



Modelled analysis of hypothetical impacts of COVID-19 related disruptions to the National Bowel Cancer Screening Program

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Executive Summary

In the current context of the COVID-19 pandemic in Australia, various health services have been disrupted including cancer screening. The National Bowel Cancer Screening Program (NBCSP) provides biennial immunochemical faecal occult blood test (iFOBT) screening to all Australians aged 50 to 74 years via mail. The screening kit is used at home and, if positive, a follow-up colonoscopy is required for further investigation. Sending screening kits to eligible Australians had not been halted as at 1st May 2020. Despite this, concerns have been expressed regarding the access, availability and willingness to undertake colonoscopies during the pandemic. As such, there has been some disruption to the NBCSP through its follow-up function, but no pause has been put in place at a national level to the sending of screening kits to eligible Australians. However, a range of COVID-19 related hypothetical disruptions to the NBCSP have been modelled.

This report outlines the results of modelling which estimate the impact of COVID-19 related hypothetical disruptions to the NBCSP using *Policy1-Bowel*, a calibrated and validated colorectal cancer (CRC) natural history microsimulation model. The model simulates the current NBCSP using, *inter alia*, published data on participation and follow-up colonoscopy compliance rates continuing uninterrupted (i.e. the comparator). Alternative scenarios have been modelled assuming hypothetical NBCSP disruptions of 3, 6 or 12 months, with or without a recovery period of reduced participation rates, and with or without comprehensive catch-up strategies for individuals affected by the disruption. We compared each scenario to the current NBCSP continuing uninterrupted and estimated shorter-term health outcomes in 2020-2021 (including adenomas and CRC cases missed or delayed, change in number of iFOBT screening kits returned and change in NBCSP-related colonoscopiesⁱ) and long-term health outcomes in 2020-2060 (additional CRC cases and deaths and change in CRC cases by stage). All outcomes were estimated for those eligible for screening in either 2020 or 2021 i.e. individuals born in 1945-1971

The health-related results show that, as a result of any hypothetical disruption, there would be CRC cases delayed or missed in detection in the short term, leading to a high number of new cases of CRC and CRC deaths as well as upstaged CRC cases in the long term. The results also illustrate the importance of both maintaining current NBCSP participation rates and, if a disruption were to occur, ensuring a comprehensive catch-up strategy is implemented to reduce the impact on CRC outcomes. In brief, this report shows that, compared to the current NBCSP, a disruption of 3 months could result in up to 1,500 CRC cases missed or delayed in 2020-2021, and up to 4,300 additional CRC cases and 2,400 additional CRC deaths in 2020-2060, depending on the recovery and catch-up strategies. After a 6-month disruption and varying recovery and catch-up assumptions, there could be up to 2,600 CRC cases missed or delayed in 2020-2021, and up to 4,600 additional CRC cases and 2,700 additional CRC deaths in 2020-2060. A 12-month disruption would result in up to 4,500 CRC cases missed or delayed in 2020-2021, and up to 12,000 additional CRC cases and 6,500 additional CRC deaths in 2020-2060.

It is also anticipated that interruptions to routine screening will lead to some cases being diagnosed at a later stage, when survival outcomes are less favourable. In the event of no catch-up strategy, 170-940 fewer cases would be diagnosed in 2020-2060 at Stage 1 and the majority of cases would be diagnosed at Stage 3 and 4. This trend was broadly similar for disruptions followed by a catch-up but with 66-410 fewer cases in 2020-2060. Additionally, up

ⁱ NBCSP-related colonoscopies related to follow-up and surveillance colonoscopies

to 2,100 CRC cases were upstaged from missed or delayed routine screening in 2020 and 2021 leading to a delay in diagnosis.

Parts of Australia have limited screening invitation timeframes due to the Hot Zone policy, whereby screening invitations are only sent for limited months per year. Selected indicative results are presented in the report by screening invitation timeframes in months to illustrate the impact on affected areas. Additionally, selected indicative results are presented by states and territories, including detailed reporting for the Northern Territory accounting for the impact of the Hot Zone policy.

Resource demand for NBCSP-related colonoscopies would also change depending on the hypothetical disruption period, recovery and catch-up strategy. In the absence of any catch-up strategy, the NBCSP-related colonoscopies not conducted in 2020 due to hypothetical 3-, 6- and 12-month disruptions would be 19,000, 37,000 and 74,000, respectively. If catch-up were undertaken in 2021 after a 12-month disruption, this would require an estimated 14,000 colonoscopies per month nationwide over a 12-month period – approximately a 77% increase in NBCSP-related colonoscopy demand in 2021.

The level of compliance to follow-up colonoscopies was also modelled for the current NBCSP and could be used as a proxy for access, availability and willingness to undertake colonoscopies. The number of follow-up colonoscopies would fall to 55,000, 37,000, 18,000 and 0 if the compliance rate was reduced to 53%, 35%, 18% and 0% respectively, compared to 74,000 colonoscopies at the current 70% compliance rates in 2020. The downstream impact on CRC cases and deaths would be 1,400, 2,500, 3,500, or 4,500 additional CRC cases and 670, 1,200, 1,700, or 2,200 additional CRC deaths at 53%, 35%, 18% or 0% colonoscopy compliance, respectively, compared to current compliance.

This report outlines the results of hypothetical disruptions to the NBCSP in 2020 compared to the current NBCSP continuing uninterrupted. The analysis shows an adverse effect on CRC outcomes resulting from a hypothetical NBCSP pause of any length. The analysis presented in this report assumes a single disruption to the NBCSP - that is, a single wave of the COVID-19 pandemic. Multiple waves of the pandemic have not been modelled at this time. Existing published data on NBCSP participation and colonoscopy compliance were used for the purposes of this report and do not include the time period affected by the COVID-19 pandemic. When updated and/or more detailed data are available on NBCSP participation and colonoscopy compliance during the COVID-19 pandemic, additional modelling could be performed to more accurately reflect current screening behaviours in Australia and on a jurisdictional basis.

Purpose and Background

This report was commissioned in March 2020 by the Australian Department of Health and submitted on 1 May by Cancer Council NSW as part of a rapid response to advising government about potential direct and indirect impacts of COVID-19 on Australia's **National Bowel Cancer Screening Program** (NBCSP). The hypotheses, assumptions and advice in this preliminary report are designed to provide rapid critical guidance to government at a time of major uncertainty and disruption to the health system.

In the current context of the COVID-19 pandemic in Australia, various health services have been disrupted. The NBCSP provides biennial immunochemical faecal occult blood test (iFOBT) screening for all Australians aged 50 to 74 years, following gradual implementation from 2006 to 2019 [1]. Current estimates suggest the NBCSP will prevent approximately 4,300 colorectal cancer (CRC) cases and 2,500 CRC deaths annually, compared to no screening.[1]

The NBCSP provides a screening kit to eligible individuals by mail which is used at home and, if positive, a follow-up colonoscopy is required for further investigation. Sending screening kits to eligible Australians had not been halted as at 1st May 2020. Despite this, concerns have been expressed regarding the access, availability and willingness to undertake colonoscopies during the pandemic. As such, there has been some disruption to the NBCSP through its follow-up function, but no pause has been put in place at a national level to the sending of screening kits to eligible Australians.

The aim of this report is to provide predictions of the impact of hypothetical disruptions to the NBCSP in 2020 due to COVID-19 on national health outcomes and resource demand, both with and without a comprehensive catch-up strategy. The report also provides indicative predictions based on screening invitation timeframe changes resulting from the Hot Zone policy, changes in compliance to follow-up colonoscopies and state or territory.

Methods

A range of disruption, recovery and catch-up scenarios have been modelled, and these have been compared to the current NBCSP assuming there has been no change to participation due to COVID-19, in order to estimate the impact of a disruption on shorter-term and long-term cancer risk and resource demand during and after the disruption.

Different combinations of disruption, recovery and catch-up were considered. Outcomes have been estimated for the affected cohorts only i.e. among **people aged 50-74 years eligible for screening in 2020 and 2021**. This cohort comprises 7.1 million people, 3.5 million men and 3.6 million women.

