order form to include reflective questions decreased utilisation of imaging by 22.5% and resulted in cost savings, without increases in adverse outcomes. [17]

Thomas et al. (2015) included studies that investigated the effectiveness of interventions by laboratories to increase rational and reduce unnecessary test ordering by family physicians. Laboratory forms were changed in six of the included studies (with the two largest studies involving 5.2 million and 3.2 million tests). No meta-analysis was conducted, but the unweighted average percentage reduction in number of tests ordered was calculated. [19]

Although no change was seen in one study, in the other studies there was a reduction in request rates for laboratory tests after modification of order forms to: [19]

- remove separate individual tests from groups of tests (2% to 58% reduction, depending on the test)
- reduce the total number of tests included on an order form (17% to 79% reduction, depending on the test and study)
- deny family physicians the option to order certain tests (100% reduction)
- justify costs over a specified value (61% reduction)
- re-organise tests into screening, tests to assess the extent of a problem, and tests to fully evaluate a problem (2% reduction, 3 months after the intervention).

The review by Chaudhuri et al. included two studies that investigated the use of point-of-care decision support tools for cardiac imaging. Order forms adapted to display appropriateness of tests at the point of care were investigated in one of the studies, but results were presented for both studies together as 'decision support tools' (these details are provided under the heading 'CPOE and CDSS'). [4]

Cadogan et al. (2015) also showed that changes to test order forms can reduce the number of test ordered. One of these studies investigated the effect of implementing cost displays on electronic health records and is described in 'Price display'. The remaining three studies were included in above review by Thomas et al. (2015). [3,19]

Associated information is also included under the heading 'system-based information' in 'Clinical decision support'.

### **3.8.2. Summary of findings**

All of the five included reviews investigated modifications or restrictions to referral or order forms. [3,4,10,17,19]

The review by Chaudhuri et al. (2016) included one relevant study, but results were presented in 'CPOE and CDSS' in 'Clinical decision support'. [4] In addition, one of the studies included by Cadogan et al. (2015) is discussed in 'Price display' in 'Clinical decision support' and the remaining three studies included by Cadogan et al. (2015) were included in the review by Thomas et al. (2015). [3,19]

Chadhuri et al. (2016) investigated quality improvement initiatives aimed at reducing inappropriate cardiac imaging, in particular, the proportion of inappropriate tests based on appropriate use criteria (findings are covered in 'Audit and feedback'). They concluded that quality improvement interventions are associated with a reduction in inappropriate cardiac testing, although these benefits seem to be closely tied to the use of physician audit and feedback mechanisms. They stated

that further research is needed to evaluate a greater diversity of intervention types, with improved study designs.[4]

Cadogan et al.(2015) investigated interventions focused on improving the appropriateness of laboratory requesting patterns from primary care. They concluded that interventions such as educational strategies, feedback and changing test order forms may improve the efficient use of laboratory tests in primary care; however, the level of evidence was quite low and the quality was poor.[3]

The main body of evidence was derived from three remaining reviews, which did not conduct a meta-analyses and instead reported the results of individual studies.[10,17,19]

Imaging was reduced by 22.5% to 36.8% after modification to a referral or order form,[10,17] whereas request rates for laboratory tests decreased by 2% to 100% after modification of order forms.[19]

All included reviews that investigated methods for quality improvement investigated modifications or restrictions to referral or order forms. There was some evidence to suggest that these intervention improve the appropriateness and clinical utility of diagnostic imaging and pathology tests requested by health professionals.

Overall, the included reviews showed that modifying a referral form to allow only three guideline-appropriate indications for imaging reduced rates of imaging, changing an order form to include reflective questions decreased utilisation of imaging and resulted in cost savings without increases in adverse outcomes, and that request rates for laboratory tests can decrease after modification of order forms to separate individual tests from groups of tests, reduce the total number of tests included, or re-organise tests based on depth of evaluation required.[10,17,19]

However, these data were only derived from three reviews. These reviews did not conduct a meta-analyses and instead reported the results of individual studies.[10,17,19]

Most data were derived from one study, which highlighted the limitations of the findings: the rationale for choosing specific tests was often not explained, most studies targeted a few tests for several months, and the tests and test volumes differed widely across studies.[19]

## 4. Discussion

These reviews identified a variety of intervention strategies that are effective under certain conditions, but current knowledge is imperfect. Heterogeneity between included studies, low number of meta-analyses, and lack of effect sizes made comparisons difficult. There was considerable overlap across the reviews; for example, audit and feedback is an essential component of quality improvement strategies and was also included in a considerable majority of multicomponent interventions. This overlap also reflects that many reviews did not refer to any theoretical or empirical frameworks for classifying behaviour change interventions (such as EPOC),[22] resulting in a variation in intervention definitions.

Passive dissemination (for example, mailing educational materials to targeted clinicians) was considered to be generally less effective for behaviour change when used alone; simply providing the evidence may not be sufficient to elicit change. However, this approach may be useful for raising awareness of the desired behaviour change and is inexpensive and feasible for widespread delivery.

Interactive approaches are more likely to be effective but are also likely to be more resource-intensive and hence more costly. Interventions of variable effectiveness include some interactive educational strategies. Awareness of price may lead to the ordering of less expensive, rather than fewer, tests. Pay-for-performance, reminders, and audit strategies may lead to reduced test utilisation, as feedback regarding the costs of procedures at the time of ordering has had a moderating effect, but effects of interventions were often not sustained after the intervention period, leading to a diminished effect. The inclusion of a patient-mediated educational component may be effective if patient counselling is also added.

Systems that proactively prompted clinicians and/or required a response were also more likely to be effective in changing professional behaviour. Alerting physicians to possible duplication and identifying outliers in imaging utilisation improved appropriateness of use. **Generally effective strategies included decision support interventions**, which facilitate improved compliance, the performance of desired behaviours and makes it harder for unwanted behaviours to occur. However, most studies were hospital-based interventions; the effectiveness of these strategies in alternative practice settings such as general practice, where most healthcare is delivered, is unclear.

This is similar for quality improvement strategies that use modifications or restrictions to test order forms. Modifying a referral form to allow only guideline-appropriate indications, changing an order form to include reflective questions, and introducing separation of individual from groups of tests decreased utilisation of imaging and testing, and resulted in cost savings without increases in adverse outcomes.

Multicomponent interventions were also more likely to be successful; however, it was difficult to specify which components of multifaceted interventions are likely to be effective and complementary under different settings, due to the very small number of included studies. The inclusion of an audit and feedback intervention appeared to provide a strong motivational component to improve utilisation of tests, particularly in hospital settings where it was combined with other strategies such as education.

Very few studies measured any patient safety or quality of care outcomes affected by reduced test use. One possible reason for this is that process-of-care measures being investigated did not impact on outcomes such as mortality, or were confounded by clinical complexity or other patient-related factors that made it difficult to assess. Quality improvement strategies to improve use of testing generally resulted in cost savings without increases in adverse outcomes.

There was some limited evidence to suggest that payment systems can improve the appropriateness of diagnostic imaging and pathology tests requested by health professionals. Numerous studies use low-investment strategies to reduce test utilisation with one-time changes in the ordering system. These low-investment strategies are promising for achievable and durable reductions in inappropriate test use. The success of pay-for-performance is most likely a factor of the size of the



incentive, baseline performance levels, and the inherent ability to improve and respond adequately to such incentives in a given setting, details not covered in this review.

Few key primary studies investigated cost outcomes. This may be a reflection of the age of some of the included studies – cost-control has become a major focus of policy makers with the rising focus on the cost of healthcare in recent years. Cost outcomes were explicitly reported for most reviews of CDS, but were infrequently reported for other interventions. Cost impact information was shown to lead to a reduction in number of overall tests ordered.

Provider price/cost display, as part of audit and feedback and computerised decision support, is likely to reduce order costs to a modest degree, but estimates were small in most reported studies and imprecise (large confidence interval). While significant cost reductions were reported in some settings in these reviews, it was not known whether the cost benefits were offset by the cost of the implementation strategies. It is therefore not possible to comment on the likely cost-effectiveness of any intervention.

This lack of economic evaluation is a major detractor from the widespread uptake of interventions, particularly as it has been suggested that quality improvement efforts, especially those focused on safety, may not be cost-saving, possibly because of additional capacity generated rather than savings.[23] Further research is needed into the costs and benefits of interventions, particularly given the cost of reportedly effective strategies, namely audit and feedback and decision support systems.

#### 4.1. Conclusions

In conclusion, there was some evidence to suggest that CDS interventions improve the appropriateness of diagnostic imaging and pathology tests requested by health professionals, with CPOE or CDSS appearing to have the greatest body of evidence. Modifying systems such as order entry can change physician behavior, encouraging greater interaction with the decision support system, resulting in fewer low-yield orders.

Continuing medical education is necessary for physician knowledge and methods that could be described as traditional, such as didactic conferences or printed materials, are important to affect physician knowledge or attitude. However, the most successful interventions combined education with peer review, feedback, and administrative (order entry) changes. Although multicomponent intervention strategies may result in significant improvements in compliance and behavioural change, the sustainability of single-point simple education-based strategies is questionable. Small group strategies with problem solving and feedback can lead to modest improvements in test ordering in primary care. No inference can be made as to timing of strategies within multi-component interventions, that is for example, whether education should precede administrative or other changes, and what is the optimal time frame for subsequent audit and feedback. Sequential or longitudinal components may be more effective. The sustainability of pay-for-performance incentives are also inconclusive, although they may be effective interventions for medical residents. Audit and feedback generally leads to small-to-moderate improvements in professional practice, and comparison with peers can lead to effective behaviour change. Chart review and feedback about practice have been shown to be effective in reducing laboratory utilisation, and reducing unnecessary blood transfusions. Interventions that employed physician audit and feedback were associated with significantly lower odds of inappropriate cardiac testing, particularly in hospital settings. However, strategies based on addressing clinical problems and associated tests can be effective in primary care. Modifications or restrictions to test order forms may improve the appropriateness of diagnostic imaging and pathology tests.

Top-down administrative changes or ‘enabling’ strategies are effective, with evidence to suggest that CDS interventions improve the appropriateness of diagnostic imaging and pathology tests requested by health professionals, with CPOE or CDSS appearing to have the greatest body of evidence. Modifying systems such as order entry can change physician behaviour, encouraging greater

interaction with the decision support system, resulting in fewer low-yield orders. Modifications or restrictions to test order forms may improve the appropriateness of diagnostic imaging and pathology tests. Reminders and alerts embedded into the process of care can substantially affect inappropriate test orders.

Although price display has not consistently shown to be effective, cost-awareness strategies are easy to implement and less time and labour intensive than active education, and are hence worthy of consideration.

The effectiveness of these strategies in primary care settings in particular remains unclear. Effectiveness and generalisability are of particular importance given that technology-based interventions are tools to support delivery of care and the context in which they are implemented is crucial.



# Figures and Tables

Figure 1. Flow of information through the literature review

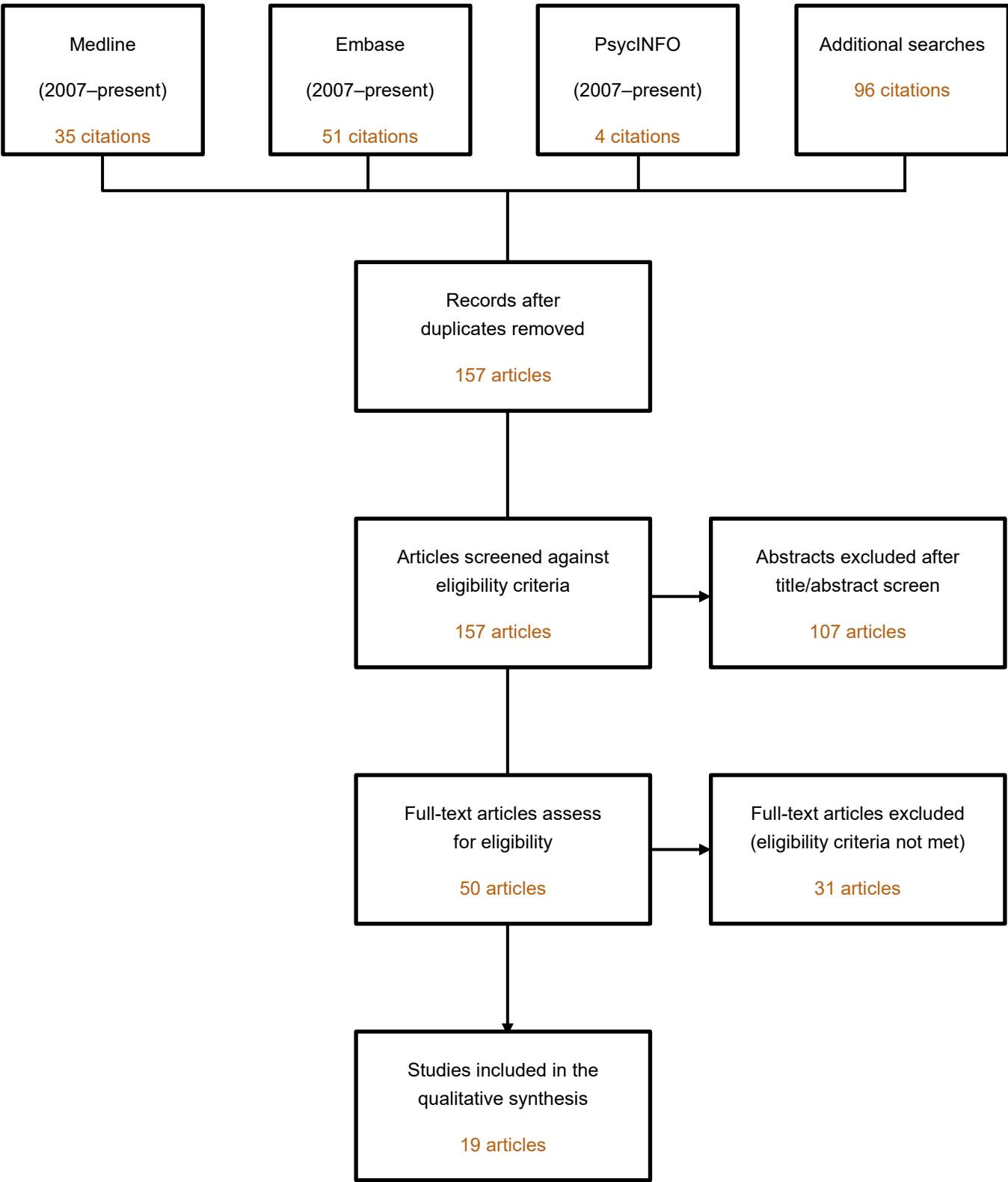


Table 2. Summary of included studies

First author (year)	Title	Review characteristics
<b>Bright TJ (2012)</b>	Effect of clinical decision support systems: a systematic review	n = 148 studies Study design: RCT Population: healthcare providers Intervention: Ds Outcome category: b, e, f Effectiveness measure: meta-analysis (OR, RR) AMSTAR quality score: 5
<b>Cadogan SL (2015)</b>	The effectiveness of interventions to improve laboratory requesting patterns among primary care physicians: a systematic review	n = 11 studies Study design: SR, RCT, CCT, BA, ITS Population: primary care physicians Intervention: Af, Ds, Ed, Qi Outcome category: b, f Effectiveness measure: narrative reporting; no meta-analysis due to heterogeneity AMSTAR quality score: 6
<b>Chaudhuri D (2016)</b>	Effectiveness of quality improvement interventions at reducing inappropriate cardiac imaging: a systematic review and meta-analysis	n = 7 studies Study design: RCT, OBS Population: physicians Intervention: Af, Ds, Ed Outcome category: f Effectiveness measure: meta-analysis (OR) AMSTAR quality score: 8

First author (year)	Title	Review characteristics
<b>Colla CH (2016)</b>	Interventions aimed at reducing use of low-value health services: a systematic review	n = 108 studies Study design: ND Population: ND Intervention: Af, Ds, Ed Outcome category: b, f Effectiveness measure: narrative reporting (% changes calculated when possible); no meta-analysis (reason not stated) AMSTAR quality score: 9
<b>Flodgren G (2016)</b>	Tools developed and disseminated by guideline producers to promote the uptake of their guidelines	n = 4 studies Study design: RCT, BA, ITS Population: qualified healthcare professionals, health system managers, policy makers Intervention: Ds Outcome category: f Effectiveness measure: median absolute risk difference and IQR for the main outcome (adherence to guidelines); no meta-analysis due to heterogeneity AMSTAR quality score: 10
<b>French SD (2010)</b>	Interventions for improving the appropriate use of imaging in people with musculoskeletal conditions	n = 28 studies Study design: RCT, CCT, ITS Population: health professionals, policy makers, general public Intervention: Af, Ds, Ed Outcome category: b, c, f, g Effectiveness measure: standardised effect sizes calculated when possible; no meta-analysis due to heterogeneity AMSTAR quality score: 9