The modelled scenarios have up to three affected periods/cohorts:

- the **screening disruption** (or pause) period – this is a hypothetical period of time where there are **no screening invitations and kits** sent or processed, and no follow-up or surveillance colonoscopies were conducted. This was modelled for 3 months, 6 months, or 12 months, depending on the scenario. For modelling purposes, these periods were assumed to occur in 2020 – starting from April for 3- or 6-month pauses, and over the course of 2020 for the 12 month pause.
- a comprehensive **catch-up** strategy – in some scenarios, we assumed that individuals who were not invited to screening due to the pause were **invited back to screening** after the screening pause. This period was modelled for the same length of time as the

corresponding pause – i.e. a 3 month pause was followed by a 3 month catch-up period. The catch-up period was modelled at **observed participation rates**, i.e. an individual has the same probability of screening during the catch-up period that they would have if there was no screening pause.

- a **recovery** period – the recovery period immediately follows a screening disruption period. In some scenarios, we assumed that **participation rates are halved** for the 12 months following the pause, i.e. overall screening participation is lowered to approximately 20% for twelve months. This was based on the theoretical situation that changes to the health system and individual attitudes to cancer screening and health services led to decreased participation.

Based on the GESA recommendations from 24th March 2020, most “elective” colonoscopies were suspended for most of March and April 2020 unless considered to be “urgent”. Recommendations suggested that colonoscopies for the investigation of a positive iFOBT be considered on a case-by-case basis only if the patient has not had a high-quality colonoscopy within the previous 4 years.[2] The continuation of urgent colonoscopies was not incorporated in these results, nor was rescheduling of elective colonoscopies. We note that recommendations to recommence colonoscopy services were announced at the end of the April 2020 but have not been incorporated into these results.

The seven specific scenarios modelled are listed in **Table 1** and illustrated in **Figure 1**.

Modelling platform and inputs

The *Policy1-Bowel* microsimulation platform was used to model CRC and screening via the NBCSP. The natural history model simulates the development of pre-cancerous lesions and CRC via two biological pathways (i.e. the conventional adenoma-carcinoma pathway and the serrated pathway) in individuals. The model has been extensively calibrated and validated to the Australian setting, including detailed modelling of the NBCSP; selected parameter values and data sources are included in Appendix A, and a detailed technical appendix can be found in Lew et al.[3]

For the purposes of this analysis, we modelled the impacted 2020 and 2021 screening cohorts, i.e. those aged 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, or 74 in either of those years. This corresponds to those born between 1945 to 1971 inclusive. For the age and sex breakdown of this cohort, both in Australia and in individual states and territories, ABS projections were used.[3]

We simulated 2 million men and 2 million women in each of the relevant cohorts, and the results were subsequently reweighted to match population projections for Australia or individual state or territory estimated by the ABS.[3]

Participation in the NBCSP was modelled based on observed participation rates (~ 40%), with all rates from 2017 onwards extrapolated from the reported data for 2017, unless otherwise noted.[1] Based on the observed data, the model assumes ~ 70% of individuals with a positive iFOBT complete a colonoscopy (referred to as a *follow-up colonoscopy* or *colonoscopy compliance*).[4] Depending on the follow-up colonoscopy findings, individuals are referred to either the NBCSP for iFOBT screening after an interval of 4 years, or to repeat colonoscopic assessments (referred to as *surveillance colonoscopies*) after 1 to 5 years based on the 2011 guidelines recommendations.[5] Combined, both follow-up and surveillance colonoscopies are referred to as *NBCSP-related colonoscopies*.

Policy1-Bowel works on an annual timestep. Therefore, to reproduce the effect of the screening pause, we assume that participation in the NBCSP for the year is reduced proportionally to the time for which the program is paused. For instance, to model a six month

pause, we assume that participation in 2020 is decreased by half from the observed rates of ~40% to a diminished rate of ~20%. Similar adjustments were made for catch-up and recovery periods that occur in 2020 and 2021. The disruption period, catch-up, and recovery for all scenarios are illustrated in **Figure 1**.

To reproduce the comprehensive catch-up strategy for Scenarios 4-7, we assumed that all individuals who would have been invited in 2020 were instead invited after the disruption, in 2020 in Scenario 4, in 2020 and 2021 in Scenario 5, and in 2021 in Scenarios 6 and 7. These individuals were assumed to participate in catch-up screening at the same participation rate as they would have experienced in 2020, ~40%. From 2022 in all scenarios, screening returns to the usual biennial schedule. It should be noted that the modelled scenarios include the possibility that some individuals are screened in both 2021 and 2022. Modelling not included in this report suggests that delaying this cohort to screen in 2024 instead of 2022 would have extremely detrimental effects on health outcomes.

For all scenarios, both shorter-term health outcomes in 2020-2021 (including adenomas and CRC cases missed or delayed, upstaged CRC cases, change in number of iFOBT screening kits returned, and change in NBCSP-related colonoscopy) and long-term health outcomes in 2020-2060 (additional CRC cases and deaths and change in CRC cases by stage) were computed. To calculate the upstaged CRC cases for those whose routine screening was missed or delayed in 2020 or 2021, we compared the additional cancers by stage and advanced adenomas in the comparator, and calculated the proportion of these that would transition to a later stage or CRC, and considered any such shift as an upstaged case.

For the analysis incorporating the Hot Zone policy, detailed information on affected areas was not readily available. Based on our current understanding, the Hot Zone policy states given months of the year in which eligible residents of certain areas, determined by postcode, are sent their NBCSP screening kit. To determine the impact of the any disruption and the Hot Zone policy, we calculated the estimated impact of a disruption while taking into account limited screening invitation timeframes. Any pause to screening would disproportionately affect areas with a shorter screening timeframe, as illustrated in **Figure 2**. The start and end of the hot zone period were approximated and modelled for Scenarios 1 and 2. For the Northern Territory, as all postcodes are affected by the Hot Zone policy, outcomes were approximated based on the proportion of the jurisdiction affected by the Hot Zone policy. This required determining what percentage of the screening invitation timeframe was affected by any screening disruption on average in the Northern Territory.

The total short-term NBCSP-related colonoscopy demand has been modelled and presented alongside each modelled scenario. We estimated the change in resource demand for each scenario including the follow-up and surveillance colonoscopies. This was also determined per month during the catch-up periods with and without a change in screening participation. It was not possible to model the detailed workforce impact of a disruption to NBCSP-related colonoscopy demand due to limited data availability. Separately, we also estimated the short-term resource demand and long-term health outcomes in due to a hypothetical drop in the compliance to follow-up colonoscopy in 2020 compared to the current NBCSP (~40% screening participation, no screening pause and ~70% compliance to follow-up colonoscopy). Reductions in colonoscopy compliance may be a result of restricted access and availability of health services or individual willingness to undertake colonoscopies during the pandemic. Scenarios were modelled with relative reductions in colonoscopy compliance of 25%, 50%, 75% and 100% in 2020, corresponding to 53%, 35%, 18% and 0% follow-up colonoscopy compliance respectively.

In addition to Australia-wide outputs, key outcomes were calculated by jurisdiction, for each state and territory. These results were informed by the population demographics (age and sex) available from the ABS and overall participation rate for the state or territory available from the AIHW NBCSP Monitoring report.[4] For the jurisdiction-based analysis, the results do not take into account any differences in jurisdiction-specific colonoscopy compliance rates or cancer incidence – all jurisdictions were assumed to have the same colonoscopy compliance rate, CRC incidence and CRC mortality rates as the Australian general population.

Results

Australia-wide health outcomes

The outcomes for the comparator are shown in **Table 2** and are summarised below. The comparator assumes there has been no change to screening invitations and kits and follow-up colonoscopy compliance, and screening participation continues at previously observed participation rates (~40%). Outcomes for the comparator are the expected number of incident CRCs and CRC deaths **in the screening cohort only**. This cohort captures **individuals born in 1945-1971**, i.e. those eligible for screening in either 2020 or 2021. Outcomes such as “CRC cases 2020-2060” **do not** include any CRC cases in other birth cohorts. These results should therefore not be treated as estimates for the entire Australian population.

The results of the modelled scenarios estimate the effects of a NBCSP disruption over 3-, 6- and 12-month periods, with and without catch-up and/or changes to screening participation in the recovery period. The outcomes for the modelled scenarios are shown in **Table 3** and summarised below. All outcomes are presented vs the comparator shown in **Table 2**.

All figures below are estimated for the modelled cohort (i.e. individuals due to receive a screening invitation in 2020 or 2021) and rounded to two significant figures.

- **Comparator:** In the absence of any changes to the NBCSP, there would be an estimated 10,000 CRC cases in 2020 and 10,000 CRC cases in 2021, and a total of 380,000 CRC cases and 120,000 CRC deaths from 2020-2060.
- **Scenario 1:** If the program were paused for 3 months with no catch-up, and there was no change to participation rates in the recovery period there would be 750 CRC cases missed in 2020, and 2,300 additional CRC cases and 1,200 additional deaths over 2020-2060 vs the comparator.
- **Scenario 2:** If the program were paused for 6 months with no catch-up, and there was no change to participation rates in the recovery period there would be 1,500 CRC cases missed in 2020, and 4,100 additional CRC cases and 2,200 additional CRC deaths over 2020-2060 vs the comparator.
- **Scenario 3:** If the program were paused for 12 months with no catch-up, and there was a drop in participation rate to ~20% in a 12-month recovery period for all other individuals, there would be 4,500 CRC cases missed in 2020-2021, and 12,000 additional CRC cases and 6,500 additional CRC deaths over 2020-2060 vs the comparator.
- **Scenario 4:** If the program were paused for 3 months with a comprehensive catch-up strategy for all those who missed screening during the pause at usual (~40%) participation rates, and a drop in the participation rate to ~20% in the recovery period, there would be 1,500 CRC cases missed or delayed in 2020-2021, and 4,300 additional CRC cases and 2,400 additional CRC deaths over 2020-2060 vs the comparator.

- **Scenario 5:** If the program were paused for 6 months with a comprehensive catch-up strategy for all those who missed screening during the pause at usual (~40%) participation rates, and a drop in the participation rate to ~20% in the recovery period, there would be 2,200 CRC cases missed or delayed in 2020-2021, and 4,100 additional CRC cases and 2,200 additional CRC deaths over 2020-2060 vs the comparator.
- **Scenario 6:** If the program were paused for 12 months with a comprehensive catch-up strategy for all those who missed screening, and no change to participation rates in the recovery period, there would be 3,100 CRC cases missed or delayed in 2020-2021, and 830 additional CRC cases and 460 additional CRC deaths over 2020-2060 vs the comparator.
- **Scenario 7:** If the program were paused for 12 months with a comprehensive catch-up strategy for all those who missed screening, and a drop in participation rate to ~20% in the recovery period, there would be 4,500 CRC cases missed or delayed in 2020-2021 and 4,600 additional CRC cases and 2,500 additional CRC deaths over 2020-2060 vs the comparator.

Any modelled hypothetical disruption to the NBCSP resulted in a stage shift in CRC cases to later stages compared to the current NBCSP. In the event of no catch-up strategy, 170-940 fewer cases would be diagnosed in 2020-2060 at Stage 1 and the majority of cases would be diagnosed at Stage 3 and 4. This trend was broadly similar for disruptions followed by a catch-up but with only 66-410 fewer cases in 2020-2060. Additionally, up to 2,100 CRC cases were upstaged from missed or delayed routine screening in 2020 and 2021 leading to a delay in diagnosis.

Hot Zone policy

Parts of Australia have limited screening invitation timeframes due to the Hot Zone policy, whereby screening invitations are only sent for limited months per year. These results differ as a screening pause may represent a larger proportion of the screening invitation timeframe for an area, as illustrated in **Figure 2**. Estimated outcomes by the duration of the screening invitation timeframe are shown in **Table 4**, with a long term increase on CRC cases detected ranging from 1.1-4.6% and on CRC deaths from 1.8-7.9%.

Resource demand

In scenarios where catch-up strategies are modelled, there would be an increase in NBCSP-related colonoscopy demand during the catch-up period, as catch-up would occur concurrently with the usual scheduled screening (**Table 3**). The NBCSP-related colonoscopies that would not be conducted in 2020 due to hypothetical 3-, 6- and 12-month pauses without catch-up would be 19,000, 37,000 and 74,000, respectively. If catch-up were undertaken in 2021 after a 12 month pause, this would require an estimated 170,000 colonoscopies in total over a 12-month period – approximately a 77% increase in NBCSP-related colonoscopy demand in 2021 compared to the NBCSP with no pause.

We estimated the increase in NBCSP-related colonoscopy demand per month during the catch-up periods with no decrease in screening participation would be approximately 14,000 per month nationwide, a 71% increase vs the comparator of 8,400 per month. If during the catch-up period, catch-up was at full participation but other invitations had participation halved, there would be approximately 11,000 additional NBCSP-generated colonoscopies per month, a 34% increase vs the comparator.

Colonoscopy compliance

The impact of relative reductions to colonoscopy compliance is outlined in relation to the number of follow-up colonoscopies in 2020 (**Figure 3**), additional CRC cases (**Figure 4**) and additional CRC deaths in 2020-2060 (**Figure 5**) compared to the current NBCSP at observed compliance rates. At 53%, 35%, 18% and 0% compliance, there would be 55,000, 37,000, 18,000 and 0 follow-up colonoscopies compared to 74,000 at the current 70% compliance. There would be 1,400, 2,500, 3,500, or 4,500 additional CRC cases and 670, 1,200, 1,700, or 2,200 additional CRC deaths at 53%, 35%, 18% or 0% colonoscopy compliance respectively, compared to current compliance.

Key outcomes by jurisdictions

Key outcomes were also calculated for individual states and territories. The comparator outcomes for individual jurisdictions are shown in **Table 5**. The scenario outcomes for each jurisdiction, including changes to resource demand and long-term health outcomes, were calculated and are shown in **Table 6 ,7 ,8 and 9**. Note that outcomes for the Northern Territory were calculated using an adjusted methodology to incorporate the Hot Zone policy. We estimated the proportion of the state that would be eligible for receiving NBCSP invitations by month, and then cross-reference this with the periods where screening was affected in each scenario. Care should be taken when comparing results for the Northern Territory to the nationwide results and other states, due to the effect of the Hot Zone policy on the implications of the modelled scenarios.

Discussion and Conclusion

This report outlines the results of a range of hypothetical disruptions to the NBCSP in 2020 compared to current screening continuing uninterrupted. The analysis shows an adverse effect on CRC health outcomes and change in resource demand resulting from a hypothetical pause in the NBCSP of any length. The analysis presented in this report assumes a single disruption to the NBCSP - that is, a single wave of the COVID-19 pandemic. Multiple waves of the pandemic have not been modelled.

The health-related results show that, as a result of any NBCSP disruption, there would be CRC cases delayed or missed in detection in the short term, leading to a high number of new cases of CRC, and CRC deaths as well as upstaged CRC cases diagnosed in the long term. The results also illustrate the importance of both maintaining current NBCSP participation rates and, if a disruption were to occur, ensuring a comprehensive catch-up strategy is implemented to reduce the impact on CRC outcomes.

Resource demand for NBCSP-related colonoscopies would also change depending on the hypothetical disruption period, recovery and catch-up strategy with demand for these services delayed, with an extreme rise in any catch-up period. The level of compliance to follow-up colonoscopies, a proxy for access, availability and willingness to undertake colonoscopies, showed that failure to follow-up individuals with a positive iFOBT would have a detrimental effect to CRC outcomes. These estimates, however, only include NBCSP-related colonoscopies which comprise approximately 10% of the total colonoscopies conducted in Australia.

The Hot Zone policy specifies the timeframes in which screening invitations and kits can be sent to areas based on their geographic location. The current results incorporate estimations of the impact by monthly screening invitation timeframes and are indicative estimates of the effect of the policy. *Policy1-Bowel* is based on national data and the results have been scaled also providing indicative results for individual states and territories. The jurisdictional results,

however, would not take into account factors that vary by jurisdiction and would be expected to affect the outcome, including accessibility and availability of colonoscopy services and a detailed account of the impact of the Hot Zone policy (with the exception of Northern Territory where the screening invitation timeframe has been incorporated into the jurisdictional estimates).