First author (year)	Title	Review characteristics
<b>Georgiou A (2007)</b>	The impact of computerised physician order entry systems on pathology services: a systematic review	n = 19 studies Study design: RCT, NRS, BA, ITS, QE Population: physicians Intervention: Ds Outcome category: b, f Effectiveness measure: narrative reporting; no meta-analysis (reason not stated) AMSTAR quality score: 2
<b>Georgiou A (2011)</b>	The impact of computerised provider order entry systems on medical-imaging services: a systematic review	n = 14 studies Study design: OBS, EXP Population: ND Intervention: Ds Outcome category: b, f Effectiveness measure: narrative reporting; no meta-analysis due to heterogeneity AMSTAR quality score: 4
<b>Goetz C (2015)</b>	The effect of charge display on cost of care and physician practice behaviors: a systematic review	n = 17 studies Study design: RCT, NRS, PP Population: ND Intervention: Ds Outcome category: b, c, g Effectiveness measure: narrative reporting; no meta-analysis due to heterogeneity AMSTAR quality score: 3
<b>Jenkins HJ (2015)</b>	Effectiveness of interventions designed to reduce the use of imaging for low-back pain: a systematic review	n = 7 studies Study design: RCT, CCT, ITS Population: patients receiving imaging for low back pain Intervention: Af, Ds, Ed, Qi Outcome category: b, f Effectiveness measure: summary statistics calculated when possible (risk ratio and 95% CI for dichotomous outcomes; % mean difference and 95% CI for continuous outcomes); no meta-

First author (year)	Title	Review characteristics
		analysis due to heterogeneity AMSTAR quality score: 8
<b>Kobewka DM (2015)</b>	Influence of educational, audit and feedback, system based, and incentive and penalty interventions to reduce laboratory test utilisation: a systematic review	n = 109 studies Study design: RCT, CCT, BA, ITS Population: physicians Intervention: Ad, Ds, Ed Outcome category: b, g Effectiveness measure: descriptive analysis of relative reductions (median and IQR); no meta-analysis due to heterogeneity AMSTAR quality score: 5
<b>Légaré F (2016)</b>	Improving decision making about genetic testing in the clinic: an overview of effective knowledge translation interventions	n = 28 studies Study design: RCT, CCT, BA, ITS Population: no restrictions Intervention: Af, Ed Outcome category: b Effectiveness measure: intervention labelled 'effective' if it had a statistically significant impact on all assessed outcomes; 'partially effective' if it had a statistically significant impact on $\geq 1$ assessed outcome; 'ineffective' if it had no statistically significant impact on any assessed outcome. No meta-analysis (reason not stated) AMSTAR quality score: 5
<b>Main C (2010)</b>	Computerised decision support systems in order communication for diagnostic, screening or monitoring	n = 24 studies Study design: RCT, CCT, ITS, PP Population: healthcare workers in practice or in training, patients undergoing testing Intervention: Ds Outcome category: b, g

First author (year)	Title	Review characteristics
	test ordering: systematic reviews of the effects and cost-effectiveness of systems	Effectiveness measure: narrative reporting; no meta-analysis due to heterogeneity AMSTAR quality score: 9
<b>Roshanov PS (2011)</b>	Can computerised clinical decision support systems improve practitioners' diagnostic test ordering behavior? A decision-maker-researcher partnership systematic review	n = 35 studies Study design: RCT Population: physicians using computerised CDSS Intervention: Ds Outcome category: b Effectiveness measure: narrative reporting; no meta-analysis due to heterogeneity AMSTAR quality score: 9
<b>Silvestri MT (2016)</b>	Impact of price display on provider ordering: a systematic review	n = 19 studies Study design: RCT, ITS, PP Population: ND Intervention: Af, Ds Outcome category: b, g Effectiveness measure: narrative reporting; no meta-analysis due to heterogeneity AMSTAR quality score: 6
<b>Stammen LA (2015)</b>	Training physicians to provide high-value, cost-conscious care: a systematic review	n = 79 studies Study design: RCT, BA, ITS, QE Population: physicians, nurses, residents, medical students, patients Intervention: Af, Ed, Qi Outcome category: b, f, g Effectiveness measure: narrative reporting (with 'relevance score' attributed); no meta-analysis (reason not stated) AMSTAR quality score: 7

First author (year)	Title	Review characteristics
<b>Thomas RE (2015)</b>	Interventions at the laboratory level to reduce laboratory test ordering by family physicians: systematic review	n = 10 studies Study design: RCT, BA, CS Population: family physicians Intervention: Qi Outcome category: b Effectiveness measure: narrative reporting (with unweighted average % reduction in number of tests ordered calculated); no meta-analysis (reason not stated) AMSTAR quality score: 4
<b>Thomas RE (2016)</b>	Interventions to educate family physicians to change test ordering: systematic review of randomised controlled trials	n = 29 studies Study design: RCT Population: GPs, patients requiring laboratory tests Intervention: Af, Ds, Ed Outcome category: b, f Effectiveness measure: calculated unweighted averages to compare intervention/control groups; no meta-analysis (reason not stated) AMSTAR quality score: 6
<b>Tzortziou Brown V (2016)</b>	Professional interventions for general practitioners on the management of musculoskeletal conditions	n = 30 studies Study design: RCT, NRS, BA, ITS Population: GPs, multidisciplinary care teams Intervention: Af, Ds, Ed Outcome category: b, c, f, g Effectiveness measure: meta-analysis (RR) AMSTAR quality score: 10

BA: before-and-after studies; CCT: controlled clinical trial; CDSS: clinical decision support systems; CS: cohort study; IQR: interquartile range; ITS: interrupted time series; NA: not applicable; ND: not described in methods; NRS: non-randomised controlled study; OBS: observational study; OR: odds ratio; PP: pre-post intervention; RCT: randomised controlled trial; RR: risk ratio/relative risk; SR: systematic review; QE: quasi-experimental

#### Intervention categories

Af: audit and feedback; Ds: clinical decision support; Ed: education; Ps: payment systems; Qi: quality improvement

#### **Outcome categories**

- a. Clinical utility (including positive and negative predictive value).**
- b. Rates of diagnostic imaging/pathology tests, or rates of their requests or referrals.**
- c. Rates of medicine prescribing after diagnostic imaging/pathology tests.**
- d. Rates of invasive treatments or procedures.**
- e. Health outcomes (morbidity, mortality, quality of life).**
- f. Rates of appropriate/inappropriate requesting for diagnostic imaging/pathology tests (including compliance with guidelines/recommendations).**
- g. Costs or cost effectiveness.**



Table 3. Key findings on clinical decision support interventions

First author (year)	Findings of key studies in the review	Result summary
<b>Alerts, prompts or reminders</b>		
Colla CH (2016)	<p><b>Baer et al. <i>Transfusion</i> 2011;51:264–9.</b> Prompts alerting physicians to non-compliance with guidelines improve compliance with transfusion guidelines in neonatal intensive care units (from 65% to 90%).</p> <p><b>Neilson et al. <i>Ann Intern Med</i> 2004;141:196–204.</b> Alerts can also be used to discontinue low-value care. One study examined the use of electronic health record prompts to decrease or discontinue standing or repeat test orders after 72 hours, significantly reducing testing.</p> <p><b>Chen et al. <i>Am J Clin Pathol</i> 2003;119:432–8.</b> Alerts can also substantially affect inappropriate test orders. An alert indicating that a test value is already in the system leads to a reduction in repeat testing. After an alert was implemented for redundant anti-epileptic drug level measurement orders, inappropriate redundant ordering decreased from 54% of all orders to 15%.</p> <p><b>Levick et al. <i>BMC Med Inform Decis Mak</i> 2013;13:43 &amp; Niles J, et al. <i>BMC Health Serv Res</i> 2010;10:70.</b> A similar alert for inappropriate repeat B-type natriuretic peptide testing for heart failure management reduced redundant tests by 21% relative to baseline, and reduced redundant viral serology test ordering by 24% in another study.</p>	Results from individual studies showed that prompts and alerts can improve compliance with guidelines and reduce rates of testing, repeat testing or redundant testing.

First author (year)	Findings of key studies in the review	Result summary
French SD (2010)	<p>To improve the use of imaging in the management of osteoporosis, the effect of any type of intervention compared with no-intervention controls was modest (absolute improvement in bone mineral density test ordering of 10%, IQR 0.0 to 27.7). Patient-mediated, reminder and organisational interventions appeared to have most potential for improving imaging use in osteoporosis.</p> <p><b>Osteoporosis</b>  <b>Stock et al. <i>Ann Intern Med</i> 1998;128(12 Pt 1):996–9.</b>  Comparison of reminders vs a no-intervention control, which reported a continuous imaging outcome (number of bone mineral density tests ordered per month). There was a significant improvement in test ordering with use of a reminder (81%; <math>p = 0.002</math>).</p> <p><b>Boyd et al. <i>J Clin Densitom</i> 2002;5(4):375–81.</b>  In a study that compared two types of reminder, there was an absolute improvement in bone mineral density test ordering of 7.1% (95% CI –8.0 to 22.0), but had a potential unit of analysis error.</p> <p><b>Low back pain</b>  <b>Baker et al. <i>AJR Am J Roentgenol</i> 1987;149:535–8</b>  Reported a 47% decrease in the number of lumbar radiology examinations after a reminder intervention. Re-analysis of this comparison using time-series regression resulted in a significant change in level (<math>p = 0.001</math>) but not in slope (<math>p = 0.251</math>), indicating a sustained effect of the reminder intervention.</p>	<p>Results from individual studies showed that patient-mediated, reminder and organisational interventions had most potential for improving imaging use in osteoporosis. Interventions for low back pain showed variable effects.</p>
Jenkins HJ (2015)	<p><b>Eccles et al. <i>Lancet</i> 2001;357:1406–9.</b>  A short educational message promoting correct imaging practices was attached to all reports of lumbar spine imaging during the intervention period. After adjustment for clustering, absolute change in lumbar spine imaging: –1.5 radiographs/1000 patients (95% CI –2.5 to –0.6) vs controls.</p> <p>This was equivalent to a reduction in imaging of 22.5% (95% CI 8.4% to 36.8%).</p>	<p>Results from a single study showed that use of imaging for low-back pain was significantly reduced with interventions involving targeted reminders.</p>

First author (year)	Findings of key studies in the review	Result summary
Tzortziou Brown V (2016)	In a meta-analysis of two studies, alerts for general practitioners led to improved bone mineral density testing rates (RR 4.75, 95% CI 3.62 to 6.24; 3047 participants) and osteoporosis medicine prescribing rates (RR 1.52, 95% CI 1.26 to 1.84; 3047 participants).	Meta-analysis of two studies showed that GP alerting on its own probably improves osteoporosis guideline-consistent GP behaviour.
CPOE and CDSS		

First author (year)	Findings of key studies in the review	Result summary
Bright TJ (2012)	<p>Both commercially and locally developed CDSS improved healthcare process measures related to performing preventive services (n = 25; OR 1.42, 95% CI 1.27 to 1.58), ordering clinical studies (n = 20; OR 1.72, 95% CI 1.47 to 2.00), and prescribing therapies (n = 46; OR 1.57, 95% CI 1.35 to 1.82).</p> <p><b>Meta-analysis results for outcomes (95% CI)</b></p> <p>Morbidity (moderate evidence strength, 22 studies, 16 in the meta-analysis): RR 0.88 (0.80–0.96) favouring CDSS. Comparators included usual care or no CDSS and the same CDSS with additional features.</p> <p>Mortality (low evidence strength, seven studies, six in the meta-analysis): OR 0.79 (0.54–1.15) favouring CDSS. Interventions were evaluated against usual care or no CDSS, except for two studies that compared the same intervention with additional features.</p> <p>Adverse events (low evidence strength, five studies, five in the meta-analysis): RR 1.01 (0.90–1.14) favouring control. All of the CDSSs were evaluated against usual care or no CDSS.</p> <p>Recommended preventive care service ordered or completed (high evidence strength, 43 studies, 25 in the meta-analysis): OR 1.42 (1.27–1.58) favouring CDSS. Comparators included usual care or no CDSS, direct comparison against the same CDSS with additional features, or comparison of the same CDSS for different conditions.</p> <p>Recommended clinical study ordered or completed (moderate evidence strength, 29 studies, 20 in the meta-analysis): OR 1.72 (1.47–2.00) favouring CDSS. Comparators included usual care or no CDSS, direct comparison against the same CDSS with additional features, or comparison of the same CDSS for different conditions.</p> <p>Recommended treatment ordered or prescribed (high evidence strength, 67 studies, 46 in the meta-analysis): OR 1.57 (1.35–1.82) favouring CDSS. Comparators not stated.</p>	<p>Meta-analyses of heterogeneous studies suggested that CDSS improved morbidity, preventive care services, ordering or completing clinical studies, and ordering the appropriate treatment.</p> <p>Meta-analysis of heterogeneous studies suggested no significant effect of CDSS on mortality or adverse events.</p>

First author (year)	Findings of key studies in the review	Result summary
Chaudhuri D (2016)	<p>Results from two studies that used decision support tools in addition to education and/or audit and feedback:</p> <p><b>Johnson et al. <i>J Am Soc Echocardiogr</i> 2014;27:749–757</b> evaluated order forms adapted to display appropriateness of tests at the point of care.</p> <p><b>Lin et al. <i>J Am Coll Cardiol</i> 2013;62:308–316</b> evaluated computer-based decisions support tool.</p> <p>Overall, quality improvement interventions were associated with significantly lower odds of inappropriate testing (OR 0.44, 95% CI 0.32 to 0.61, <math>p &lt; 0.001</math>). However, there was significant heterogeneity observed between studies (<math>I^2 = 70\%</math>). Quality improvement initiatives were also associated with higher odds of appropriate testing (OR 1.67, 95% CI 1.19 to 2.35), with significant heterogeneity observed (<math>I^2 = 0.87</math>).</p> <p>Stratifying by use, decision support tools demonstrated that initiatives using these interventions were also associated with significantly (OR 0.35, 95% CI 0.22 to 0.56) and consistently (<math>I^2</math> within group = 22%) lower odds of inappropriate testing, although this effect did not significantly differ from that in groups not using this feature, and did not fully explain differences between interventions.</p>	<p>One of two studies looking at decision support tools assessed a computer-based decision support tool. The use of decision support tools led to large and consistent reductions in inappropriate tests, but the observed benefit did not significantly differ from initiatives without decision support tools.</p>
Georgiou A (2007)	<p><b>Impact of CPOE on test volumes</b></p> <p>Of 11 included studies, seven reported a significant decrease in test volume, three showed no change and one reported an increase in tests ordered.</p> <p><b>Impact of CPOE on test costs</b></p> <p>Of five included studies, four reported significant reductions and one showed no change. In most cases, changes in test costs reflected underlying changes in test volume.</p> <p><b>Impact of CPOE on redundant test rates</b></p> <p>The rate of redundant tests was the focus of a study at Brigham and Women’s Hospital that investigated the impact of providing computerised reminders to physicians about apparently redundant tests. It reported a significantly reduced rate of redundant tests in the intervention groups (27%) compared with the control group (51%).</p> <p><b>Impact of CPOE on compliance with guidelines</b></p> <p>Four studies found that CPOE systems with computerised decision support improved compliance with guideline advice.</p>	<p>Results from individual studies showed that use of CPOE can reduce hospital pathology test volumes and costs, and increase compliance with guidelines.</p>

First author (year)	Findings of key studies in the review	Result summary
Georgiou A (2011)	<p>Of 10 included studies that evaluated the impact of CPOE systems on test ordering behaviour, seven assessed the effect of decision-support features that promoted the use of guidelines in the test ordering process. The other three studies did not specify the presence of a decision-support feature.</p> <p><b>Carton et al. <i>Clin Radiol</i> 2002;57:123e8.</b> Computerised guidelines were made available to practitioners on alternating months during a 6-month study period. The availability of guidelines in the CPOE system decreased the percentage of radiology orders that did not conform to guidelines from 33.2% to 26.9% (<math>p = 0.0001</math>).</p> <p><b>Chin et al. <i>Proc AMIA Symp</i> 1999:221e5.</b> There were improvements in the percentage of upper gastrointestinal radiography orders conforming to guidelines after their implementation in a CPOE system (from 55% to 86%, 6 months post implementation).</p> <p><b>Sanders and Miller. <i>Proc AMIA Symp</i> 2001:583e7.</b> Only practitioners who selected a patient's clinical context from a list generated in the CPOE system (as opposed to those entering free text), were provided with guidelines. Most practitioners ordered the examination recommended by the guidelines (<math>n = 328</math>; 60%, <math>p = 0.001</math>).</p> <p><b>Nelson et al. <i>Ann Intern Med</i> 2004;141:196e204.</b> The first intervention, aimed at reducing test ordering beyond 72 hours, prompted practitioners to elect whether to continue or discontinue requested examinations. This intervention did not result in a statistically significant change in ordering of portable chest X-rays. The second intervention, which limited orders to one portable chest X-ray per fixed period of time, resulted in a reduction in the average number of daily orders by 18.6 orders/day (<math>p = 0.03</math>).</p> <p><b>Wang et al. <i>Arch Intern Med</i> 2002;162:1885e90.</b> Implemented a three-part intervention consisting of practitioner education, guidelines, and order templates, within one inpatient ward. Practitioners at the intervention site were educated about the guidelines and were encouraged to use the order templates in the CPOE system. The average daily test utilisation of portable chest X-rays/ICU day decreased in the intervention ward from 0.97 to 0.88 (<math>p = 0.10</math>). Test utilisation in the control ward increased significantly from 0.75 to 0.96 (<math>p &lt; 0.001</math>).</p> <p><b>Sistrom et al. <i>Radiology</i> 2009;251:147e55.</b></p>	Results of individual studies showed that CPOE for medical imaging can reduce unnecessary and inappropriate imaging, and increase compliance with guidelines.

First author (year)	Findings of key studies in the review	Result summary
	<p>Used decision support to provide an appropriateness score after once a practitioner had chosen clinical indications and submitted a request via a CPOE. They showed decreases of 2.75% (<math>p &lt; 0.001</math>), 1.2% (<math>p = 0.016</math>) and 1.3% (<math>p = 0.001</math>), respectively, in the growth rate for CT, MRI, and ultrasound examinations.</p> <p><b>Vartanians et al. <i>Radiology</i> 2010;255:842e9.</b></p> <p>Used the same approach as Siström, et al. (2009) but reported on the impact of a modification to the system that required all examinations with low-yield scores to be personally authorised by a responsible clinician. The intervention resulted in a decrease of 5.43% (2106/38,801) to 1.92% (1261/65,765) (<math>p &lt; 0.001</math>) in low-yield CT, MRI and nuclear medicine examinations.</p>	

First author (year)	Findings of key studies in the review	Result summary
Main C (2010)	<p><b>Study question 2: What is the impact of CDSS in OCS for diagnostic, screening or monitoring test ordering compared with OCS without CDSS on process outcomes, patient outcomes and adverse events/safety?</b></p> <p>Overall, if the findings of both primary and secondary outcomes are taken into account, CDSS significantly improved practitioner performance in 15/24 studies (62.5%), including 1/3 studies (33.3%) assessing the impact of price display, 1/2 studies (50%) assessing the impact of the display of previous test results, 6/10 studies (60%) assessing the use of reminders and 2/7 studies (28.6%) that assessed the impact of the display of recommendations.</p> <p><b>Study question 4: What is known about the cost-effectiveness of CDSS in diagnostic, screening or monitoring test order communication systems compared with OCS without CDSS?</b></p> <p>Only two studies met the inclusion criteria, both of which were cost-comparison analyses. A Dutch study reported a mean cost decrease of 3% (€639) for blood test orders in each of the intervention clinics compared with a 2% (€208) increase in control clinics. However, this difference failed to reach conventional levels of statistical significance (<math>p = 0.09</math>). The CDSS yielded a mean cost saving of €847/practice/6 months (ie, €639 plus €208).</p> <p>A Spanish study reported a significant increase in the cost of laboratory tests from €41.8/patient/year to €47.2/patient/year after implementation of the system (difference of 5.4, 95% CI 2.0 to 8.7, <math>p = 0.0017</math>).</p>	Practitioner performance was improved with CDSS in just under two-thirds of included studies, with a higher proportion of studies investigating reminders showing improved performance than studies investigating price display, display of guidelines or display of previous test results.
Roshanov PS (2011)	Overall findings showed that 18/33 of included studies (55%) reported improvements in diagnostic testing after implementation of the CDSS. This included 5/6 (83%) for diagnosis, 5/8 (63%) for treatment monitoring, 6/17 (35%) for disease monitoring, and 3/3 (100%) for other purposes. Four of the systems explicitly attempted to reduce test ordering rates and all succeeded. Factors of particular interest to decision makers, including costs, user satisfaction, and impact on workflow, were rarely investigated or reported.	CDSS improved overall test ordering behaviour in just over one-half of included studies.
<b>System-based interventions</b>		
Kobewka DM (2015)	Included 109 studies that investigated 119 interventions aimed at reducing laboratory test utilisation. Of 119 interventions, 54 (45.4%) had a system-based component. The overall median relative reduction in test utilisation was 22.2% (IQR 3.6 to 68.3). The percentage relative reduction in test utilisation was statistically significantly decreased vs controls, with 36 out of 54 interventions (median relative reduction 19.6, IQR 10.4 to 36.1).	System-based components led to reduced laboratory test utilisation by physicians.



First author (year)	Findings of key studies in the review	Result summary
Thomas RE (2016)	Included 10 studies that investigated system-based interventions, which usually consisted of computer-assisted decision making. The unweighted average desired change in testing for 26 outcomes in the intervention group compared with the control group was 14.9%. Three of 10 studies found minimal changes, two found change > 8%, two found change > 15% and three studies found changes of 26% to 44%.	System-based components laboratory test ordering by physicians.
<b>Utility score ratings, health information exchanges and clinical team decision support</b>		
Colla CH (2016)	<p><b>Aston et al. <i>Hosp Health Netw</i> 2010;84:34–6 &amp; Solberg et al. <i>Am J Manag Care</i> 2010;16:102–6.</b> Rating the utility score of advanced imaging tests (MRI, CT, nuclear imaging) has been shown to reduce the rate of growth for CT and MRI use from 12% to 7% and 1%, respectively, and increase compliance with appropriateness criteria for head CT, head and spine MRIs.</p> <p><b>Rosenthal et al. <i>J Am Coll Radiol</i> 2006;3:799–806.</b> CPOE systems using utility scores for radiology orders reduced low-utility examinations from 6% to 2%.</p> <p><b>O'Connor et al. <i>AJR Am J Roentgenol</i> 2014;203:W482–90.</b> Requiring clinical justification for repeat CT orders decreased the number of repeat CT orders (redundant orders cancelled after alert) by 23% relative to the pre-intervention period.</p> <p><b>Bailey et al. <i>Ann Emerg Med</i> 2013;62:16–24.</b> When HIEs were accessed in one study, 10% of patients received additional imaging, in contrast to 24% of patients when the HIE was not accessed.</p> <p><b>Bailey et al. <i>J Gen Intern Med</i> 2013;28:176–83.</b> HIEs also resulted in 33% higher odds of guideline adherence for emergency evaluation of headaches, with 7% higher odds of adherence for each additional visit.</p> <p><b>Calderon-Margalit et al. <i>Int J Qual Healthcare</i> 2005;17:243–8.</b> One study examined an administrative intervention to restrict available emergency laboratory tests and commonly repeated orders, coupled with educational feedback measures. The restrictive policy resulted in an overall reduction of 19% in laboratory tests a year after the intervention was implemented, but corresponding clinical outcomes were not examined.</p> <p><b>Friedman et al. <i>J Am Coll Radiol</i> 2009;6:119–24 &amp; Vartanians et al. <i>Radiology</i> 2010;255:842–9.</b> Department-level non-payer-based utilisation management resulted in 14% of neuroradiology studies ordered not being performed, and decreases in inappropriate outpatient imaging orders that were scheduled and performed from 5.43% to 1.92%.</p>	<p>Appropriateness scores integrated into the electronic health record to warn physicians if they are ordering a low-value test are effective in reducing low-value care.</p> <p>Overall, appropriateness scores and alerts integrated directly into electronic health records have been shown to reduce redundant testing and inappropriate care. However, physicians can experience alert fatigue, which introduces challenges such as overriding potentially critical notifications.</p> <p>The use of HIEs has been shown to reduce</p>

First author (year)	Findings of key studies in the review	Result summary
Guideline dissemination or implementation tools		<p>duplicative imaging for back pain.</p>
Flodgren G (2016)	<p><b>Daucourt et al. <i>Med Care</i> 2003;41:432–41.</b></p> <p>Reported the number of requests for a thyroid function test that complied with guidelines at 4 weeks (guideline conformity rate). A total of 1412 orders for thyroid function tests were collected, the adherence rate improved from 62.0% (95% CI 47.7 to 76.4) pre-intervention to 77.9% (95% CI 68.9 to 87.0) post intervention.</p>	<p>Results from a single study, in a hospital setting, showed increased adherence to guidelines for appropriate ordering of thyroid function tests after the implementation of a memorandum pocket card and a test request form that indicated inappropriate tests.</p>
Jenkins HJ (2015)	<p><b>Matowe et al. <i>Clin Radiol</i> 2002;57:575–8.</b></p> <p>Absolute change in imaging referrals (all patients with any clinical presentation) the first month after postal distribution of current clinical guidelines: –7.7 (95% CI –24.7 to –40.2).</p>	<p>No evidence of effectiveness was shown for postal dissemination of guidelines as an intervention.</p>
Price display		
Cadogan SL (2015)	<p><b>Horn DM, et al. <i>J Gen Intern Med</i> 2014;29:708–14.</b></p> <p>Price displays within electronic health records at the time of ordering were investigated vs no cost information. Changes to order forms to show cost display led to a 1% to 2.6% reduction in the volume of tests ordered for 5/27 different laboratory tests (0.4–5.6 laboratory orders/1000 visits/month; <math>p &lt; 0.001</math>). For higher cost tests, a reduction in test requests was observed in only 1/6 tests.</p>	<p>Results from a single study showed that real-time price display results in a significant but small change in laboratory testing patterns. However, this change was dependent on</p>

First author (year)	Findings of key studies in the review	Result summary
		specifics of the test with insignificant changes for 5/6 of the high-cost tests.
<b>Goetz C (2015)</b>	<p>Twelve studies were conducted in a clinical environment while five were survey or simulation studies (ie, studies that asked physicians how they might behave in a clinical setting). In most studies, price display changed ordering and prescribing behaviour.</p> <p>Of the clinically based interventions looking at laboratory and radiology ordering, 7/9 studies reported statistically significant cost reduction when charges were displayed. Only 3/6 studies that reported differences in the number of tests ordered also reported a statistically significant decrease in the number of tests ordered.</p> <p>All three clinically based interventions looking at medicine choice came from the anaesthesiology literature. Medicine expenditure decreased in 2/3 studies.</p> <p>Of the five studies that looked at physician decisions in surveys or simulated settings, two looked at test ordering and three looked at medicine ordering. Both test ordering surveys noted a decrease in test ordering when price information was displayed. All three medicine ordering survey studies showed a trend towards choosing less expensive medicine options when price was displayed.</p>	Price display led to decreased costs for ordering of laboratory tests or radiology imaging in most included studies.
<b>Silvestri MT (2016)</b>	<p>Of 15 studies reporting the quantitative impact of price display on aggregate order costs or volume, 10 demonstrated a statistically significant decrease in the intervention group.</p> <p>Thirteen studies reported the numeric impact of price display on aggregate order costs, and nine demonstrated a statistically significant (<math>p &lt; 0.05</math>) decrease in order costs with effect sizes ranging from 10.7% to 62.8%. Decreases were found for laboratory costs, imaging costs and medicine costs. These were observed in both the inpatient and outpatient settings.</p> <p>Eight studies reported the numeric impact of price display on aggregate order volume, and three demonstrated a statistically significant decrease in order volume with effect sizes ranging from 14.2% to 25.5%.</p> <p>Price display was found to decrease aggregate order costs (9/13 studies) more frequently than order volume (3/8 studies).</p>	Provider price display likely reduces order costs to a modest degree.



Table 4. Key findings on education

First author (year)	Findings of key studies in review	Result summary
<b>Traditional educational</b>		
<b>Cadogan SL (2015)</b>	<p><b>Barrichi et al. <i>BMC Health Serv Res</i> 2012;12:187.</b> Pathology-specific laboratory algorithms for seven common clinical scenarios were tested. Education was provided (eight training sessions) to the physicians about the algorithms and their use vs current practice alone. A 5% reduction in the volume of tests requested by the intervention district 1 year after the intervention (retrospective audit) compared with a 1% increase in the control district (<math>p &lt; 0.001</math>).</p> <p><b>Larsson et al. <i>Scand J Prim HealthCare</i> 1999;17:238–43.</b> Evaluated an education program (2-day lecture series) vs current practice. A total of seven ratios were recommended to decrease in volume; five did at <math>p &lt; 0.05</math>. A total of seven were expected to increase in volume, and four did at <math>p &lt; 0.05</math>.</p>	Education-based interventions appear to have promising effects on improving primary care physician laboratory testing patterns.
<b>Chaudhuri D (2016)</b>	<p><b>Willens et al. <i>JACC Cardiovasc Imaging</i> 2013;6:297–309.</b> Didactic lectures in a multicentre study with a 3-month follow-up for the appropriateness of transthoracic echocardiography showed no significant effect on inappropriate testing (OR, 1.04, 95% CI 0.59 to 1.83).</p> <p><b>Gibbons et al. <i>Am Heart J</i> 2010;159:484–9.</b> A single centre prospective study of didactic lectures, distribution of grand rounds summary, and didactic sessions to relevant physicians with a 2-year follow-up. Results showed an improvement in the reduction of inappropriate cardiac testing (OR 0.79, 95% CI 0.48 to 1.29).</p>	Studies that lacked a feedback component had no significant effect on inappropriate testing (OR 0.89, 95% CI 0.61 to 1.29, $p = 0.51$ ).
<b>Colla CH (2016)</b>	<p><b>Thompson et al. <i>Prev Med</i> 1983;12:385–96.</b> An educational campaign discouraging routine use of chest X-rays and multichannel blood tests was associated with a 5-fold fall in non-indicated X-ray use and a 1.5-fold fall in non-indicated blood test use.</p> <p><b>Mozes et al. <i>Arch Intern Med</i> 1989;149:1836–8.</b> Another intervention targeting inappropriate use of pre-operative blood coagulation tests consisted of five 1-hour seminars to educate surgeons on evidence-based practices, followed by biweekly memos on appropriate use. Overall, 64% reported being convinced by those sessions, but only 20% stopped ordering tests based on them. Only after implementation of a requirement that all preoperative tests be accompanied by written justification did ordering rates drop substantially (50%).</p> <p><b>Hui et al. <i>J Am Coll Radiol</i> 2014;11:373–7</b> Education alongside a national consensus guideline for adrenal cysts in a single health system decreased</p>	Passive educational interventions, those with a narrow scope, or those with only one educational tactic are often less successful at reducing low-value care. Clinician education can be an effective tool to reduce low-value care, particularly when used in conjunction with other interventions.

First author (year)	Findings of key studies in review	Result summary
	unnecessary pelvic ultrasound follow-up requests by 58%.  <b>Howard et al. <i>Health Aff</i> 2013;32:596–602.</b> The US Preventive Services Task Force recommendation that men older than 75 years not be screened for prostate cancer is estimated to have led to a 7.9% point reduction in prostate-specific antigen testing rates in men over 75.	
<b>Kobewka DM (2015)</b>	<b>Eisenberg et al. <i>J Med Educ</i> 1977;52:578–81.</b> Evaluated an education program with a weekly lecture; results from a single audit on utility of testing were circulated along with a memorandum from the medical director asking for careful consideration of test usage. Before–after results showed a 42.1% reduction in tests.  <b>Pilon et al. <i>Crit Care Med</i> 1997;25:1308–13.</b> A guideline about when ABGs should be used was distributed on pocket cards and taught during education sessions. Before-after results showed a 36.7% reduction in tests.  <b>Thompson et al. <i>Prev Med</i> 1983;12:385–96.</b> An educational program against blood chemistry tests and chest X-ray led to 60.0% reduction in tests.  <b>Toubert et al. <i>Eur J Endocrinol</i> 2000;142:605–10.</b> Educational material on thyroid disease was distributed. Physicians were told that any test other than thyroid-stimulating hormone required justification, resulting in a 39.6% reduction in tests.  <b>Gross et al. <i>Am J Infect Control</i> 1988;16:114–7.</b> Guidelines on when to order blood cultures were distributed. Results showed a 75.0% improvement in blood cultures.  <b>Ratnaïke et al. <i>Med J Australia</i> 1993;159:666–71.</b> Guidelines were created by the hospital and issued to the cardiology unit. No further details about the guidelines were given. Results showed a 57.2% improvement in blood tests.  <b>Kelly AM. <i>Aust Health Rev</i> 1998;21:245–50.</b> Guidelines on who should receive a blood culture were distributed. Results showed a 53.0% improvement in blood cultures.	Interventions with an educational component had the highest median relative reduction in test volume of any intervention type at 34.5% (IQR 16.5 to 49.0). Interventions that were exclusively educational showed median RR (IQR) of 30.6 (16.5 to 48.5).