A strength of this analysis includes the use of a well-established model of CRC natural history and screening via the NBCSP, that is calibrated and validated to the Australian context using published data. However, *Policy1-Bowel* models all events on a yearly timestep and does not differentiate between events that occur within the same year. For this reason, the 12-month screening pause scenarios were modelled assuming that the pause occurred across all of 2020. Although this does not reflect real events, as the pandemic had not taken effect until March, for modelling purposes this is appropriate as the differences between January-March 2020 and January-March 2021 are negligible on a population scale.

Implications

- Our analysis was informed by data published on NBCSP participation rates and follow-up colonoscopy compliance rates as real-time data were not accessible. **Once updated shifts in screening behaviour are documented, continued modelling to uncover the complex impact of disruption by sub-groups, including geographic areas and demographic groups of interest, could be conducted to guide targeted recovery efforts.** Selected Australians scheduled for screening in 2020 were invited for the first time as the NBCSP, as of 2020, had reached full implementation. Of special note are particular groups at higher risk (and eligible for screening in 2020) than the general population. Those at higher risk include people who are aged 54 who had not been invited since 2016, and people who are aged 58 who had not been invited since 2017. Therefore, if they miss screening in 2020, people aged 54 and 58 would have had a 6-year and 5-year gaps between screening invitations respectively. Additionally, people aged 50, due to screen for the first time in 2020, and people aged 74, due to screen for the last time, may be at higher risk if missed. In this report, the catch-up strategies were not modelled to prioritise high risk groups or staged approaches based on geographical location or past screening behaviour. **A more targeted approach to improving screening participation in these particular higher risk or under-screened groups would be beneficial to ensure equity is maintained in the wake of any disruption to the NBCSP.**
- Colonoscopy demand, availability and accessibility are issues of specific concern to jurisdictions and particularly important as they are likely to be the most disrupted component of the NBCSP at this point. Further modelling could highlight the potential impact of the evolving COVID-19 situation on compliance to follow-up colonoscopy and capacity to perform NBCSP-related colonoscopies. **Given that NBCSP-related colonoscopies present only 10% of the total colonoscopies performed, the current environment could provide an opportunity to focus on managing colonoscopy services in the recovery period, potentially through reducing unnecessary out-of-program colonoscopy screening and resetting colonoscopy prioritisation strategies.**
- Indicative estimates are provided by states and territories and indicate the substantial impact across all jurisdictions in addition to the impact of the Hot Zone policy, if applicable. Given additional detailed data on the Hot Zone policy, future work could involve detailed jurisdictional estimates for affected areas. As affected areas can have a higher proportion of Aboriginal and Torres Strait Islander populations, future work could also employ an existing modified version of *Policy1-Bowel* which has been calibrated to reproduce health outcomes observed in Aboriginal and Torres Strait Islander populations. **The jurisdictional results are estimated as they would not take into account local issues that, given appropriate data, could be modelled to guide more targeted local initiatives.**

Table 1 – Scenarios modelled in this evaluation.

| | 1. Disruption /pause periods: | 2. Recovery kit return rate in 2021 | 3. Catch-up timeframes | Purpose |
|---|-------------------------------|-------------------------------------|---|--|
| 1 | 3 months | No reduction | No catch-up for people who were missed due to the disruption | Likely health impact of a short-term disruption |
| 2 | 6 months | No reduction | No catch-up for people who were missed due to the disruption | Likely health impact of a medium-term disruption |
| 3 | 12 months | 50% reduction | No catch-up for people who were missed due to the disruption | A worst-case scenario |
| 4 | 3 months | 50% reduction | All eligible people who missed screening in 2020 are invited later in 2020 at usual participation rates with a comprehensive catch up strategy | Determine resource requirements and health outcomes |
| 5 | 6 months | 50% reduction | All eligible people who missed screening in 2020 are invited later in 2020 or in 2021 at usual participation rates with a comprehensive catch up strategy | Determine resource requirements and health outcomes |
| 6 | 12 months | No reduction | All eligible people who missed screening in 2020 are invited in 2021 at usual participation rates with comprehensive catch up strategy | The most optimistic recovery and catch-up strategies to determine the largest likely surge in resource requirements and best health outcomes |
| 7 | 12 months | 50% reduction | All eligible people who missed screening in 2020 are invited in 2021 at usual participation rates with comprehensive catch up strategy | A more conservative recovery strategy but comprehensive catch-up strategy to determine the resource requirements and health outcomes |

Table 2 – Outcomes for the **comparator** – NBCSP screening continues in 2020-2021 with no change to participation rates or compliance. Note that these outcomes are only for the modelled cohorts – those born 1945-1971, and therefore eligible for screening in 2020/2021. All values are shown to two significant figures.

| Outcome | Adenomas detected by the NBCSP | | | | CRC cases | | | | | | | CRC Deaths | Number of NBCSP iFOBT kits returned | | NBCSP-related colonoscopy demand ^a | |
|--|--------------------------------|--------|----------|--------|-----------|--------|-----------|-----------|---------|---------|---------|------------|-------------------------------------|-----------|---|---------|
| | Any | | Advanced | | Any Stage | | | Stage 1 | Stage 2 | Stage 3 | Stage 4 | | | | | |
| Time Period | 2020 | 2021 | 2020 | 2021 | 2020 | 2021 | 2020-2060 | 2020-2060 | | | | 2020-2060 | 2020 | 2021 | 2020 | 2021 |
| Value for all individuals born 1945-1971 | 33,000 | 32,000 | 18,000 | 17,000 | 10,000 | 10,000 | 380,000 | 83,000 | 130,000 | 100,000 | 59,000 | 120,000 | 1,400,000 | 1,400,000 | 94,000 | 100,000 |

^a NBCSP-related colonoscopy demand refers to both follow-up colonoscopies after a positive iFOBT, and surveillance colonoscopies for people who have previously had a follow-up colonoscopy. These results are presented for the 2020 and 2021 screening cohorts, so surveillance colonoscopies for the 2020 screening cohort in addition to the iFOBT follow-up colonoscopies mean that the total colonoscopies in 2021 is higher than in 2020.

Table 3 – Modelled outputs vs comparator shown in Table 2. The modelled cohort is those individuals due to receive a screening invitation in 2020 or 2021. All values are shown to two significant figures.

| Scenario | Disruption period | Recovery kit return rate | Catch-up | Adenomas missed or delayed in detection, 2020-2021 ^b | | CRC cases missed or delayed, 2020-2021 ^b | Additional CRC cases, 2020-2060 | Upstaged CRC cases ^c | Change in CRC cases, 2020-2060 | | | | Additional CRC deaths, 2020-2060 | Change in number of iFOBT screening kits returned | | Change in NBCSP-related colonoscopy demand ^d | |
|----------|-------------------|----------------------------|----------|---|----------|---|---------------------------------|---------------------------------|--------------------------------|---------|---------|---------|----------------------------------|---|------------|---|---------------------|
| | | | | Any | Advanced | | | | Stage 1 | Stage 2 | Stage 3 | Stage 4 | | 2020 | 2021 | 2020 | 2021 |
| 1 | 3 months | No reduction | No | 7,900 | 4,300 | 750 | 2,300 | 340 | -170 | 800 | 920 | 750 | 1,200 | -340,000 | 0 | -19,000 | -570 ^e |
| 2 | 6 months | No reduction | No | 16,000 | 8,500 | 1,500 | 4,100 | 700 | -270 | 1,500 | 1,600 | 1,300 | 2,200 | -670,000 | 0 | -37,000 | -1,100 ^e |
| 3 | 12 months | 50% reduction ^a | No | 48,000 | 26,000 | 4,500 | 12,000 | 2,100 | -940 | 4,600 | 4,800 | 3,800 | 6,500 | -1,300,000 | -690,000 | -74,000 | -40,000 |
| 4 | 3 months | 50% reduction ^a | Yes | 16,000 | 8,600 | 1,500 | 4,300 | 680 | -290 | 1,400 | 1,800 | 1,400 | 2,400 | -340,000 | -340,000 | -19,000 | -19,000 |
| 5 | 6 months | 50% reduction ^a | Yes | 24,000 | 13,000 | 2,200 | 4,100 | 1,000 | -270 | 1,500 | 1,600 | 1,300 | 2,200 | -510,000 | -210,000 | -28,000 | -10,000 |
| 6 | 12 months | No reduction | Yes | 32,000 | 17,000 | 3,100 | 830 | 1,400 | -66 | 410 | 230 | 260 | 460 | -1,300,000 | +1,200,000 | -74,000 | +72,000 |
| 7 | 12 months | 50% reduction ^a | Yes | 48,000 | 26,000 | 4,500 | 4,600 | 2,100 | -410 | 1,700 | 1,800 | 1,500 | 2,500 | -1,300,000 | +530,000 | -74,000 | +35,000 |

^a 50% reduction in participation for all individuals invited in the 12 months following the disruption (~20% participation).