First author (year)	Findings of key studies in review	Result summary
	<p><b>Kumwilaisak et al. <i>Crit Care Med</i> 2008;36:2993–9.</b></p> <p>Guidelines regarding when certain blood tests should be used were introduced at a staff meeting and sent out by email. A session was repeated for new residents every month</p> <p>Results showed a 20.8% improvement in blood tests.</p>	
	<p><b>Larocque and Maykut. <i>Can J Surg</i> 1994;37:397–401.</b></p> <p>Guidelines on which tests were appropriate for different medical conditions were posted on the wards and distributed as pocket cards. Results showed a 10.1% improvement in blood tests.</p>	
	<p><b>Marton et al. <i>Arch Intern Med</i> 1985;145:816–21.</b></p> <p>A manual about rational test ordering was given to the trainees. Results showed a 18.2% improvement in blood tests.</p>	
	<p><b>Prat et al. <i>Intens Care Med</i> 2009;35:1047–53.</b></p> <p>A guideline was created on when to perform each of the common blood tests. The cost of each test was also shown on the guideline. Teaching was done on how to reduce test utilisation. Results showed a 49.0% improvement in use of tests.</p>	

First author (year)	Findings of key studies in review	Result summary
French SD (2010)	<p><b>Hollingworth et al. <i>Br J Gen Pract</i> 2002;52:475–80.</b> The distribution of educational materials showed there was no evidence that referrals for radiography of the lumbar spine had decreased after the intervention.</p> <p><b>Jackson et al. <i>Southern Med J</i> 2005;98:139–43.</b> The distribution of educational materials found no significant change in level of guideline compliance for lower back imaging, and a significant deterioration in lumbar imaging, indicated by an increase in slope (<math>p = 0.1</math>).</p> <p><b>Matowe et al. <i>Clin Radiol</i> 2002;57:575–8.</b> The distribution of educational materials resulted in no significant difference in musculoskeletal imaging referrals, either in absolute change in referral, or in change in referral trend.</p> <p><b>Oakeshott et al. <i>Br J Gen Pract</i> 1994;44:197–200.</b> Distribution of educational materials. Results showed the percentage of limb and joint X-ray requests conforming to a guideline was an absolute change from baseline of 6.7%, and the absolute improvement was 5.2% (not significant). The same cluster RCT comparison also reported a non-significant effect of number of X-rays requested (relative percentage change of 38.6%, SD 0.27).</p>	<p>Most the 12 studies concerning low back pain included distribution of educational materials as an intervention component, and most observed no significant improvement in appropriate imaging.</p> <p>All the included studies conducted in people with musculoskeletal conditions other than osteoporosis, low back pain and knee pain observed no significant change in appropriate imaging outcomes. The interventions' distribution of educational materials, educational meetings and audit and feedback were not shown to be effective for changing imaging ordering behaviour in other musculoskeletal conditions.</p>
Stammen LA (2015)	<p><b>Sucov et al. <i>J Emerg Med</i> 1999;17:391–7.</b> Guidelines were created regarding which tests to order for which patient groups. The guideline was then rolled out with a series of educational sessions, resulting in a 22% reduction in test ordering. There was a significant decline in total testing from 209 to 163 tests/100 patients (<math>p &lt; 0.001</math>); costs were \$50,000–\$100,000 less.</p> <p><b>Davidoff et al. <i>Med Care</i> 1989;27:45–58.</b> A cost-containment education led to significantly fewer orders for laboratory tests vs placebo group (16%, <math>p = 0.032</math>).</p>	<p>No analyses or commentary as to the effectiveness of the interventions in this format was provided.</p>
Thomas RE (2016)	<p><b>van der Weijden et al. <i>Implementation Sci</i> 2012;7:29.</b> A 3-hour education session vs no control to increase lipid testing led to an increase of 1.4% in the control group (not significant).</p>	



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Tzortziou Brown V (2016)	<p><b>Hollingworth et al. <i>Br J Gen Pract</i> 2002;52:475–80.</b> The distribution of educational materials showed no evidence that referrals for radiography of the lumbar spine had decreased after the intervention.</p> <p><b>Rozental et al. <i>J Bone Joint Surg Am</i> 2008;90:953–61.</b> 1. Case management (treating orthopaedic surgeon ordered bone mineral density test then forwarded results to primary care physician). 2. Professional intervention (distribution of educational materials: treating orthopaedic surgeon sent guideline to primary care physician). This study showed that when an orthopaedic surgeon orders a bone mineral density test and forwards the results to the GP, there may be an improvement in the rates of osteoporosis medicine prescribing (74% compared with 26%). This was in comparison with participants whose GP simply received a letter from the orthopaedic surgeon outlining guidelines for osteoporosis screening. However, this was a very small study (50 participants randomised into two intervention groups).</p>	Of the 10 studies on low back pain, seven showed that guideline dissemination and educational opportunities for GPs may lead to little or no improvement with regard to guideline-consistent GP behaviour.
<b>Education and audit/feedback</b>		
French SD (2010)	<p><b>Curtis et al. <i>Arch Intern Med</i> 2007;167:591–6.</b> Professional intervention (audit and feedback + distribution of educational materials with online modules) designed for adult learning. The study reported a non-significant deterioration in bone mineral density test ordering.</p> <p><b>Kerry et al. <i>Fam Pract</i> 2000;17:46–52.</b> A comparison of the distribution of educational materials + individual audit and feedback on referral rates vs no-intervention control. Only total numbers of X-rays were reported. The study reported a significant 20% absolute improvement in the use of appropriate imaging of the lumbar spine (95% CI 4 to 36); also showed that the intervention may result in little or no reduction in GP knee radiology requests (relative change 10%, not statistically significant). Overall a 1% reduction in the numbers of limb and joint X-ray requests was observed in the intervention group compared with a 9% increase in the control group (giving a total of 10% difference), but this did not achieve statistical significance (95% CI –5 to 25). Overall, the intervention may result in a little or no reduction in GP radiology referrals.</p>	The effect of any type of intervention vs a no-intervention control in osteoporosis studies ranged from –1.9% to 51.0%, with a median absolute improvement in bone mineral density test ordering, of any type of intervention to change practice, of +10% (IQR 0.0 to 27.7). Five of the comparisons (three from one study) reported a non-significant deterioration in test ordering and seven comparisons reported a significant improvement in test ordering. The combination of guidelines and audit/feedback may result in a slight reduction in spinal radiology requests according to one study.

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Thomas RE (2016)	<p><b>Borgiel et al. <i>CMAJ</i> 1999;161:965–70.</b></p> <p>Evaluated a continuing medical education plan with a feedback component (practice assessment report) to improve test ordering, which showed a 1% increase in the control group for increasing cholesterol testing (no significance statement).</p>	<p>The intervention arm that received continuing medical education and visits from a mentor over 3 years increased the number of Pap smears by 5.3% and decreased cholesterol tests by 1% compared with the less intensive physician assessment report intervention arm.</p>
Tzortziou Brown V (2016)	<p><b>Kerry et al. <i>Fam Pract</i> 2000;17:46–52.</b></p> <p>A comparison of the distribution of educational materials + individual audit and feedback on referral rates vs no-intervention control. Only total numbers of X-rays were reported. The study reported a significant 20% absolute improvement in the use of appropriate imaging of the lumbar spine (95% CI 4 to 36); also showed that the intervention may result in little or no reduction in GP knee radiology requests (relative change 10%, not statistically significant). Overall a 1% reduction in the numbers of limb and joint X-ray requests was observed in the intervention group compared to a 9% increase in the control group (giving a total of 10% difference), but this did not achieve statistical significance (95% CI –5 to 25). Overall, the intervention may result in a little or no reduction in GP radiology referrals.</p>	<p>Two studies showed that the combination of guidelines, education and GP feedback on the total number of investigations requested may have an effect on GP behaviour and result in a slight reduction in the number of tests.</p>
Interactive educational (educational meetings, workshops, outreach/academic detailing)		

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French SD (2010)	<p><b>Dey et al. <i>Br J Gen Pract</i> 2004;54:33–7.</b></p> <p>Practitioner education vs no intervention.</p> <p>Face-to-face workshop that included guideline dissemination and implementation strategies with guidelines on secondary care referral, for reduction of lumbar spine radiography. After adjustment for clustering, results showed a risk difference of 1.4% (95% CI –4.1% to 6.8%) vs control. There was no change in GP behaviour with regard to ordering X-rays, issuing sickness certificates and prescribing opioids.</p>	<p>Results found variable effects for educational interventions. Most of the studies concerning low back pain included distribution of educational materials as an intervention component, and most observed no significant improvement in appropriate imaging.</p> <p>The median effect of any intervention vs a no-intervention control was +9.3% (range –1.4% to 11.3%) absolute improvement in the appropriate ordering of lumbar imaging, with most of the outcomes observing a non-significant effect.</p> <p>For all comparisons of an intervention vs a different intervention reporting dichotomous outcomes, the absolute deterioration in lumbar imaging behaviour ranged from –8.3% to 1.0% (IQR –8.0% to –0.7%).</p> <p>Seven cluster RCT comparisons reporting dichotomous outcomes evaluated interventions vs a different intervention control. Five of the seven comparisons reported a non-significant deterioration in low back pain imaging outcomes.</p>

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Jenkins HJ (2015)	<p><b>Dey et al. <i>Br J Gen Pract</i> 2004;54:33–7.</b>  Practitioner education vs no intervention.  Face-to-face workshop that included guideline dissemination and implementation strategies with guidelines on secondary care referral, for reduction of lumbar spine radiography. After adjustment for clustering, results showed a risk difference of 1.4% (95% CI –4.1% to 6.8%) vs control. There was no change in GP behaviour with regard to ordering X-rays, issuing sickness certificates and prescribing opioids.</p> <p>After adjustment for cluster variance, Dey et al. found a 12.2% (95% CI 2.8 to 21.6) increase in the number of patients in the intervention group being referred to physiotherapy or to educational programs at the back clinic. The increase in these referrals was considered to be a positive effect of the intervention.</p> <p><b>French et al. <i>PLoS ONE</i> 2013;8:e65471.</b>  Practitioner education vs guideline dissemination.  Face-to-face workshop that included guideline dissemination and implementation strategies for reducing lumbar spine radiography and spine CT.  After adjustment for clustering, results showed IRR of 0.8 (95% CI 0.6 to 1.1) vs control (lumbar spine X-ray); IRR of 0.9 (95% CI 0.7 to 1.3) vs control (spine CT).  Imaging referral was not statistically significantly different between groups and the potential importance of effects was unclear; RR 0.87 (95% CI 0.68 to 1.10) for X-ray or CT scan.</p>	<p>No evidence of effectiveness was shown for interventions that involved face-to-face education sessions between primary care doctors and an educational team.</p>

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Tzortziou Brown V (2016)	<p><b>Broadhurst et al. <i>BMC Fam Pract</i> 2007;8:12.</b> This study evaluated the effect of academic detailing on the management of shoulder pain and recorded the number of shoulder X-rays and ultrasound scans before, during and after the intervention. Academic detailing (two sessions) outreach + educational material (DVD) + guideline + follow-up session 3 months afterwards (distribution of educational material) demonstrated temporary slight reduction in ultrasound requests, but little or no change in the X-ray requests (<math>p = 0.11</math>).</p> <p><b>Dey et al. <i>Br J Gen Pract</i> 2004;54:33–7.</b> Practitioner education vs no intervention. Face-to-face workshop that included guideline dissemination and implementation strategies with guidelines on secondary care referral, for reduction of lumbar spine radiography. After adjustment for clustering, results showed a risk difference of 1.4% (95% CI –4.1% to 6.8%) vs control. There was no change in GP behaviour with regard to ordering X-rays, issuing sickness certificates and prescribing opioids.</p> <p><b>French et al. <i>PLoS ONE</i> 2013;8:e65471.</b> Practitioner education vs guideline dissemination. Face-to-face workshop that included guideline dissemination and implementation strategies for reducing lumbar spine radiography and spine CT. After adjustment for clustering, results showed IRR of 0.8 (95% CI 0.6 to 1.1) vs control (lumbar spine X-ray); IRR of 0.9 (95% CI 0.7 to 1.3) vs control (spine CT). Imaging referral was not statistically significantly different between groups and the potential importance of effects was unclear; RR 0.87 (95% CI 0.68, 1.10) for X-ray or CT. Overall there was no difference in the number of X-ray and CT requests (risk difference of –0.2% and 0.0% respectively).</p>	Individual studies evaluating reduction in imaging requests showed little or no change in ordering outcomes. The authors found that overall, educational sessions, workshops and guidelines on the management of osteoarthritis may result in some positive changes in GP behaviour and patient-related outcomes. However, these interventions showed no improvements in GP prescribing.
Légaré F (2016)	<p><b>Smith et al. <i>Prenat Diagn</i> 1995;15:317–24.</b> Educational outreach to health professionals effective regarding knowledge-related outcomes in 1/1 studies. Educational outreach to health professionals effective regarding behaviour-related outcomes in 1/1 studies. Educational outreach to health professionals effective regarding wellbeing-related outcomes in 0/0 studies.</p>	Overall, of the 28 included studies, 14 (50%) reported effectiveness regarding knowledge-related outcomes, 15 (54%) reported effectiveness regarding behaviour-related outcomes and 13 (46%) reported effectiveness regarding wellbeing-related outcomes. Regarding the effectiveness of the intervention type in studies, audit

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		and feedback was significantly effective in 100% (1/1) of the studies, and educational outreach to health professionals was significantly effective in 100% (2/2) of the studies.
Kobewka DM (2015)	<p><b>Berwick et al. <i>Proc Annu Symp Comput Appl Med Care</i> 1995;314–8.</b> Doctors met to discuss the use of particular tests, and journal articles were distributed on the use of these tests. Results showed 0.2% change in improvement of laboratory test ordering.</p> <p><b>Everett et al. <i>Med Educ</i> 1985;19:138–42.</b> Residents were taught about laboratory utilisation using specific cases. Results showed 12.3% increase of laboratory test ordering.</p>	Interventions with an educational component had the highest median relative reduction in test volume of any intervention type at 34.5% (IQR 16.5 to 49.0). Interventions that were exclusively educational showed median RR (IQR) of 30.6 (16.5 to 48.5).
Thomas RE (2016)	<p><b>Lafata et al. <i>Med Care</i> 2007;45:966–72.</b> In an intervention with feedback to increase testing after dispensing angiotensin-converting enzyme inhibitors/angiotensin-II receptor blockers, diuretics, or digoxin, Lafata et al. found no increase in follow-up testing after prescribing digoxin, a 3.3% increase in testing after prescribing angiotensin-converting enzyme inhibitors/angiotensin-II receptor blockers, and a 4.9% increase after prescribing a diuretic.</p>	No summary provided.
<b>Educational multicomponent</b>		
Cadogan SL (2015)	<p><b>Verstappen, et al. <i>JAMA</i> 2003;289:2407–12.</b> Feedback on compliance with national guidelines followed by small group discussions on clinical problems were shown to significantly decrease inappropriate ordering (as defined by guidelines) for cardiovascular topics and upper and lower abdominal complaints, but not for chronic obstructive pulmonary disease and asthma, general complaints, and degenerative joint complaints. Results showed a decrease in total number of tests ordered (–67 tests/physician, <math>p = 0.01</math>) and inappropriate tests ordered (–16 tests/physician, <math>p = 0.01</math>) with a 12% reduction in testing in a physician group asked to solve problems involving 15 laboratory tests and a 5% reduction in a group with problems</p>	All but one study found significant reductions in the volume of tests after the intervention, with effect sizes ranging from 1.2 to 60 %. Due to heterogeneity, meta-analysis was not performed. Education-based interventions appear to have promising effects on improving

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	involving 10 laboratory tests.	primary care physician laboratory testing patterns in this review.
<b>Thomas RE (2016)</b>	<p><b>Verstappen et al. <i>JAMA</i> 2003;289:2407–11.</b></p> <p>To improve test ordering strategy: in this study used an intervention with a feedback, education and small group quality improvement arm (Arm A) was compared with a feedback only arm (Arm B). Results showed Arm A 12% fewer tests than Arm B for cardiovascular, and abdominal complaints; but Arm B showed 5% fewer tests than Arm A for lung disorders, non-specific and degenerative complaints. There was a 12% reduction in testing in a physician group asked to solve problems involving 15 laboratory tests and a 5% reduction in a group with problems involving 10 laboratory tests.</p>	Overall, for 11 outcomes, the average increase in test ordering in the intervention group compared with the control group was 4.9% (converting the desired reductions to positive change).