^b Adenoma and CRC that would have been detected by colonoscopy but were not are considered missed or delayed, including those that would have been detected in 2020 but were detected in 2021 instead.

^c The number of cases in which an advanced adenoma progress to cancer or a cancer progressed to a worse stage or over the following year for individuals whose routine screening was missed or delayed in 2020 or 2021

^d NBCSP-related colonoscopy demand refers to both follow-up colonoscopies after a positive iFOBT, and surveillance colonoscopies for people who have previously had a follow-up colonoscopy

^e Colonoscopy demand is reduced, due to fewer surveillance colonoscopies from individuals who would have had a positive iFOBT in 2020.

Table 4 – Estimated effects of screening pauses on areas affected by the **Hot Zone policy**, i.e. with limited screening invitation timeframes. All results are presented relative to the comparator, no change to screening in 2020 in the same area. Any pause to screening would disproportionately affect areas with shorter screening invitation timeframes. For each screening invitation timeframe length, the start and end months of the timeframe were taken as the average of all postcodes with that timeframe length. For these analyses, Scenarios 1 and 2 were modelled. All results are for the **2020 screening cohort only**, and are presented to two significant figures.

| | Decrease in iFOBT screening kits returned, 2020 | | Decrease in CRC cases detected, 2020 | | Increase in CRC cases detected, 2020-2060 | | Increase in CRC deaths, 2020-2060 | |
|---|---|---------------|--------------------------------------|---------------|---|---------------|-----------------------------------|---------------|
| Screening invitation timeframe (months) | 3 month pause | 6 month pause | 3 month pause | 6 month pause | 3 month pause | 6 month pause | 3 month pause | 6 month pause |
| 1 | 100% | 100% | 44% | 44% | 4.6% | 4.6% | 7.3% | 7.3% |
| 2 | 72% | 100% | 32% | 44% | 3.3% | 4.6% | 5.3% | 7.3% |
| 3 | 52% | 100% | 23% | 44% | 2.4% | 4.6% | 3.8% | 7.3% |
| 4 | 48% | 100% | 21% | 44% | 2.2% | 4.6% | 3.5% | 7.3% |
| 5 | 40% | 100% | 18% | 44% | 1.8% | 4.6% | 2.9% | 7.3% |
| 6 | 49% | 99% | 22% | 43% | 2.2% | 4.5% | 3.6% | 7.2% |
| 7 | 42% | 85% | 18% | 37% | 1.9% | 3.9% | 3.1% | 6.2% |
| 8 | 37% | 75% | 16% | 33% | 1.7% | 3.4% | 2.7% | 5.5% |
| 9 | 33% | 66% | 14% | 29% | 1.5% | 3.0% | 2.4% | 4.8% |
| 10 | 30% | 60% | 13% | 26% | 1.4% | 2.7% | 2.2% | 4.4% |
| 11 | 27% | 54% | 12% | 24% | 1.2% | 2.5% | 2.0% | 3.9% |
| 12 | 25% | 50% | 11% | 22% | 1.1% | 2.3% | 1.8% | 3.6% |

Table 5—Outcomes for the comparator stratified by state or territory— NBCSP screening continues in 2020-2021 with no change to participation rates or treatment. Note that these outcomes are only for the modelled cohorts – those born 1945-1971, and therefore eligible for screening in 2020/2021. To calculate jurisdiction -specific results, outcomes were adjusted to account for the age and sex breakdown of the jurisdiction, and the overall participation for that jurisdiction. All values are shown to two significant figures.

| | New South Wales | Victoria | Queensland | South Australia | Western Australia | Tasmania | Northern Territory | Australian Capital Territory |
|--|-----------------|----------|------------|-----------------|-------------------|----------|--------------------|------------------------------|
| iFOBT demand, 2020 | 430,000 | 340,000 | 270,000 | 100,000 | 140,000 | 34,000 | 10,000 | 20,000 |
| iFOBT demand, 2021 | 440,000 | 350,000 | 280,000 | 100,000 | 140,000 | 35,000 | 11,000 | 20,000 |
| NBCSP-related colonoscopy demand, 2020 | 30,000 | 23,000 | 19,000 | 7,200 | 9,400 | 2,400 | 680 | 1,400 |
| NBCSP-related colonoscopy demand, 2021 | 33,000 | 25,000 | 21,000 | 7,800 | 10,000 | 2,600 | 730 | 1,500 |
| CRC Cases, 2020 | 3,400 | 2,600 | 2,100 | 810 | 1,100 | 270 | 74 | 150 |
| CRC Cases, 2021 | 3,400 | 2,700 | 2,200 | 820 | 1,100 | 280 | 76 | 150 |
| CRC Cases, 2020-2060 | 120,000 | 95,000 | 76,000 | 28,000 | 38,000 | 9,300 | 3,100 | 5,600 |
| CRC Deaths, 2020-2060 | 40,000 | 31,000 | 25,000 | 9,300 | 13,000 | 3,100 | 1,000 | 1,900 |

Table 6 – iFOBT demand outcomes by jurisdiction vs comparator shown in Table 4. The modelled cohort is those individuals due to receive a screening invitation in 2020 or 2021. Please note that, due to the prevalence of the hot-zone policy, health outcomes in the Northern Territory have a larger relative increase than other jurisdictions, as any interruption to screening represents a larger proportion of eligible screening months lost. All values are shown to two significant figures.

| | Change in iFOBT demand, 2020 (thousands) | | | | | | | | Change in iFOBT demand, 2021 (thousands) | | | | | | | |
|-------------------|--|----------|------------|-----------------|-------------------|----------|---------------------------------|------------------------------|--|----------|------------|-----------------|-------------------|----------|---------------------------------|------------------------------|
| | New South Wales | Victoria | Queensland | South Australia | Western Australia | Tasmania | Northern Territory ^a | Australian Capital Territory | New South Wales | Victoria | Queensland | South Australia | Western Australia | Tasmania | Northern Territory ^a | Australian Capital Territory |
| Scenario 1 | -100 | -89 | -67 | -27 | -38 | -9.6 | -3.5 | -5.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Scenario 2 | -200 | -180 | -130 | -53 | -77 | -19 | -7.1 | -11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Scenario 3 | -400 | -350 | -270 | -110 | -150 | -38 | -7.1 | -21 | -200 | -180 | -140 | -54 | -78 | -20 | -3.6 | -11 |
| Scenario 4 | -100 | -89 | -67 | -27 | -38 | -9.6 | -1.8 | -5.3 | -100 | -91 | -69 | -27 | -39 | -9.8 | -1.8 | -5.4 |
| Scenario 5 | -150 | -130 | -100 | -40 | -57 | -14 | -2.7 | -7.9 | -62 | -56 | -42 | -17 | -24 | -6.0 | -1.1 | -3.2 |
| Scenario 6 | -400 | -350 | -270 | -110 | -150 | -38 | -7.1 | -21 | 360 | 320 | 240 | 96 | 140 | 35 | 6.6 | 19 |
| Scenario 7 | -400 | -350 | -270 | -110 | -150 | -38 | -7.1 | -21 | 160 | 140 | 110 | 42 | 61 | 15 | 3.0 | 8.4 |

^a As results for the Northern Territory were adjusted to account for the Hot Zone policy, these results may not be directly comparable to other jurisdictions or nationwide results.