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French SD (2010)	<p><b>Robling et al. <i>Clin Radiol</i> 2002;57:402–7.</b></p> <ol style="list-style-type: none"> <li>1. Distribution of local guidelines + practice-based seminar during which a 15-minute video was shown (outreach visit).</li> <li>2. Distribution of local guidelines + feedback on practice-specific MRI use and comparative data on orthopaedic and neurosurgical referrals (audit and feedback).</li> <li>3. (1 + 2), Distribution of educational material plus outreach visits plus audit and feedback.</li> <li>4. Control group: distribution of local guidelines by post.</li> </ol> <p>No difference was found in guideline-concordant GP behaviour (guideline-concordant requests for MRIs (risk difference 4%, range –12.1 to 12.1). Cost-effectiveness analysis showed that accessing the MRI service in writing is probably more cost effective compared with telephone access, and dissemination of guidelines is probably more cost effective compared with the other types of intervention used.</p> <p><b>Solomon et al. <i>Arthritis Rheum</i> 2004;51:383–7.</b></p> <p>Professional intervention (distribution of educational materials + educational meeting + audit and feedback). Results showed a 3.8% deterioration in bone mineral density test ordering.</p> <p><b>Verstappen et al. <i>JAMA</i> 2003;289:2407–12.</b></p> <ol style="list-style-type: none"> <li>1. Professional intervention (distribution of educational materials + audit and feedback + educational meetings).</li> <li>2. Same intervention but for a different group of conditions.</li> </ol> <p>For number of X-rays ordered, and number of inappropriate X-rays ordered, change in both outcomes was not significant, with an average relative percentage improvement of 25.4% and an average standardised mean difference of +0.31.</p>	<p>Most the 12 studies concerning low back pain included distribution of educational materials as an intervention component and most observed no significant improvement in appropriate imaging.</p> <p>Only one of the included low back pain studies reported healthcare outcomes and this observed a non-significant change in pain at 3 and 6 months follow-up for an organisational intervention.</p> <p>Most the 12 studies that evaluated interventions vs no-intervention controls to improve the management of people with osteoporosis, or people at risk of osteoporosis, observed significant improvements in bone mineral density test ordering. However, it is not clear which intervention, or intervention combination, is likely to have the largest effect. All the included studies conducted in people with musculoskeletal conditions other than osteoporosis, low back pain and knee pain observed no significant change in appropriate imaging outcomes. The interventions distribution of educational materials, educational meetings and audit and feedback were not shown to be effective for changing imaging ordering</p>



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		behaviour in other musculoskeletal conditions.
Colla CH (2016)	<p><b>Bhatia et al. <i>JACC Cardiovasc imaging</i> 2013;6:545–55.</b></p> <p>An educational intervention including a lecture on appropriate use criteria, a pocket card, and biweekly email feedback on ordering behaviour resulted in significantly lower inappropriate echocardiography use. Pre–post intervention had 26% reduction in number of transthoracic echocardiograms ordered per day (<math>p &lt; 0.001</math>); proportion of inappropriate transthoracic echocardiograms was significantly lower (5% vs 13%, <math>p &lt; 0.001</math>) and proportion of appropriate transthoracic echocardiograms was significantly higher (93% vs 84%, <math>p &lt; 0.001</math>).</p> <p><b>Vidyarthi et al. <i>Am J Med Qual</i> 2015;30:81–7.</b></p>	Multicomponent educational interventions with continued clinician support are costly and time-consuming, yet effective at reducing utilisation and targeted inappropriate use.

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	A combination of clinician education, social marketing, financial incentives, and audit and feedback resulted in an 8% reduction in laboratory testing over 3 years among medical residents.	
Stammen LA (2015)	<p><b>Bhatia et al. <i>JACC Cardiovasc imaging</i> 2013;6:545–55.</b> Pre–post intervention had 26% reduction in number of transthoracic echocardiograms ordered per day (<math>p &lt; 0.001</math>); proportion of inappropriate transthoracic echocardiograms was significantly lower (5% vs 13%; <math>p &lt; 0.001</math>) and proportion of appropriate transthoracic echocardiograms was significantly higher (93% vs 84%, <math>p &lt; 0.001</math>).</p> <p><b>Thakkar et al. <i>Am J Clin Pathol</i> 2015;143:393–7.</b> A pre-post intervention consisting of an education, flyer, email, cost impact information led to a reduction in number of overall tests ordered (4.14 vs 3.79/patient/day, <math>p = 0.001</math>); cost reduction of \$6.33/patient/day.</p> <p><b>Attali et al. <i>Mt Sinai J Med</i> 2006;73:787–94.</b> Evaluated an educational lecture about excessive and inappropriate testing; a senior physician gave feedback about ordering practices; findings showed a 34.5% relative reduction of targeted tests.</p>	No analyses or commentary as to the effectiveness of the interventions in this format was provided.
Kobewka DM (2015)	<p><b>Attali et al. <i>Mt Sinai J Med</i> 2006;73:787–94.</b> Evaluated an educational lecture about excessive and inappropriate testing; a senior physician gave feedback about ordering practices; findings showed a 34.5% relative reduction of targeted tests.</p> <p><b>Power et al. <i>Anaesth Intensive Care</i> 1999;27:481–8.</b> Published guidelines on test ordering were distributed. A maximum number of tests per patient was instituted and test ordering was reviewed by a consultant. Results showed a decrease of 37.1% in selected tests.</p>	Interventions with an educational component had the highest median relative reduction in test volume of any intervention type at 34.5% (IQR 16.5 to 49.0). Interventions that were exclusively educational showed median RR (IQR) of 30.6 (16.5 to 48.5).

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	<p><b>Bareford et al. <i>Br Med J</i> 1990;301:1305–7.</b></p> <p>Monthly usage statements were distributed to physicians. Guidelines on appropriate testing were distributed and some tests were cancelled if inappropriate. Results showed a reduction in testing of 62.1%</p>	
<b>Tortziou Brown V (2016)</b>	<p><b>Robling et al. <i>Clin Radiol</i> 2002;57:402–7.</b></p> <ol style="list-style-type: none"> <li>1. Distribution of local guidelines + practice-based seminar during which a 15-minute video was shown (outreach visit).</li> <li>2. Distribution of local guidelines + feedback on practice-specific MRI use and comparative data on orthopaedic and neurosurgical referrals (audit and feedback).</li> <li>3. (1 + 2); Distribution of educational material plus outreach visits plus audit and feedback.</li> <li>4. Control group: distribution of local guidelines by post.</li> </ol> <p>No difference was found in guideline-concordant GP behaviour (guideline-concordant requests for MRIs, risk difference 4%, range –12.1 to 12.1). Cost-effectiveness analysis showed that accessing the MRI service in writing is probably more cost effective compared with telephone access, and dissemination of guidelines is probably more cost effective compared with the other types of intervention used.</p>	<p>Multiple-component interventions, mainly including dissemination of educational materials and educational meetings/outreach showed that these interventions may result in little or no improvement in GP behaviour and patient-related outcomes.</p>
<b>Combined physician and patient directed educational interventions</b>		

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French SD (2010)	<p><b>Feldstein et al. <i>J Am Geriatr Soc</i> 2006;54:450–7.</b></p> <ol style="list-style-type: none"> <li>1. Professional intervention (reminders: electronic medical record message about patient's risk of osteoporosis + distribution of education materials).</li> <li>2. Professional intervention (reminders + distribution of education materials) + patient mediated (education materials).</li> </ol> <p>There was a significant improvement in bone mineral density test ordering, with an absolute change of 34.6% (<math>p &lt; 0.01</math>).</p> <p><b>Lafata et al. <i>J Gen Intern Med</i> 2007;22:346–51.</b></p> <ol style="list-style-type: none"> <li>1. Patient mediated (education materials).</li> <li>2. Patient mediated (education materials) + professional intervention (reminder).</li> <li>3. Standard practice control group.</li> </ol> <p>The intervention resulted in little difference in test ordering outcomes (risk difference for bone mineral density 10.6% and 18.1%, respectively) and for osteoporosis medicine prescribing rates (2.7% and 3.4%, respectively).</p> <p><b>Majumdar et al. <i>Ann Intern Med</i> 2004;141:366–73.</b></p> <p>Professional intervention (distribution of educational materials + reminders) + patient mediated (educational materials + verbal education). Results showed a significant improvement in bone mineral density test ordering, with an absolute change of 44.8% (<math>p &lt; 0.001</math>).</p> <p><b>Majumdar et al. <i>Can Med Assoc J</i> 2008;178:569–75.</b></p> <p>Professional intervention (distribution of educational materials + reminder) + patient mediated (education and counselling via telephone). Results showed a significant improvement in bone mineral density test ordering, with an absolute change of 34.0% (<math>p &lt; 0.001</math>).</p> <p><b>Prihar et al. <i>J Am Geriatrics Society</i> 2008;56:961–2.</b></p> <p>Patient mediated (educational materials) + professional intervention (distribution of educational materials: poster).</p> <p>Results showed a difference in absolute change from baseline was a 9.4% improvement in bone mineral density test ordering.</p> <p><b>Schectman et al. <i>J Gen Intern Med</i> 2003;18:773–80.</b></p> <ol style="list-style-type: none"> <li>1. Professional intervention (distribution of educational materials + educational meeting (including local</li> </ol>	Overall, results from individual studies showed that educational interventions with a patient component can significantly reduce bone mineral density test ordering,

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	<p>opinion leader) + audit and feedback.</p> <p>2. Patient mediated (education materials: pamphlet and video).</p> <p>3. (1 + 2).</p> <p>The outcome measures were the proportion of lumbar plain X-rays, CT or MRI consistent with guideline within 2 months. Results showed an absolute change of –1.0 (UAE) for lumbar X-ray, 1.5 (UAE) for lumbar CT or MRI, 0.5 (UAE) for lumbar</p> <p>X-ray not consistent with guidelines, and 1.9 for lumbar CT or MRI not consistent with guidelines. The median effect size was 1.</p> <p><b>Solomon et al. <i>J Bone Miner Res</i> 2007;22:1808–15.</b></p> <p>1. Professional intervention (distribution of educational materials + educational outreach).</p> <p>2. Patient mediated (education materials).</p> <p>This study investigated the number of patients who began osteoporosis medicine or had a bone mineral density test within 12 months; and any medicine use. Authors reported a non-significant deterioration in test ordering (absolute percentage change –1.8, non-significant).</p> <p><b>Solomon et al. <i>J Gen Intern Med</i> 2007;22:362–7.</b></p> <p>1. Professional intervention (distribution of educational materials + educational outreach + reminder) + patient mediated (education via automated telephone call). Significant improvement in bone mineral density test ordering, with an absolute change of 3.8% (p = 0.01).</p>	

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Jenkins HJ (2015)	<p><b>Schectman et al. <i>J Gen Intern Med</i> 2003;18:773–80.</b></p> <ol style="list-style-type: none"> <li>1. Professional intervention (distribution of educational materials + educational meeting (including local opinion leader) + audit and feedback.</li> <li>2. Patient mediated (education materials: pamphlet and video).</li> <li>3. (1 + 2).</li> </ol> <p>The outcome measures were the proportion of lumbar plain X-rays, CT or MRI consistent with guideline within 12 months. Results showed a RR 1.1 (95% CI 0.8 to 1.4) for lumbar spine radiography, and RR 0.8 (95% CI 0.5 to 1.2) for lumbar spine CT or MRI for the intervention, with no effect size reported. The authors also reported referral to physical therapy (RR 0.8, 95% CI 0.6 to 1.1) and referral to specialist (RR 1.2, 95% CI 0.8 to 1.8) for the interventions; no effect size reported.</p>	<p>In the single included study the analysis did not adjust for clustering. It was concluded that a statistically significant decrease in imaging was not shown compared with the control group.</p>

First author (year)	Findings of key studies in review	Result summary
Tzortziou Brown V (2016)	<p><b>Lafata et al. <i>J Gen Intern Med</i> 2007;22:346–51.</b></p> <ol style="list-style-type: none"> <li>1. Patient-directed component (educational material on osteoporosis).</li> <li>2. Patient-directed (educational material on osteoporosis) + physician prompt/reminder (reminder on electronic medical record and biweekly letter to physician listing patients needing treatment).</li> <li>3. Standard practice control group.</li> </ol> <p>The intervention resulted in little difference in test ordering outcomes (risk difference for bone mineral density test 10.6% and 18.1%, respectively) and for osteoporosis medicine prescribing rates (2.7% and 3.4%, respectively).</p> <p><b>Solomon et al. <i>J Bone Miner Res</i> 2007;22:1808–15.</b></p> <ol style="list-style-type: none"> <li>1. Physician education by trained pharmacists or nurses (academic-detailing approach via outreach visits) + educational material and handouts for patients.</li> <li>2. Patient-directed component: 3 mailed letters with educational material and questions to ask the physician.</li> </ol> <p>This study evaluated the effect of a brief program of patient and/or GP education (academic detailing) and showed that the intervention resulted in no difference in the probability of the primary composite end-point (bone mineral density testing or osteoporosis medicine prescribing) between the usual care and intervention groups. Results varied. The RR for the patient and GP intervention was 1.04 (95% CI 0.85 to 1.26), for the GP-only intervention 0.70 (95% CI 0.56 to 0.86) and for the patient only intervention 0.90 (95% CI 0.73 to 1.10).</p> <p><b>Bishop et al. <i>Spine J</i> 2006;6:282–8.</b></p> <p>An intervention with GP education (guidelines) and three patient-specific reminder letters to GPs vs GP and patient education and reminders vs a control group. Clinician adherence to the guidelines showed that the interventions may lead to little or no improvements (risk difference &lt; 5%).</p> <p><b>Schectman et al. <i>J Gen Intern Med</i> 2003;18:773–80.</b></p> <ol style="list-style-type: none"> <li>1. Professional intervention (distribution of educational materials + educational meeting (including local opinion leader) + audit and feedback.</li> <li>2. Patient mediated (education materials: pamphlet and video).</li> <li>3. (1 + 2).</li> </ol> <p>The outcome measures were the proportion of lumbar plain X-rays, CT or MRI consistent with guideline within 12 months. Results showed an absolute change of –1.0 (UAE) for lumbar X-ray, 1.5 (UAE) for lumbar CT or MRI, 0.5 (UAE) for lumbar X-ray not consistent with guidelines, and 1.9 for lumbar CT or MRI not consistent with guidelines. The median effect size was 1.</p>	<p>Adding a patient-directed component probably does not lead to a greater effect (RR 0.94, 95% CI 0.81 to 1.09; 2995 participants) for bone mineral density testing and RR 0.93 (95% CI 0.79 to 1.10; 2995 participants) for osteoporosis medicine.</p>

First author (year)	Findings of key studies in review	Result summary
	<p><b>Feldstein et al. <i>J Am Geriatr Soc</i> 2006;54:450–7.</b></p> <ol style="list-style-type: none"> <li>1. Professional intervention (reminders: electronic medical record message about patient’s risk of osteoporosis + distribution of education materials).</li> <li>2. Professional intervention (reminders + distribution of education materials) + patient mediated (education materials).</li> </ol> <p>Results showed a significant improvement in bone mineral density test ordering, with an absolute change of 34.6% (<math>p &lt; 0.01</math>).</p> <p><b>Majumdar et al. <i>Ann Intern Med</i> 2004;141:366–73.</b></p> <p>Professional intervention (distribution of educational materials + reminders) + patient mediated (educational materials) + verbal education.</p> <p>Results showed a significant improvement in bone mineral density test ordering, with an absolute change of 44.8% (<math>p &lt; 0.001</math>).</p>	



Table 5. Key findings on audit and feedback

First author (year)	Findings of key studies in the review	Result summary
Colla CH (2016)	<p><b>Chinnaiyan et al. <i>J Am Coll Cardiol</i> 2012;60:1185–91.</b> In a multicentre study with a 6-month follow-up, didactic sessions and letters to physicians, results showed an improvement in the reduction of inappropriate cardiac testing (OR 0.36, CI% 0.31 to 0.43]. Appropriate use of scans increased from 61.3% to 80.0% and inappropriate use decreased from 14.6% to 5.8%.</p> <p><b>Ruangkanchanasetr S. <i>J Med Assoc Thai</i> 1993;76:194–208.</b> Implementation of clinician education combined with audit and feedback improved overall appropriateness scores for laboratory test orders in another study. However, while over-utilisation decreased, underutilisation increased, suggesting that volumes of test orders were being reduced regardless of value.</p> <p><b>Miyakis et al. <i>Postgrad Med</i> 2006;82:823–9.</b> After an assessment on the usefulness of 25 tests was presented to medical staff, followed by a discussion of how to reduce unnecessary tests, use of avoidable tests decreased from 2.01 to 1.58 tests/patient/day after the intervention, though test orders increased to previous levels in the semester after the intervention, a 13.5% reduction in ordering of tests after the intervention.</p> <p><b>Sorita et al. <i>J Hosp Med</i> 2014;9:13–8.</b> Feedback to residents including individual meetings, phone calls, and emails from direct supervisors has been shown to significantly decrease laboratory test orders.</p> <p><b>Thomas et al. <i>Lancet</i> 2006;367:1990–6.</b> Provided practice-level feedback in the form of a booklet with data for targeted overused tests compared with regional rates. Feedback alone reduced overuse for nine tests (significantly for four), and when combined with educational reminders, reduced total requests by 22%. Feedback led to greater reductions in the number of laboratory tests ordered compared with reminders although the model-based analyses suggested similar effects (adjusted change relative to baseline performance in audit and feedback arm: 12%; OR for feedback 0.87, 95% CI 0.81 to 0.94; OR for reminders 0.89, 95% CI 0.83 to 0.93).</p>	While over-utilisation decreased, underutilisation increased, suggesting that volumes of test orders were being reduced regardless of value.

First author (year)	Findings of key studies in the review	Result summary
Stammen LA (2015)	<b>Dowling et al. <i>Acad Med</i> 1989;64:410–2.</b> Feedback and cost-effectiveness theme led to significant reduction in thyroid-stimulating hormone test ordering ( $p < 0.001$ ) and complete blood cell counts ( $p = 0.05$ ); percentage of appropriate thyroid-stimulating hormone tests indicated increased ( $p < 0.001$ ).	Results from individual studies showed that feedback can reduce the rates of test ordering and increase the rates of appropriate tests, potentially leading to cost savings.
	<b>Miyakis et al. <i>Postgrad Med</i> 2006;82:823–9.</b> After an assessment on the usefulness of 25 tests was presented to medical staff, followed by a discussion of how to reduce unnecessary tests, use of avoidable tests decreased from 2.01 to 1.58 tests/patient/day after the intervention, though test orders increased to previous levels in the semester after the intervention, a 13.5% reduction in ordering of tests after the intervention.	
	<b>Sucov et al. <i>J Emerg Med</i> 1999;17:391–7.</b> Guidelines were created regarding which tests to order for which patient group and rolled out with a series of educational sessions, discussion of ordering and utilisation of feedback, resulting in 22.0% reduction in tests. There was a significant decline in total testing from 209 to 163 tests/100 patients ( $p < 0.001$ ); \$50,000–\$100,000 less charged.	
Jenkins HJ (2015)	<b>Eccles et al. <i>Lancet</i> 2001;357:1406–9.</b> Audit and feedback vs guideline dissemination for lumbar spine radiography. After adjustment for clustering, absolute change in imaging of $-0.07$ radiographs/1000 patients (95% CI $-1.3$ to $0.7$ ) vs control (not significant). Adding reminders to audit and feedback reduced X-ray utilisation (adjusted change relative to baseline control = 46%; no $p$ -value reported). Comparing audit and feedback with reminders, educational reminders appended to radiology reports were more effective than twice-yearly feedback to GPs for reducing overall radiology requests (median adjusted change relative to baseline performance in audit and feedback arm 15%).	Audit and feedback interventions were associated with variable results. Interventions that used practitioner audits and feedback, practitioner education or guideline dissemination did not significantly reduce imaging rates.

First author (year)	Findings of key studies in the review	Result summary
Cadogan SL (2015)	<p><b>Baker et al. <i>Scand J Prim Healthcare</i> 2003;21:219–23.</b> Guidelines followed by feedback about the numbers of thyroid function, rheumatoid factor test and urine cultures they ordered (quarterly for 1 year) vs guidelines then feedback about lipid and plasma viscosity tests (each a control group for the other) showed no effect. No change in volume of tests/1000 requested in either of the study groups for any of the tests.</p> <p><b>Thomas et al. <i>Lancet</i> 2006;367:1990–6.</b> Quarterly feedback of requesting rates and reminder messages. Practices allocated to one of four groups: control, enhanced feedback alone, reminder messages alone, or both enhanced feedback and reminder messages. Control was current practice. An 11 % reduction in requests for practices receiving enhanced feedback or reminder messages (OR 0.89, 95% CI 0.83 to 0.93) compared with the control group. Feedback led to greater reductions in the number of laboratory tests ordered compared with reminders although the model-based analyses suggested similar effects (adjusted change relative to baseline performance in audit and feedback arm: 12%; OR for feedback 0.87, 95% CI 0.81 to 0.94; OR for reminders 0.89; 95% CI 0.83 to 0.93). Adding reminders to audit and feedback both significantly reduced blood test utilisation and the effect seemed to be additive, but not synergistic (adjusted change relative to baseline performance in the audit and feedback alone arm: –2%; OR 0.78, 95% CI 0.71 to 0.85 for both vs OR 0.87, 95% CI 0.81 to 0.94 for reminders alone; no p-value reported).</p> <p><b>Tomlin et al. <i>BMJ Qual Saf</i> 2011;20:282–90.</b> Three marketing programs (guidelines, individual feedback and professional development) vs locum and other physicians not targeted by the programs showed a 60% reduction in number of erythrocyte sedimentation rate tests by the intervention group after the intervention vs an 18% reduction in comparison with doctors after intervention.</p>	The feedback-based interventions in this review were multifaceted, and their effects were dependent on the particular combination of strategies used.

First author (year)	Findings of key studies in the review	Result summary
Kobewka DM (2015)	<p><b>Everett et al. <i>Arch Intern Med</i> 1983;143:942–4.</b> An RCT in a single hospital found that combining written education regarding costs with feedback regarding laboratory use seemed to decrease test utilisation compared with audit and feedback alone (unadjusted difference 22.3%, high risk of bias; no p-value reported). Relative reduction of targeted tests 15.1%.</p> <p><b>Miyakis et al. <i>Postgrad Med</i> 2006;82:823–9.</b> The results of an audit on test use were presented along with strategies for reducing utilisation in a single teaching hospital. Results showed a 13.5% reduction in ordering of tests after the intervention.</p> <p><b>Barie et al. <i>J Trauma</i> 1997;43:590–6.</b> Testing pathways were introduced and audit and feedback was done monthly in an intensive care unit to improve use of blood tests and chest radiographs. Results showed a 34.6% relative reduction in ordering after the intervention.</p> <p><b>Rhyne et al. <i>J Fam Pract</i> 1979;8:1003–7.</b> A chart audit of test ordering was done and the results were presented to family doctors, resulting in a 36.4% reduction in ordering of thyroid function tests after the intervention.</p> <p><b>Sorita et al. <i>J Hosp Med</i> 2011;6:S135–6.</b> Study involved a 1-hour teaching session regarding when to order STAT blood tests and results of an audit were presented. The highest users of STAT tests were given individual feedback, resulting in a 21% decrease in test ordering after the intervention.</p> <p><b>Dowling et al. <i>Acad Med</i> 1989;64:410–2.</b> Lectures and guidelines on appropriate testing were distributed. Audit and feedback of test usage was performed repeatedly to reduce complete blood count and thyroid stimulating hormone testing. Results showed a 47.5% reduction in ordering after the intervention.</p> <p><b>Eisenberg et al. <i>J Med Educ</i> 1977;52:578–81.</b> Results from a single audit on utility of testing were circulated along with a memorandum from the medical director asking for careful consideration of test usage in a community hospital setting. Results showed a 42.1% decrease in test ordering after the intervention.</p> <p><b>Sucov et al. <i>J Emerg Med</i> 1999;17:391–7.</b></p>	<p>Audit feedback interventions, overall: median RR (IQR) 22.0 (8.6 to 34.6). Percentage relative reductions in test utilisation were statistically significantly decreased vs controls with 18/51 interventions: median RR (IQR) 22.0 (8.6 to 34.6); for exclusively audit and feedback interventions: median RR (IQR) 18.4 (2.1 to 24.8). For exclusively cost display: median RR (IQR) 18.4 (2.1 to 28.8).</p>

First author (year)	Findings of key studies in the review	Result summary
	<p>Guidelines were created regarding which tests to order for which patient group and rolled out with a series of educational sessions with discussion of ordering and utilisation of feedback, resulting in 22% reduction in tests. There was a significant decline in total testing from 209 to 163 tests per 100 patients (<math>p &lt; 0.001</math>); \$50,000 to \$100,000 less charged.</p> <p><b>Dickinson et al. <i>Fam Pract Res J</i> 1987;7:12–21.</b></p> <p>The number of unnecessary tests was measured and shown to department heads; results showed a decrease of 24.5% in all blood tests.</p> <p><b>Winkens et al. <i>Br Med J</i> 1992;304:1093–6.</b></p> <p>Biannual reports were sent on the number and rationality of laboratory testing compared with peers. Results showed a decrease of 25.0% in 46 blood tests.</p> <p><b>Fowkes et al. <i>Br Med J</i> 1986;292:883–5.</b></p> <p>A guideline on testing was distributed and weekly meetings were held with medical staff to discuss their use of tests in the previous week. Results showed a decrease of 63.4% in all blood tests.</p> <p><b>Gama et al. <i>Ann Clin Biochem</i> 1991;28(Pt 2):143–9.</b></p> <p>Data on personal and peer expenditure of laboratory resources was given to physicians monthly for 12 months. Results showed a decrease of 24.6% in all clinical chemistry tests.</p> <p><b>Gamma et al. <i>J Clin Pathol</i> 1992;45:248–9.</b></p> <p>Data on personal and peer clinical chemistry expenditure per patient was provided to physicians monthly for 12 months. Results showed a decrease of 27.0% in all clinical chemistry and haematology tests.</p> <p><b>Gortmaker et al. <i>Med Care</i> 1988;26:631–42.</b></p> <p>Nine staff meetings were held to discuss cost issues. Data on excess usage was sent to all doctors. All physicians reached a consensus on when each test was considered inappropriate. Results showed a decrease of 14.0% in 11 tests.</p>	

**Grivell et al. *Clin Chem* 1981;27:1717–20.**

Physicians received a report every 4 weeks on the type and number of tests ordered. Physicians were also shown where they ranked in comparison to their peers. Results showed no change.

**Lewandrowski et al. *Lab Med* 1994;25:460–3.**

A guideline on appropriate testing was developed. All requests were then reviewed by laboratory staff and the ordering physician was contacted if the request was not in accordance with the guideline. Results showed a decrease of 99.6% in isoenzyme tests.

**Martin et al. *N Engl J Med* 1980;303:1330–6.**

There was a 1-hour lecture on laboratory costs. Senior physicians then met weekly with residents; they reviewed cases and suggested changes in test ordering practices.

Results showed an increase of 17.8% in tests.

**Marton et al. *Arch Intern Med* 1985;145:816–21.**

Feedback on laboratory usage and costs incurred was shown to trainees along with their usage compared with peers. A manual about rational test ordering was given to the trainees. They also received feedback on laboratory usage, costs incurred and their usage compared with peers. Results showed a decrease of 33.3% in all blood tests.

**Pop et al. *J R Coll Gen Pract* 1989;39:507–8.**

Two times per year physicians were given a report of tests they had ordered and whether they were appropriate or not. Physicians were also informed of their redundant tests.

Results showed a decrease of 36.2% in selected tests.

**Power et al. *Anaesth Intensive Care* 1999;27:481–8.**

Published guidelines on test ordering were distributed. A maximum number of tests per patient was instituted and test ordering was reviewed by a consultant.

Results showed a decrease of 37.1% in selected tests.

First author (year)	Findings of key studies in the review	Result summary
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**Ramoska et al. *Am J Emerg Med* 1998;16:34–6.**

Graphs of laboratory utilisation and costs of laboratory tests at the hospital was displayed on a bulletin board. Results showed a decrease of 17.8% in all blood tests.

First author (year)	Findings of key studies in the review	Result summary
Légaré F (2016)	<p><b>Modell et al. <i>BMJ</i> 1998;317:788–91.</b>  An intervention designed to increase uptake of genetic testing for haemoglobin disorders was effective for a number of screening test requests at 1 year (no statistics provided).  Audit and feedback effective regarding knowledge-related outcomes in 0/0 studies.  Audit and feedback effective regarding behaviour-related outcomes in 1/1 studies.  Audit and feedback effective regarding wellbeing-related outcomes in 0/0 studies.</p>	A single study showed that audit and feedback may be effective at improving 'behaviour-related' outcomes (eg, intention to undergo genetic testing, quitting smoking after genetic testing).
Chaudhuri D (2016)	<p><b>Bhatia et al. <i>JACC Cardiovas imaging</i> 2014;7:857–66</b>  An RCT evaluating the use of lectures, a pocket card, and monthly individualised feedback with a 9-month follow-up showed an improvement in inappropriate cardiac testing (OR 0.30, 95% CI 0.15 to 0.58).</p> <p><b>Chinnaiyan et al. <i>J Am Coll Cardiol</i> 2012;60:1185–91.</b>  In a multicentre study with a 6-month follow-up, didactic sessions and letters to physicians, results showed an improvement in the reduction of inappropriate cardiac testing (OR 0.36, 95% CI 0.31 to 0.43). Appropriate use of scans increased from 61.3% to 80.0% and inappropriate use decreased from 14.6% to 5.8%.</p> <p><b>Johnson et al. <i>J Am Soc Echocardiogr</i> 2014;27:749–57.</b>  A single centre observational study using didactic lectures, and physician audit and feedback (individualised reports, inappropriate studies listed by patient record and indication) with results benchmarked to performance of the group showed an improvement in ordering of inappropriate cardiac tests at 2-year follow-up (OR 0.31, 95% CI 0.15 to 0.61).</p> <p><b>Lin et al. <i>J Am Coll Cardiol</i> 2013;62:308–16.</b>  A physician audit and feedback intervention with computer-based decision support tool providing real-time feedback showed an improvement in ordering of inappropriate cardiac tests at 8-month follow-up (OR 0.22, 95% CI 0.0 to 0.54).</p>	<p>Overall, interventions were associated with significantly lower odds of inappropriate testing (OR 0.44, 95% CI 0.32 to 0.61, <math>p &lt; 0.001</math>). However, there was significant heterogeneity observed between studies (<math>I^2 = 70\%</math>).</p> <p>Initiatives were associated with higher odds of appropriate testing (OR 1.67, 95% CI 1.19 to 2.35), with significant heterogeneity observed (<math>I^2 = 0.87</math>).</p> <p>The presence of a physician audit and feedback mechanism was associated with lower odds of inappropriate testing (OR 0.36, 95% CI 0.31 to 0.41, <math>p &lt; 0.001</math>), whereas studies that lacked this process had no significant effect on inappropriate testing (OR 0.89, 95% CI 0.61 to 1.29, <math>p = 0.51</math>; <math>p</math>-value for difference <math>&lt; 0.001</math>).</p>



First author (year)	Findings of key studies in the review	Result summary
Thomas RE (2016)	<p><b>Winkens et al. <i>Lancet</i> 1995;345:498–502.</b> Feedback to physicians over a 9-year period; there was a 19% decrease in test ordering but in another centre that did not receive feedback there was a 49% increase.</p> <p><b>O'Connor et al. <i>Diabetes Care</i> 2009;32:1158–63.</b> 1. Patient feedback (mailed information). 2. Physician feedback (prioritised lists of patients with recommended clinic actions). 3. Both patient and physician. LDL testing, patient intervention 0.8% greater (<math>p &lt; 0.05</math>); physician intervention 3% lower (<math>p &lt; 0.01</math>); both interventions 1.1% lower (<math>p &lt; 0.01</math>) compared with control. For HbA<sub>1c</sub>, patient intervention was 0.6% greater in control, physician intervention was 3.4% greater in control, both interventions were 3.6% greater in controls (all non-significant).</p> <p><b>Kiefe et al. <i>JAMA</i> 2001;285:2871–9.</b> Chart review, specific feedback, achievable benchmarks vs chart review, specific feedback for cholesterol and triglycerides. Cholesterol was 5% greater (<math>p = 0.13</math>), triglycerides were 2% greater (<math>p = 0.22</math>) and glucose was 5% greater with the intervention (no significance statement).</p> <p><b>Bonevski et al. <i>Prev Med</i> 1999;29:478–86.</b> Evaluated a computerised continuing medical education program with feedback Intervention to increase cholesterol testing, resulting in 12% more tests in the intervention group (<math>p &lt; 0.001</math>).</p> <p><b>Baker et al. <i>Scand J Prim Healthcare</i> 2003;21:219–23.</b> Laboratory sent guidelines encouraging reduced urine tests. Feedback (every 3 months <math>\times</math> 1 year) about test numbers. The lead GP received data and convened meeting to reduce lab tests. There were no changes.</p> <p><b>Bunting et al. <i>Clin Chem</i> 2004;50:321–6.</b> Educational material plus individual visits from laboratory representatives to reduce laboratory tests vs no feedback. The intervention led to 7.9% fewer tests/visit than control (<math>p &lt; 0.0001</math>).</p> <p><b>Verstappen et al. <i>Int J Qual Healthcare</i> 2004;16:391–8.</b> 1. Feedback: education on guidelines; quality improvement sessions in small groups.</p>	Two interventions used feedback (one 5% increase, one 27% desired decrease); eight education and feedback (average increase in desired direction $>$ control 4.9%), one system change and feedback (increases 5% to 44%), three education and system change and feedback (average 7.7% increase).