Table 7 – NBCSP-related colonoscopy demand by jurisdiction vs comparator shown in Table 4. The modelled cohort is those individuals due to receive a screening invitation in 2020 or 2021. All values are shown to two significant figures.

| | Change in NBCSP-related colonoscopy demand, 2020 | | | | | | | | Change in NBCSP-related colonoscopy demand, 2021 | | | | | | | |
|-------------------|--|----------|------------|-----------------|-------------------|----------|---------------------------------|------------------------------|--|----------|------------|-----------------|-------------------|----------|---------------------------------|------------------------------|
| | New South Wales | Victoria | Queensland | South Australia | Western Australia | Tasmania | Northern Territory ^a | Australian Capital Territory | New South Wales | Victoria | Queensland | South Australia | Western Australia | Tasmania | Northern Territory ^a | Australian Capital Territory |
| Scenario 1 | -5,500 | -4,900 | -3,700 | -1,500 | -2,100 | -540 | -190 | -290 | -170 | -150 | -110 | -47 | -63 | -17 | -5 | -9 |
| Scenario 2 | -11,000 | -9,800 | -7,400 | -3,000 | -4,200 | -1,100 | -370 | -580 | -340 | -300 | -230 | -93 | -130 | -34 | -9 | -17 |
| Scenario 3 | -22,000 | -19,000 | -15,000 | -5,900 | -8,400 | -2,100 | -370 | -1,200 | -12,000 | -10,000 | -7,900 | -3,100 | -4,500 | -1,100 | -200 | -610 |
| Scenario 4 | -5,500 | -4,900 | -3,700 | -1,500 | -2,100 | -540 | -94 | -290 | -5,700 | -5,100 | -3,900 | -1,500 | -2,200 | -550 | -96 | -300 |
| Scenario 5 | -8,300 | -7,300 | -5,600 | -2,200 | -2,700 | -800 | -140 | -430 | -3,000 | -2,700 | -2,100 | -810 | -1,200 | -290 | -51 | -160 |
| Scenario 6 | -22,000 | -20,000 | -15,000 | -5,900 | -8,400 | -2,100 | -370 | -1,200 | 21,000 | 19,000 | 14,000 | 5,700 | 8,200 | 2,100 | 370 | 1,100 |
| Scenario 7 | -22,000 | -20,000 | -15,000 | -5,900 | -8,400 | -2,100 | -370 | -1,200 | 10,000 | 9,200 | 7,000 | 2,800 | 3,900 | 1,000 | 180 | 540 |

^a As results for the Northern Territory were adjusted to account for the Hot Zone policy, these results may not be directly comparable to other jurisdictions or nationwide results.

Table 8 – Health outcomes by jurisdiction vs comparator shown in Table 4. The modelled cohort is those individuals due to receive a screening invitation in 2020 or 2021. All values are shown to two significant figures.

| | CRC cases missed or delayed, 2020 | | | | | | | | CRC cases missed or delayed, 2021 | | | | | | | |
|-------------------|-----------------------------------|----------|------------|-----------------|-------------------|----------|---------------------------------|------------------------------|-----------------------------------|----------|------------|-----------------|-------------------|----------|---------------------------------|------------------------------|
| | New South Wales | Victoria | Queensland | South Australia | Western Australia | Tasmania | Northern Territory ^a | Australian Capital Territory | New South Wales | Victoria | Queensland | South Australia | Western Australia | Tasmania | Northern Territory ^a | Australian Capital Territory |
| Scenario 1 | 220 | 200 | 150 | 60 | 84 | 22 | 7 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Scenario 2 | 450 | 400 | 300 | 120 | 170 | 45 | 7 | 23 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Scenario 3 | 910 | 800 | 610 | 250 | 340 | 90 | 14 | 46 | 440 | 390 | 300 | 120 | 170 | 43 | 7 | 22 |
| Scenario 4 | 220 | 200 | 150 | 60 | 84 | 22 | 4 | 11 | 210 | 190 | 140 | 57 | 80 | 21 | 3 | 11 |
| Scenario 5 | 340 | 300 | 230 | 92 | 130 | 34 | 5 | 17 | 330 | 290 | 220 | 88 | 120 | 32 | 11 | 17 |
| Scenario 6 | 910 | 800 | 610 | 250 | 340 | 90 | 14 | 47 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Scenario 7 | 910 | 800 | 610 | 250 | 340 | 90 | 2 | 47 | 440 | 390 | 300 | 120 | 170 | 43 | 7 | 22 |

^a As results for the Northern Territory were adjusted to account for the Hot Zone policy, these results may not be directly comparable to other jurisdictions or nationwide results.

Table 9 – Health outcomes by jurisdiction vs comparator shown in Table 4. The modelled cohort is those individuals due to receive a screening invitation in 2020 or 2021. All values are shown to two significant figures.

| | Additional CRC cases, 2020-2060 | | | | | | | | Additional CRC deaths, 2020-2060 | | | | | | | |
|-------------------|---------------------------------|----------|------------|-----------------|-------------------|----------|---------------------------------|------------------------------|----------------------------------|----------|------------|-----------------|-------------------|----------|---------------------------------|------------------------------|
| | New South Wales | Victoria | Queensland | South Australia | Western Australia | Tasmania | Northern Territory ^a | Australian Capital Territory | New South Wales | Victoria | Queensland | South Australia | Western Australia | Tasmania | Northern Territory ^a | Australian Capital Territory |
| Scenario 1 | 680 | 610 | 460 | 180 | 270 | 63 | 24 | 37 | 370 | 330 | 250 | 96 | 140 | 34 | 12 | 20 |
| Scenario 2 | 1,200 | 1,100 | 830 | 320 | 470 | 110 | 48 | 66 | 650 | 580 | 440 | 170 | 250 | 61 | 25 | 35 |
| Scenario 3 | 3,600 | 3,200 | 2,500 | 950 | 1,400 | 340 | 69 | 200 | 1,900 | 1,700 | 1,300 | 510 | 750 | 180 | 37 | 100 |
| Scenario 4 | 1,300 | 1,100 | 870 | 330 | 500 | 120 | 25 | 69 | 690 | 620 | 470 | 180 | 270 | 65 | 13 | 38 |
| Scenario 5 | 1,200 | 1,100 | 830 | 320 | 480 | 110 | 23 | 66 | 650 | 580 | 440 | 170 | 250 | 60 | 12 | 35 |
| Scenario 6 | 250 | 220 | 170 | 65 | 96 | 23 | 5 | 13 | 130 | 120 | 91 | 35 | 53 | 12 | 3 | 7 |
| Scenario 7 | 1,400 | 1,200 | 930 | 360 | 530 | 130 | 26 | 74 | 740 | 670 | 510 | 190 | 290 | 69 | 14 | 40 |

^a As results for the Northern Territory were adjusted to account for the Hot Zone policy, these results may not be directly comparable to other jurisdictions or nationwide results.

Figure 1 – NBCSP disruption, catch-up and recovery period timelines for each modelled scenario. For 3- and 6-month pauses, the pause was assumed to begin in April 2020, and for a 12 month pause the pause was assumed to comprise all of 2020, for modelling purposes. Pauses of the same duration that occur in other times of the year may have slightly differing impacts, depending on the scenarios and pause length.