First author (year)	Findings of key studies in the review	Result summary
	<p>2. Feedback only (Arm A received intervention for cardiovascular, upper abdominal, and lower abdominal complaints); 12% fewer tests.</p> <p>Decrease in total number of tests ordered (–67 tests/physician; <math>p = 0.01</math>) and inappropriate tests ordered (–16 tests/physician; <math>p = 0.01</math>). There was a 12% reduction in testing in a physician group asked to solve problems involving 15 laboratory tests and a 5% reduction in a group with problems involving 10 laboratory tests.</p> <p><b>Thomas et al. <i>Lancet</i> 2006;367:1990–6.</b></p> <p>Provided practice-level feedback in the form of a booklet with data for targeted overused tests compared with regional rates. Feedback alone reduced overuse for nine tests (significantly for four), and when combined with educational reminders, reduced total requests by 22%. Feedback led to greater reductions in the number of laboratory tests ordered compared with reminders although the model-based analyses suggested similar effects (adjusted change relative to baseline performance in audit and feedback arm: 12%; OR for feedback 0.87, 95% CI 0.81 to 0.94; OR for reminders 0.89, 95% CI 0.83 to 0.93).</p> <p><b>Flottorp et al. <i>BMJ</i> 2002;325:367.</b></p> <p>Found a 0.4% decrease in number of throat swabs in the intervention group and 5.1% fewer urine tests in the intervention group compared with the control groups.</p> <p><b>Bonevski et al. <i>Prev Med</i> 1999;29:478–86.</b></p> <p>Found a 12% increase in cholesterol testing in the intervention group compared with the control group.</p> <p><b>Claes et al. <i>Eur Heart J</i> 2005;26:2159–65.</b></p> <p>Found a 14% improvement in the percentage of time INR results were within 0.5 of the target range in the education group, 11% in the feedback group, 8% in the group that used the INR in-office test, and 8% in the group that used computer-assisted decision making (compared with the control group).</p>	

First author (year)	Findings of key studies in the review	Result summary
<b>Tzortziou Brown V (2016)</b>	<p><b>Eccles et al. <i>Lancet</i> 2001;357:1406–9.</b></p> <ol style="list-style-type: none"> <li>1. Professional intervention (distribution of educational materials + audit and feedback).</li> <li>2. Professional intervention (distribution of educational materials + reminders).</li> <li>3. Professional intervention (distribution of educational materials + audit and feedback + reminders).</li> <li>4. Distribution of educational materials (guideline).</li> </ol> <p>The study showed that there may be some deterioration in the percentage of spinal radiographs that are concordant with the guidelines in the intervention groups (risk difference range –2.5% to –8.3%) and a slight reduction in the number of spinal radiograph requests across the groups (standardised mean difference was small for the feedback group at 0.2, and moderate for the reminder group at 0.4).</p> <p><b>Cranney et al. <i>Osteoporos Int</i> 2008;19:1733–40.</b></p> <p>Participants received a letter 2 weeks and 2 months post fracture with advice to see their GP, and an educational booklet (patient-directed component); GPs were mailed reminders and guidelines. Results showed that the intervention improved bone mineral density testing (risk difference 26%, rates 53.5% in the intervention group vs 25.5% in controls; reported adjusted OR 3.38, 95% CI 1.83 to 6.26, <math>p &lt; 0.001</math>) and osteoporosis medicine prescribing rates (risk difference 17.7%; rates 28% in the intervention group vs 10% in controls; reported adjusted OR 3.45, 95% CI 1.58 to 7.56, <math>p = 0.002</math>).</p>	Eccles 2001 showed that providing GP feedback combined with guidelines on the total number of investigations requested may result in a slight reduction in the number of radiology requests.
<b>French SD (2010)</b>	<p><b>Eccles et al. <i>Lancet</i> 2001;357(9266):1406–9.</b></p> <ol style="list-style-type: none"> <li>1. Professional intervention (distribution of educational materials + audit and feedback).</li> <li>2. Professional intervention (distribution of educational materials + reminders).</li> <li>3. Professional intervention (distribution of educational materials + audit and feedback + reminders).</li> <li>4. Distribution of educational materials (guideline).</li> </ol> <p>The study showed that there may be some deterioration in the percentage of spinal radiographs that are concordant with the guidelines in the intervention groups (risk difference range –2.5% to –8.3%) and a slight reduction in the number of spinal radiograph requests across the groups (standardised mean difference was small for the feedback group at 0.2, and moderate for the reminder group at 0.4).</p>	Providing GP feedback on the total number of investigations requested may result in a slight reduction in the number of radiology requests.

First author (year)	Findings of key studies in the review	Result summary
Silvestri MT (2016)	<p>Everett et al. <i>Arch Intern Med</i> 1983;143:942–4.</p> <p>Found that combining written education regarding costs with feedback regarding laboratory use seemed to decrease test utilisation compared to audit and feedback alone (unadjusted difference 22.3%, high risk of bias; no p-value reported). No numerical values were reported.</p>	Of 17 studies, 12 showed that price display was associated with statistically significant decreases in either order costs or volume, either in aggregate (10 studies) or for individual orders (two studies).

Table 6. Key findings on quality improvement

First author (year)	Review findings	Result summary
<b>Modifications or restrictions to referral or order forms</b>		
Cadogan SL (2015)	<p><b>Kahan et al. <i>Am J Manag Care</i> 2009;15:173–6.</b>            Evaluated a new version of a computerised order form for three target tests (vitamin B12, folic acid and ferritin) vs test requests for haemoglobin and iron as controls. The new vs old order form led to a 31% to 41% reduction in volume of test requests relative to the pre-intervention month, with a 36% to 58% reduction the following month. In comparison, the effect on test requests for controls tests ranged from –2% to 3%.</p>	<p>Results from individual studies showed that changing order forms to include a reduced number of tests or include decision support based on guideline can lead to a reduction in the volume of laboratory tests ordered.</p>
	<p><b>Shalev et al. <i>Int J Med Inform</i> 2009;78:639–44.</b>            Evaluated changing the volume of tests on order form (27 tests removed and two tests added, reducing the number of tests available using a check-box form from 51 to 26) vs a standard form before intervention. For deleted tests there was a 27% and 19.2 % reduction 1 and 2 years after the intervention, respectively (<math>p &lt; 0.001</math>).</p>	
	<p>For unchanged tests the percentage changes were +18.4 % in year 1 and –22.4% in year 2; 60.7% (year 1) and 90% (year 2) increases in volume were found in which tests were added to the order form (<math>p &lt; 0.001</math>).</p>	
	<p><b>Zaat et al. <i>Med Care</i> 1992;30:189–98.</b>            Evaluated a standard order form vs a modified request form in which only 15 tests were listed and all other tests had to be handwritten. There was an 18% reduction in the number of tests requested on a monthly basis in the intervention group. In the comparison period the difference between groups was significant (<math>p &lt; 0.0001</math>).</p>	
	<p><b>van Wijk et al. <i>Ann Intern Med</i> 2001;134:274–81.</b>            Evaluated a guideline-based order form vs a restricted guideline-based electronic order form. Decision support based on guidelines was more effective in changing blood test ordering than decision support based on initially displaying a limited number of tests.</p>	
	<p>Those who used BloodLink-Guideline requested 20% fewer tests on average than those who used BloodLink-Restricted: mean (<math>\pm</math> SD) <math>5.5 \pm 0.9</math> tests vs <math>6.9 \pm 1.6</math> tests (<math>p = 0.003</math>).</p>	

First author (year)	Review findings	Result summary
Jenkins HJ (2015)	<p><b>Baker et al. <i>AJR Am J Roentgenol</i> 1987;149:535-8.</b></p> <p>Absolute change in imaging referrals during the first month after implementation of a modified referral form that allowed only three guideline-appropriate indications for imaging: -44.3 (95% CI -48.7 to -39.9). This was equivalent to a decrease in imaging of 36.8% (95% CI 33.2% to 40.5%).</p>	<p>Results from a single study showed that clinical decision support involving a modified referral form in a hospital setting reduced rates of imaging.</p>
Stammen LA (2015)	<p><b>Krinsley. <i>J Intensive Care Med</i> 2003;18:330-9.</b></p> <p>Evaluated reflective questions on an order form (to residents), to see if it would safely decrease utilisation of imaging. Chest X-ray utilisation rate decreased by 22.5% during the study period, resulting in \$109,968 cost savings, which were not associated with any adverse clinical outcomes.</p>	<p>Results from a single study showed that changing an order form to include reflective questions decreased utilisation of imaging and resulted in cost savings, without increases in adverse outcomes.</p>

First author (year)	Review findings	Result summary
Thomas RE (2015)	<p><b>Bailey et al. <i>J Clin Pathol</i> 2005;58:853–5.</b> Removed CRP, RF, LDH and serum calcium from a 16-item lab form (previously included as individual check boxes). Compared with the original request rate, the request rate for serum LDH declined to 21%, calcium tests to 38%, CRP to 70% and RF to 73% (all <math>p &lt; 0.001</math>).</p> <p><b>Emerson et al. <i>Am J Clin Pathol</i> 2001;116:879–84.</b> Found that family physicians at baseline ordered 0.55 laboratory tests/patient visit. Seven months after a 6-month familiarisation period they ordered 0.6 laboratory tests/patient visit, with no significant differences.</p> <p><b>Kahan et al. <i>Am J Manag Care</i> 2009;15:173–6.</b> A computerised form was re-formatted to separate grouped tests. They separated vitamin B12, folic acid and ferritin (which had been grouped and labelled 'anaemia') and found a decrease of 58% in folic acid tests, 50% in ferritin tests, 39% in B12 tests, 4% in Hgb tests, and 2% in iron tests (no numbers of patients, tests or physicians were provided).</p> <p><b>Shalev et al. <i>Int J Med Inform</i> 2009;78:639–44.</b> Changed the set-up of a check-box laboratory order form embedded in a computerised medical record. They reduced the number of tests on the form from 51 to 26. For the deleted tests there was a 30% decrease in the first and a 39% decrease in the second year. For the unchanged tests there was a 13% increase in the first year and a 1% increase in the second (all <math>p &lt; 0.001</math>).</p> <p><b>Vardy et al. <i>J Med Syst</i> 2005;29:619–26.</b> Reorganised 26 common tests comprising 84% of total laboratory costs into three levels: screening, tests to assess the extent of the problem, and full evaluation of the problem. In the year before the intervention there was a 19% increase in tests ordered, but there was a 2% decrease in the 3 months after the intervention.</p> <p><b>Zaat et al. <i>Med Care</i> 1992;30:189–98.</b> Reduced their laboratory form to only 15 haematological and chemical tests (in addition to 'some urine and faeces tests'). Physicians were provided with a booklet explaining the essential features of the 15 tests and sample calculations of prior and posterior probabilities. There was an 18% reduction in orders after the intervention compared with a control group from a different area (<math>p &lt; 0.0001</math>). After the intervention the standard form was re-introduced and the order rate increased again.</p> <p><b>Huang et al. <i>Clin Biochem</i> 2012;45:455–9.</b> Change of form for coeliac disease and ability to order coeliac diseases tests denied to all family physicians led to a 100% reduction in test ordering.</p> <p><b>Liu Z et al. <i>Lab Med</i> 2012;43:164–7.</b></p>	Results from individual studies showed that there was a reduction in request rates for laboratory tests after modification of order forms to separate individual tests from groups of tests, reduce the total number of tests included on an order form, or re-organise tests based on depth of evaluation required.

First author (year)	Review findings	Result summary
	The request for physicians to justify costs more than CA\$20 for tests that needed to be referred out to other laboratories resulted in a 61% decrease in ordering.	



# Appendices

## Appendix 1: The full electronic search strategies used for the systematic searches

### *Embase search for reviews investigating diagnostic imaging*

Search Strategy:

1. Primary Healthcare/ (58175)
2. Family Practice/ (79519)
3. General Practice/ (82625)
4. General Practitioners/ (85537)
5. Physicians, Family/ (85539)
6. GP.mp. (67693)
7. or/1-6 (255940)
8. unnecessary procedures.mp. or Unnecessary Procedures/ (2779)
9. Clinical Decision-Making/ (33922)
10. Decision Support Systems, Clinical/ (507)
11. Education, Medical, Continuing/ (190666)
12. Inservice training.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading] (399)
13. General practitioners education.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading] (12)
14. Medical Audit/ (53265)
15. interventions.mp. (422459)
16. test utilization.mp. (432)
17. Clinical Audit/ (52975)
18. Guideline Adherence/ (274544)
19. practice pattern feedback.mp. (3)
20. practice patterns, physicians/ (262207)
21. Quality Improvement/ (21004)
22. Practice Guideline/ (309806)
23. Practice guidelines as topic.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading] (179)
24. or/9-23 (1185270)
25. imaging.tw. (820369)

26. ultrasound\*.tw. (287921)
27. MRI.tw. (302313)
28. CT scan.tw. (77286)
29. Magnetic Resonance Imaging/ or Diagnostic Imaging/ (448097)
30. Ultrasonography/ (176753)
31. ultraso\*.tw. (423741)
32. Magnetic resonance imaging.tw. (212624)
33. tomography, X-ray computed/ (418641)
34. x ray\*.tw. (318058)
35. X-rays/ (80991)
36. or/25-35 (2088128)
37. 7 and 24 and 36 (1282)
38. 7 and 8 and 36 (15)
39. 37 or 38 (1286)
40. "systematic review"/ (156066)
41. 39 and 40 (38)
42. limit 41 to (human and english language and yr="2007 -Current") (28)

#### ***Embase search for reviews investigating pathology tests***

Search Strategy:

1. Primary Healthcare/ (58167)
2. Family Practice/ (79508)
3. General Practice/ (82614)
4. General Practitioners/ (85512)
5. Physicians, Family/ (85514)
6. GP.mp. (67670)
7. or/1-6 (255880)
8. medical tests.mp. (645)
9. (diagnostic tests and procedures).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading] (2197)
10. Diagnostic Tests, Routine/ (78558)
11. Haematologic Tests/ (11198)
12. Pathology, Clinical/ (846801)
13. blood tests.mp. (13016)
14. Clinical Laboratory Techniques/ (121938)
15. or/8-14 (1061813)
16. unnecessary procedures.mp. or Unnecessary Procedures/ (2779)

17. Clinical Decision-Making/ (33905)
18. Decision Support Systems, Clinical/ (504)
19. Education, Medical, Continuing/ (190624)
20. in service training.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading] (15722)
21. general practitioners education.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading] (12)
22. Medical Audit/ (53264)
23. interventions.mp. (422250)
24. test utilization.mp. (431)
25. Clinical Audit/ (52970)
26. Guideline Adherence/ (274407)
27. practice pattern feedback.mp. (3)
28. practice patterns, physicians/ (262118)
29. Quality Improvement/ (20984)
30. Practice Guideline/ (309669)
31. practice guidelines as topic.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading] (179)
32. or/17-31 (1197876)
33. 7 and 15 and 32 (1502)
34. 7 and 15 and 16 (10)
35. 33 or 34 (1508)
36. "systematic review"/ (155897)
37. 35 and 36 (35)
38. limit 37 to (human and english language and yr="2007 -Current") (23)

### *Medline search for reviews investigating diagnostic imaging*

#### Search Strategy:

1. Primary Healthcare/ (63673)
2. Family Practice/ (63342)
3. General Practice/ (10378)
4. General Practitioners/ (5295)
5. Physicians, Family/ (15571)
6. GP.mp. (30952)
7. or/1-6 (164821)
8. unnecessary procedures.mp. or Unnecessary Procedures/ (4947)
9. Clinical Decision-Making/ (1316)
10. Decision Support Systems, Clinical/ (6212)
11. Education, Medical, Continuing/ (23192)
12. Inservice training.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (19257)
13. General practitioners education.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (4)
14. Medical Audit/ (15985)
15. interventions.mp. (281533)
16. test utilization.mp. (230)
17. Clinical Audit/ (1188)
18. Guideline Adherence/ (26098)
19. practice pattern feedback.mp. (2)
20. practice patterns, physicians/ (48836)
21. Quality Improvement/ (13126)
22. Practice Guideline/ (22349)
23. Practice guidelines as topic.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (97337)
24. or/9-23 (513068)
25. imaging.tw. (512197)
26. ultrasound\*.tw. (168812)
27. MRI.tw. (158268)
28. CT scan.tw. (39230)
29. Magnetic Resonance Imaging/ or Diagnostic Imaging/ (363559)
30. Ultrasonography/ (162061)

31. ultraso\*.tw. (266136)
32. Magnetic resonance imaging.tw. (148860)
33. tomography, X-ray computed/ (331104)
34. x ray\*.tw. (215439)
35. X-rays/ (26868)
36. or/25-35 (1396089)
37. 7 and 24 and 36 (541)
38. 7 and 8 and 36 (31)
39. 37 or 38 (549)
40. limit 39 to (english language and humans and yr="2007 -Current" and systematic reviews) (29)

### *Medline search for reviews investigating pathology tests*

#### Search Strategy:

1. Primary Healthcare/ (63748)
2. Family Practice/ (63352)
3. General Practice/ (10395)
4. General Practitioners/ (5309)
5. Physicians, Family/ (15577)
6. GP.mp. (34620)
7. or/1-6 (168588)
8. medical tests.mp. (472)
9. (diagnostic tests and procedures).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (2325)
10. Diagnostic Tests, Routine/ (9196)
11. Haematologic Tests/ (8409)
12. Pathology, Clinical/ (4828)
13. blood tests.mp. (7224)
14. Clinical Laboratory Techniques/ (18705)
15. or/8-14 (48755)
16. unnecessary procedures.mp. or Unnecessary Procedures/ (5032)
17. Clinical Decision-Making/ (1349)
18. Decision Support Systems, Clinical/ (6215)
19. Education, Medical, Continuing/ (23222)
20. in service training.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (992)
21. general practitioners education.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (4)
22. Medical Audit/ (15995)
23. interventions.mp. (331268)
24. test utilization.mp. (279)
25. Clinical Audit/ (1195)
26. Guideline Adherence/ (26133)
27. practice pattern feedback.mp. (2)
28. practice patterns, physicians/ (48895)
29. Quality Improvement/ (13215)
30. Practice Guideline/ (22458)

31. practice guidelines as topic.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (97547)
32. or/17-31 (547059)
33. 7 and 15 and 32 (332)
34. 7 and 15 and 16 (23)
35. 33 or 34 (344)
36. limit 35 to (English language and humans and yr="2007 -Current" and systematic reviews) (6)

*PsycINFO search for reviews investigating diagnostic imaging*

Search Strategy:

1. Primary Healthcare/ (15335)
2. Family Practice/ (0)
3. General Practice/ (0)
4. General Practitioners/ (5431)
5. Physicians, Family/ (0)
6. GP.mp. (3722)
7. or/1-6 (21674)
8. medical tests.mp. (156)
9. (diagnostic tests and procedures).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures] (96)
10. Diagnostic Tests, Routine/ (0)
11. Haematologic Tests/ (0)
12. Pathology, Clinical/ (0)
13. blood tests.mp. (594)
14. Clinical Laboratory Techniques/ (0)
15. or/8-14 (845)
16. unnecessary procedures.mp. or Unnecessary Procedures/ (20)
17. Clinical Decision-Making/ (0)
18. Decision Support Systems, Clinical/ (0)
19. Education, Medical, Continuing/ (0)
20. Medical Audit/ (419)
21. interventions.mp. (160232)
22. test utilization.mp. (45)
23. Clinical Audit/ (419)
24. Guideline Adherence/ (0)
25. practice pattern feedback.mp. (0)
26. practice patterns, physicians/ (0)
27. Quality Improvement/ (0)
28. Practice Guideline/ (0)
29. or/17-28 (160648)
30. 7 and 15 and 29 (4)
31. 7 and 15 and 16 (0)
32. 30 or 31 (4)
33. limit 32 to (english language and humans and yr="2012 -Current" and systematic reviews) [Limit not valid in PsycINFO; records were retained] (0)



34. 7 and 15 and 30 (4)
35. Primary Healthcare/ (15335)
36. Family Practice/ (0)
37. General Practice/ (0)
38. General Practitioners/ (5431)
39. Physicians, Family/ (0)
40. GP.mp. (3722)
41. or/35-40 (21674)
42. unnecessary procedures.mp. or Unnecessary Procedures/ (20)
43. Clinical Decision-Making/ (0)
44. Decision Support Systems, Clinical/ (0)
45. Education, Medical, Continuing/ (0)
46. Medical Audit/ (419)
47. interventions.mp. (160232)
48. test utilization.mp. (45)
49. Clinical Audit/ (419)
50. Guideline Adherence/ (0)
51. practice pattern feedback.mp. (0)
52. practice patterns, physicians/ (0)
53. Quality Improvement/ (0)
54. Practice Guideline/ (0)
55. or/43-54 (160648)
56. imaging.tw. (64160)
57. ultrasound\*.tw. (2960)
58. MRI.tw. (29047)
59. CT scan.tw. (1194)
60. Magnetic Resonance Imaging/ or Diagnostic Imaging/ (16596)
61. Ultrasonography/ (0)
62. ultraso\*.tw. (4950)
63. Magnetic resonance imaging.tw. (36081)
64. tomography, X-ray computed/ (0)
65. x ray\*.tw. (2273)
66. X-rays/ (0)
67. or/56-66 (84348)
68. 41 and 55 and 67 (5)
69. 41 and 42 and 67 (0)
70. 68 or 69 (5)

71. limit 70 to (human and english language and yr="2007 -Current") (4)

*PsycINFO search for reviews investigating pathology tests*

Search Strategy:

1. Primary Healthcare/ (15335)
2. Family Practice/ (0)
3. General Practice/ (0)
4. General Practitioners/ (5431)
5. Physicians, Family/ (0)
6. GP.mp. (3722)
7. or/1-6 (21674)
8. medical tests.mp. (156)
9. (diagnostic tests and procedures).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures] (96)
10. Diagnostic Tests, Routine/ (0)
11. Haematologic Tests/ (0)
12. Pathology, Clinical/ (0)
13. blood tests.mp. (594)
14. Clinical Laboratory Techniques/ (0)
15. or/8-14 (845)
16. unnecessary procedures.mp. or Unnecessary Procedures/ (20)
17. Clinical Decision-Making/ (0)
18. Decision Support Systems, Clinical/ (0)
19. Education, Medical, Continuing/ (0)
20. in service training.mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures] (1231)
21. general practitioners education.mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures] (2)
22. Medical Audit/ (419)
23. interventions.mp. (160232)
24. test utilization.mp. (45)
25. Clinical Audit/ (419)
26. Guideline Adherence/ (0)
27. practice pattern feedback.mp. (0)
28. practice patterns, physicians/ (0)
29. Quality Improvement/ (0)
30. Practice Guideline/ (0)

31. practice guidelines as topic.mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures] (2)
32. or/17-31 (161798)
33. 7 and 15 and 32 (4)
34. 7 and 15 and 16 (0)
35. 33 or 34 (4)
36. limit 35 to (english language and humans and yr="2012 -Current" and systematic reviews) [Limit not valid in PsycINFO; records were retained] (0)

## References

1. Colla CH, Mainor AJ, Hargreaves C, et al. Interventions aimed at reducing use of low-value health services: a systematic review. *Med Care Res Rev* 2016.
2. Bright TJ, Wong A, Dhurjati R, et al. Effect of clinical decision-support systems: a systematic review. *Ann Intern Med* 2012;157 (1):29–43. [at http://annals.org/aim/article/1206700/effect-clinical-decision-support-systems-systematic-review](http://annals.org/aim/article/1206700/effect-clinical-decision-support-systems-systematic-review)
3. Cadogan SL, Browne JP, Bradley CP, et al. The effectiveness of interventions to improve laboratory requesting patterns among primary care physicians: a systematic review. *Implement Sci* 2015;10 167. [at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4670500/pdf/13012\\_2015\\_Article\\_356.pdf](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4670500/pdf/13012_2015_Article_356.pdf)
4. Chaudhuri D, Montgomery A, Gulenchyn K, et al. Effectiveness of quality improvement interventions at reducing inappropriate cardiac imaging: a systematic review and meta-analysis. *Circ Cardiovasc Qual Outcomes* 2016;9 (1):7–13. [at http://circoutcomes.ahajournals.org/content/circvvoq/9/1/7.full.pdf](http://circoutcomes.ahajournals.org/content/circvvoq/9/1/7.full.pdf)
5. Flodgren G, Hall AM, Goulding L, et al. Tools developed and disseminated by guideline producers to promote the uptake of their guidelines. *Cochrane Database Syst Rev* 2016 (8):CD010669. [at http://onlinelibrary.wiley.com/store/10.1002/14651858.CD010669.pub2/asset/CD010669.pdf?v=1&t=izxj0qfp&s=83612f3f683035d83ce2825f25db0c8b8b598f13](http://onlinelibrary.wiley.com/store/10.1002/14651858.CD010669.pub2/asset/CD010669.pdf?v=1&t=izxj0qfp&s=83612f3f683035d83ce2825f25db0c8b8b598f13)
6. French SD, Green S, Buchbinder R, et al. Interventions for improving the appropriate use of imaging in people with musculoskeletal conditions. *Cochrane Database Syst Rev* 2010 (1):CD006094. [at http://onlinelibrary.wiley.com/store/10.1002/14651858.CD006094.pub2/asset/CD006094.pdf?v=1&t=izno50iv&s=c0202655b40b7f7676f120b11139afb3531e220a](http://onlinelibrary.wiley.com/store/10.1002/14651858.CD006094.pub2/asset/CD006094.pdf?v=1&t=izno50iv&s=c0202655b40b7f7676f120b11139afb3531e220a)
7. Georgiou A, Prgomet M, Markewycz A, et al. The impact of computerized provider order entry systems on medical-imaging services: a systematic review. *J Am Med Inform Assoc* 2011;18 (3):335–40. [at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3078656/pdf/amiajnl-2010-000043.pdf](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3078656/pdf/amiajnl-2010-000043.pdf)
8. Georgiou A, Williamson M, Westbrook JJ, et al. The impact of computerised physician order entry systems on pathology services: a systematic review. *Int J Med Inform* 2007;76 (7):514–29.
9. Goetz C, Rotman SR, Hartoularos G, et al. The effect of charge display on cost of care and physician practice behaviors: a systematic review. *J Gen Intern Med* 2015;30 (6):835–42. [at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4441675/pdf/11606\\_2015\\_Article\\_3226.pdf](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4441675/pdf/11606_2015_Article_3226.pdf)
10. Jenkins HJ, Hancock MJ, French SD, et al. Effectiveness of interventions designed to reduce the use of imaging for low-back pain: a systematic review. *CMAJ* 2015;187 (6):401–8. [at https://www.ncbi.nlm.nih.gov/pubmed/25733741](https://www.ncbi.nlm.nih.gov/pubmed/25733741)

11. Kobewka DM, Ronksley PE, McKay JA, et al. Influence of educational, audit and feedback, system based, and incentive and penalty interventions to reduce laboratory test utilization: a systematic review. *Clin Chem Lab Med* 2015;53 (2):157–83. [at https://www.ncbi.nlm.nih.gov/pubmed/25263310](https://www.ncbi.nlm.nih.gov/pubmed/25263310)
12. Main C, Moxham T, Wyatt JC, et al. Computerised decision support systems in order communication for diagnostic, screening or monitoring test ordering: systematic reviews of the effects and cost-effectiveness of systems. *Health Technol Assess* 2010;14 (48):1–227.
13. Roshanov PS, You JJ, Dhaliwal J, et al. Can computerized clinical decision support systems improve practitioners' diagnostic test ordering behavior? A decision-maker-researcher partnership systematic review. *Implement Sci* 2011;6 88. [at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3174115/pdf/1748-5908-6-88.pdf](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3174115/pdf/1748-5908-6-88.pdf)
14. Silvestri MT, Bongiovanni TR, Glover JG, et al. Impact of price display on provider ordering: A systematic review. *J Hosp Med* 2016;11 (1):65–76. [at http://onlinelibrary.wiley.com/store/10.1002/jhm.2500/asset/jhm2500.pdf?v=1&t=izs\\_zkxch&s=f39be7380993f3977bd2870d587ef310206cce86](http://onlinelibrary.wiley.com/store/10.1002/jhm.2500/asset/jhm2500.pdf?v=1&t=izs_zkxch&s=f39be7380993f3977bd2870d587ef310206cce86)
15. Thomas RE, Vaska M, Naugler C, et al. Interventions to educate family physicians to change test ordering systematic review of randomized controlled trials. *Academic Pathology* 2016;3 doi:10.1177/2374289516633476. [at http://journals.sagepub.com/doi/full/10.1177/2374289516633476](http://journals.sagepub.com/doi/full/10.1177/2374289516633476)
16. Tzortziou Brown V, Underwood M, Mohamed N, et al. Professional interventions for general practitioners on the management of musculoskeletal conditions. *Cochrane Database Syst Rev* 2016 (5):CD007495. [at http://onlinelibrary.wiley.com/store/10.1002/14651858.CD007495.pub2/asset/CD007495.pdf?v=1&t=iznopuo3&s=0f1d3dd994ea853775865936d229f0154dd980ba](http://onlinelibrary.wiley.com/store/10.1002/14651858.CD007495.pub2/asset/CD007495.pdf?v=1&t=iznopuo3&s=0f1d3dd994ea853775865936d229f0154dd980ba)
17. Stammen LA, Stalmeijer RE, Paternotte E, et al. Training physicians to provide high-value, cost-conscious care: a systematic review. *JAMA* 2015;314 (22):2384–400. [at http://jama.jamanetwork.com/pdfaccess.ashx?url=/data/journals/jama/934739/joi150149.pdf](http://jama.jamanetwork.com/pdfaccess.ashx?url=/data/journals/jama/934739/joi150149.pdf)
18. Legare F, Robitaille H, Gane C, et al. Improving decision making about genetic testing in the clinic: An overview of effective knowledge translation interventions. *PLoS One* 2016;11 (3):e0150123. [at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4777394/pdf/pone.0150123.pdf](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4777394/pdf/pone.0150123.pdf)
19. Thomas RE, Vaska M, Naugler C, et al. Interventions at the laboratory level to reduce laboratory test ordering by family physicians: Systematic review. *Clin Biochem* 2015;48 (18):1358–65. [at https://www.ncbi.nlm.nih.gov/pubmed/26436568](https://www.ncbi.nlm.nih.gov/pubmed/26436568)
20. Colla CH, Sequist TD, Rosenthal MB, et al. Use of non-indicated cardiac testing in low-risk patients: Choosing Wisely. *BMJ Qual Saf* 2015;24 (2):149–53.
21. Whiting-O'Keefe QE, Henke C, Simborg DW. Choosing the correct unit of analysis in Medical Care experiments. *Med Care* 1984;22 (12):1101–14.
22. Effective Practice and Organisation of Care (EPOC). EPOC Taxonomy; 2015. [at http://epoc.cochrane.org/sites/epoc.cochrane.org/files/public/uploads/2015%20EPOC%20Taxonomy%20FINAL.pdf](http://epoc.cochrane.org/sites/epoc.cochrane.org/files/public/uploads/2015%20EPOC%20Taxonomy%20FINAL.pdf) (accessed 23 March 2017).

23. Rauh SS, Wadsworth EB, Weeks WB, et al. The savings illusion – why clinical quality improvement fails to deliver bottom-line results. *N Engl J Med* 2011;365 (26):e48. [at http://www.nejm.org/doi/pdf/10.1056/NEJMp1111662](http://www.nejm.org/doi/pdf/10.1056/NEJMp1111662)