Scenario 1: 3-month program pause, no catch-up, no effect on participation in 2021

| | 2020 | | | | | | | | | | | | 2021 | | | | | | | | | | | | 2022 | | | |
|---------------|------|-----|-----|-----------------|-----|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr |
| Paused Cohort | | | | Screening Pause | | | | | | | | | | | | | | | | | | | | | | | | |
| Other Cohorts | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Scenario 2: 6-month program pause, no catch-up, no recovery period

| | 2020 | | | | | | | | | | | | 2021 | | | | | | | | | | | | 2022 | | | |
|---------------|------|-----|-----|-----------------|-----|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr |
| Paused Cohort | | | | Screening Pause | | | | | | | | | | | | | | | | | | | | | | | | |
| Other Cohorts | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Scenario 3: 12-month program pause, no catch-up screening, 12 month reduced participation recovery period

| | 2020 | | | | | | | | | | | | 2021 | | | | | | | | | | | | 2022 | | | |
|---------------|-----------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr |
| Paused Cohort | Screening Pause | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Other Cohorts | | | | | | | | | | | | | Recovery period (~20% participation) | | | | | | | | | | | | | | | |

Scenario 4: 3-month program pause, catch-up screening in 2020, 12 month reduced participation recovery period

| | 2020 | | | | | | | | | | | | 2021 | | | | | | | | | | | | 2022 | | | |
|---------------|------|-----|-----|-----------------|-----|-----|--------------------------------------|-----|-----|-----|-----|-----|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr |
| Paused Cohort | | | | Screening Pause | | | Catch-up | | | | | | | | | | | | | | | | | | | | | |
| Other Cohorts | | | | | | | Recovery period (~20% participation) | | | | | | | | | | | | | | | | | | | | | |

Scenario 5: 6-month program pause, catch-up screening in 2020/2021, 12 month reduced participation recovery period

| Scenario 3: 6-month program pause, catch-up screening in 2021/2022, 12-month reduced participation recovery period | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--|------|-----|-----|-----------------|-----|-----|-----|-----|-----|--------------------------------------|-----|-----|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|
| | 2020 | | | | | | | | | | | | 2021 | | | | | | | | | | | | 2022 | | | |
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr |
| Paused Cohort | | | | Screening Pause | | | | | | Catch-up | | | | | | | | | | | | | | | | | | |
| Other Cohorts | | | | | | | | | | Recovery period (~20% participation) | | | | | | | | | | | | | | | | | | |

Scenario 6: 12-month program pause, catch-up screening in 2021, no recovery period

| | 2020 | | | | | | | | | | | | 2021 | | | | | | | | | | | | 2022 | | | |
|---------------|-----------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr |
| | Screening Pause | | | | | | | | | | | | Catch-up | | | | | | | | | | | | | | | |
| Paused Cohort | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Other Cohorts | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Scenario 7: 12-month program pause, catch-up screening in 2021, reduced participation recovery period

| | 2020 | | | | | | | | | | | | 2021 | | | | | | | | | | | | 2022 | | | |
|---------------|-----------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr |
| Paused Cohort | Screening Pause | | | | | | | | | | | | Catch-up | | | | | | | | | | | | | | | |
| Other Cohorts | | | | | | | | | | | | | Recovery period (~20% participation) | | | | | | | | | | | | | | | |

| | |
|--|--|
| | Usual screening - observed participation rates (~40%) at usual invitation schedule |
| | Disruption - no kits sent, no participation |
| | Catch-up screening - invites for people who missed out during the disruption |
| | Recovery period - lower participation rates |

Figure 2 - Example scenarios for a postcode affected by the hot zone purposes. Compare with Figure 1. For illustration purposes, a postcode with 9 screening months was chosen, and no screening invitations sent in December, January or February. For example, note that in Scenario 2, a 3 month pause now represents a 33% reduction in screening for that year, instead of a 25% reduction in screening for a postcode with no screening pause.

Comparator - Usual screening Schedule

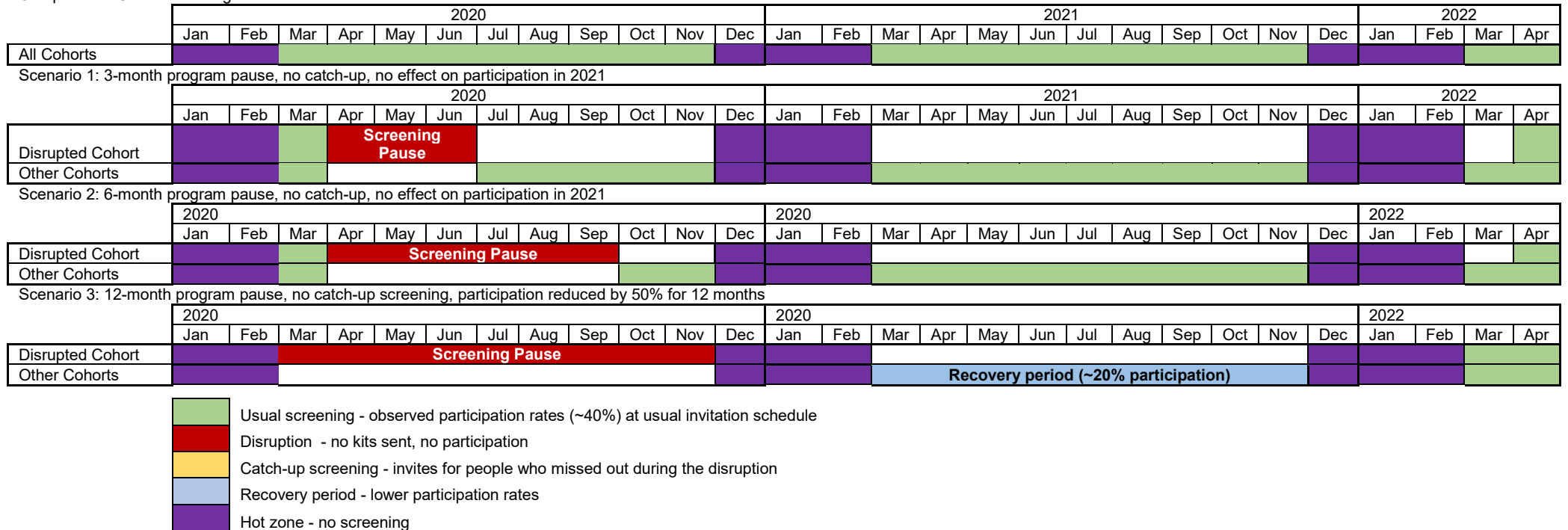


Figure 3 - Estimated impact of changes to colonoscopy compliance in 2020 on iFOBT follow-up colonoscopy demand in 2020. For this modelling, no changes were made to the iFOBT screening invitation schedule or participation rate i.e. the comparator was used.

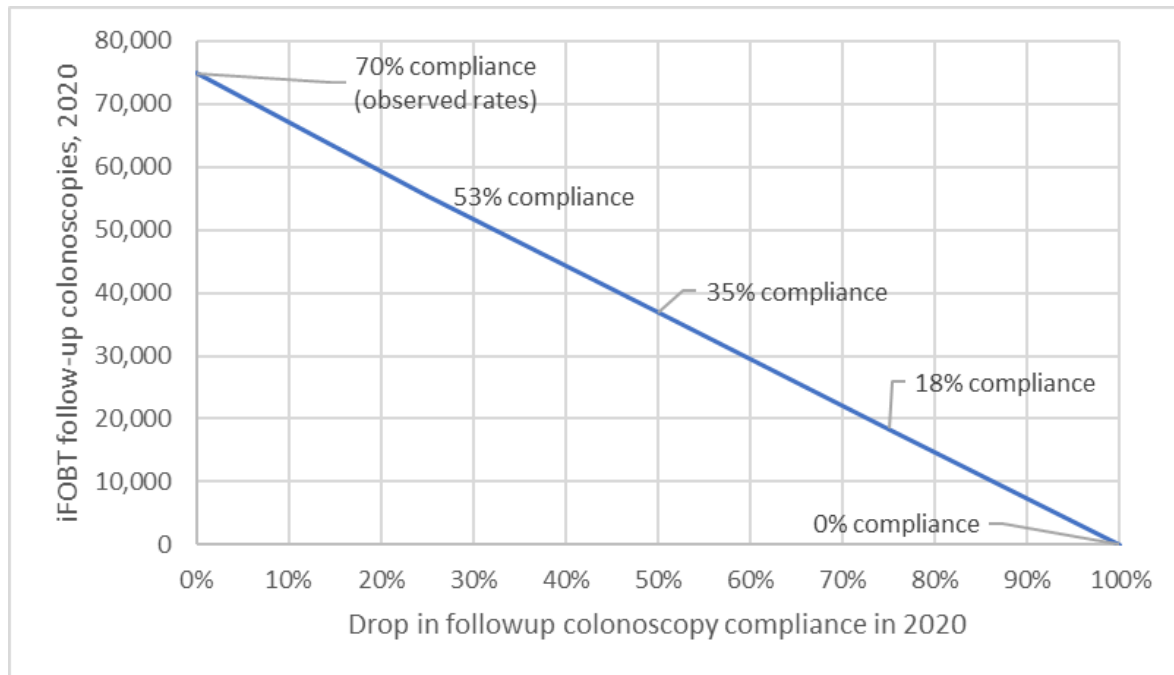


Figure 4 - Estimated impact of changes to colonoscopy compliance in 2020 on CRC cases over 2020-2060 in the 2020 screening cohort.

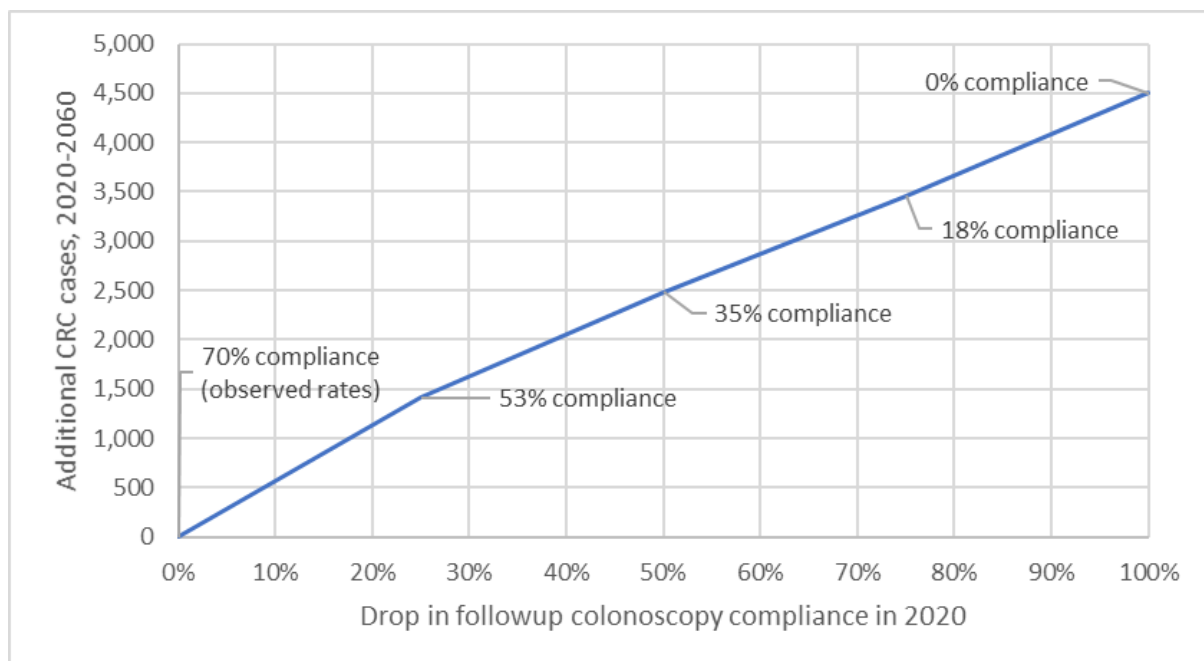
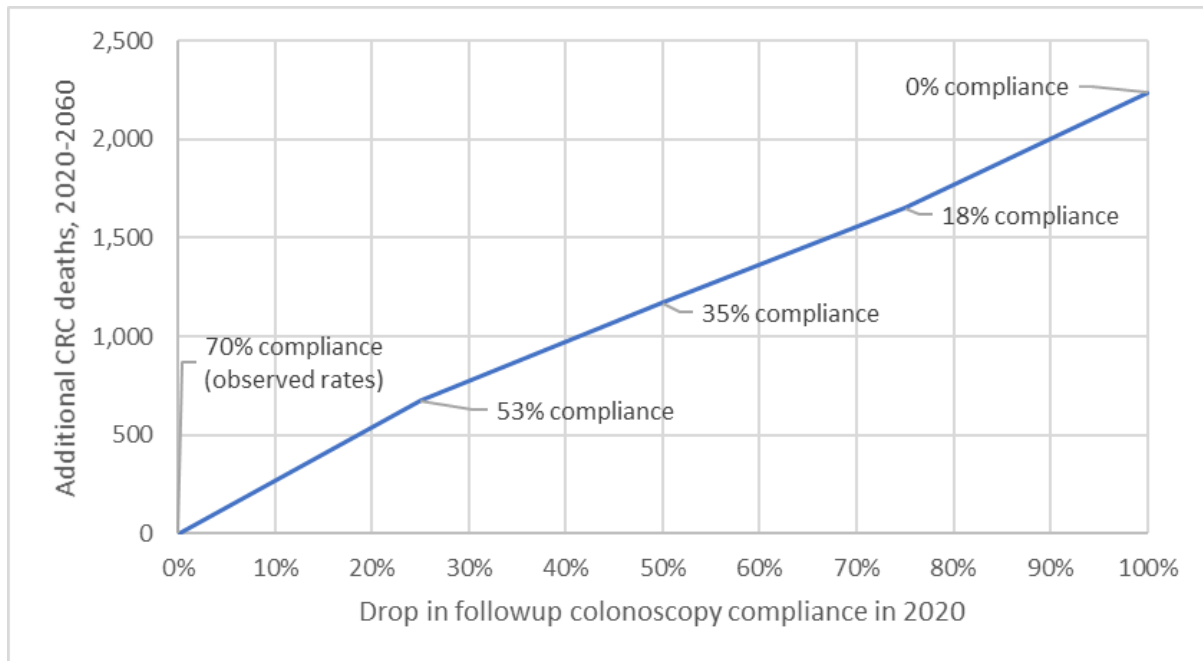


Figure 5 - Estimated impact of changes to colonoscopy compliance in 2020 on CRC deaths over 2020-2060 in the 2020 screening cohort.



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Appendix A: Key model parameters for *Policy1-Bowel*

Table 1 – Key model parameters used by Policy1-Bowel.

| Key model parameter | Value | Reference |
|--|--------------------------|--|
| iFOBT test characteristics (per person) | | |
| Specificity for any adenoma | 94.8% | Obtained via calibrating to iFOBT positivity rates observed in NBCSP and colonoscopy outcomes among positive iFOBT [6] |
| Sensitivity for conventional adenoma of any size | 15.2% | |
| Sensitivity for conventional adenoma > 5mm | 30.2% | |
| Sensitivity for conventional adenoma >10mm | 41.5% | |
| Sensitivity for CRC | 58.6% | |
| Colonoscopy test detection rate (per lesion) | | |
| Conventional adenoma 1-5 mm | 79% | Van Rijn et al 2006 [7, 8] |
| Conventional adenoma 6-9 mm | 85% | |
| Conventional adenoma ≥10mm | 92% | |
| Sessile serrated lesions (any size) | 78% | |
| CRC (any stage) | 95% | |
| Colonoscopy completion rate | 100% to the end of cecum | Based on values used in [9] |
| Colonoscopy adverse event probability | | |
| Non-fatal adverse event | 0.27% | AIHW 2015 [6, 10] |
| Death | 0% | AIHW 2015 [6, 10], Jentschura et al 1994 [11] |
| Baseline colonoscopy compliance rate | | |
| Follow-up colonoscopy after positive iFOBT result | 71% | AIHW 2015 [6] |
| Surveillance colonoscopy | 80% | Based on values used in [12] |
| 5-year survival rate in patient with symptomatically-detected CRC | | |
| Stage 1 cancer | 86.9% | Morris et al 2007 [13] |
| Stage 2 cancer | 73.0% | |
| Stage 3 cancer | 42.4% | |
| Stage 4 cancer | 9.5% | |
| Relative 5-year survival of screen-detected CRC versus symptomatically-detected CRC | | |
| Stage 1 cancer | 1.1 | Parente et al 2015, Gill et al 2014, Pande et al 2013 [14-16] |
| Stage 2 cancer | 1.2 | |
| Stage 3 cancer | 1.4 | |
| Stage 4 cancer | 2.3 | |