Australian Government

Department of Health

A poliovirus reintroduction and outbreak risk assessment methodology for Australia

Version 1

January 2019

Office of Health Protection

Australian Government Department of Health

Contents

1. Risk assessment methodology

1.1 Overview

The risk assessment employs a structured, transparent and reproducible mixed-methods approach to the systematic evaluation and documentation of the various components of likelihood and impact that influence poliovirus reintroduction and outbreak risk in Australia (for a specified timeframe). The key output is a semi-quantitative risk characterisation estimate (RCE), which is plotted on a risk matrix to:

1. Graphically depict the results of the risk assessment; and
2. Allow monitoring and visualisation of longer-term temporal trends in national polio reintroduction and outbreak risk, following intermittent repeated assessment (e.g. at annual or five year intervals).

The RCE also allows qualitative risk characterisation, employing a risk matrix with distinct cells corresponding to qualitative descriptors to comprehensively define the level of polio reintroduction and outbreak risk (ranging from very low – very high). The approach has been adapted and expanded from a methodology published by WHO for polio risk assessment at regional level (1), and informed by WHO guidelines for rapid risk assessment of acute public health events (2), using three key components in risk characterisation: hazard assessment, exposure assessment and context assessment. A summary of the risk assessment cycle (process and outputs) is provided (Table 1).

Table 1: Summary of the 10 step risk assessment cycle (process and outputs)

Step	Process	Output
1	Assemble the risk assessment team	▪ Incorporate expertise in the fields of epidemiology, virology, laboratory biosafety, immunisation and health systems from national government health departments and independent academic or research institution
2	Develop and document the risk assessment methodology	▪ Risk assessment methodology developed (intermittent review and updates, as required) ▪ Risk element weightings determined by expert elicitation (Polio Expert Delphi survey – 2018)
3	Formulate the overarching risk question	▪ One overarching risk question defined
4	Identify the key risk elements	▪ Four key risk elements identified: ❖ Reintroduction hazard (H) ❖ Population susceptibility (S) ❖ Detection capability (D) ❖ Response capability (R)
5	Develop focused risk questions to address sub-components of each risk element	▪ Eight focused risk questions developed
6	Identify risk indicators, data sources and evaluation methods for each focused risk question	▪ 25 risk indicators, corresponding data sources and relevant evaluation methods identified
7	Compile and analyse data, evaluate documentary evidence and document the outcomes for each risk indicator	▪ Outcomes for each risk indicator briefly summarised and documented for the purpose of risk characterisation

Step	Process	Output
8	Risk characterisation	▪ Risk element and confidence coefficient scores assigned ▪ One semi-quantitative risk characterisation estimate (RCE) calculated and displayed in a risk matrix ▪ One qualitative risk characterisation derived (a defined level of risk based on descriptive risk categories)
9	Document the risk assessment assumptions, results, limitations and recommendations	▪ A formal risk assessment report prepared for the Australian Government Department of Health
10	Risk communication: Disseminate the findings to relevant stakeholders	▪ The formal risk assessment report informs the work of the Australian National Certification Committee for the Eradication of Poliomyelitis (NCC), in preparation of annual WHO Western Pacific Regional Certification Committee for the Eradication of Poliomyelitis (RCC) progress reports ▪ Findings shared with the Australian Polio Expert Panel (PEP)

Relevant steps (3 – 6 and 8) that pertain to implementing the risk assessment methodology are described below, in Sections 1.2 – 1.6.

1.2 Formulate the overarching risk question

The scope of the assessment is defined through the formulation of an overarching risk question, which is the key question or unknown factor that the assessment seeks to answer. For the purpose of this assessment, the overarching risk question was defined as follows:

What is the risk of wild-type poliovirus (WPV) OR vaccine-derived poliovirus (VDPV)[1] reintroduction, AND resultant outbreaks of poliovirus infection, AND sustained transmission occurring in Australia in the next five years?

Answering the risk question requires systematic evaluation of the multiple components relating to the likelihood and impact (consequences) of the introduction, exposure to, establishment and spread of a hazard (wild-type or vaccine-derived poliovirus), whilst incorporating the relevant (global, regional and national) context and stipulating a timeframe covered by the assessment.

[1] Vaccine-derived polioviruses (VDPVs) include circulating VDPVs (cVDPV), immunodeficiency-related VDPVs (iVDPV) and ambiguous VDPVs (aVDPV).

1.3 Identify the key risk elements

The overarching risk question is comprehensive, but also fairly complex, being comprised of multiple components relating to the likelihood and impact of the reintroduction of poliovirus, exposure of susceptible populations, the establishment of infection and sustained transmission of poliovirus in the Australian population. To facilitate systematic evaluation, the overarching risk question is deconstructed into its constituent components, and summarised as four key risk elements (Table 2).

Table 2: Risk characterisation components and key risk elements in the comprehensive national polio risk assessment process

Risk assessment component (WHO Guidelines)	Risk element		Sub-components
Hazard assessment	**Likelihood**	**Reintroduction hazard (H)** ▪ Likelihood of poliovirus importation ▪ Likelihood of laboratory containment failure	▪ Poliovirus importation threats (infectious travellers) ▪ Laboratory containment policies, practices and import regulations
Exposure assessment		**Population susceptibility (S)** ▪ Likelihood of exposure to poliovirus, and establishment of infection and outbreak(s) in vulnerable subpopulations ▪ Likelihood of sustained transmission of poliovirus in the general population	▪ Population immunity profile, including vulnerable subpopulations ▪ National immunisation program (NIP) performance and delivery ▪ Population access to water, sanitation and hygiene (WASH) services
Context assessment	**Impact**	**Detection capability (D)** ▪ Likelihood of delayed detection due to suboptimal surveillance, resulting in a significant disease burden at population level and associated public health social, economic, reputational and political consequences	▪ Poliovirus surveillance system quality and performance (clinical, enterovirus and environmental components) ▪ Nationally notifiable status and supporting surveillance infrastructure ▪ Track record of imported case and environmental detection event management and outcomes
		Response capability (R) ▪ Likelihood of a suboptimal outbreak response, or other external factors contributing to a failure of containment and control, resulting in a significant disease burden at population level and associated public health, social, economic, reputational and political consequences	▪ Health system infrastructure, system and IHR core capacities ▪ Polio outbreak response preparedness ▪ Socio-political stability

1.4 Develop focused risk questions to address each risk element

The next step in the process involves reframing of the risk characterisation components into eight, more specific, focused risk questions (A – H) that the assessment will seek to answer to address each risk element (Table 3).

Table 3: Focused risk questions, categorised by key risk element

Risk element	Focused risk question
Reintroduction hazard (H)	**A.** *What is the likelihood of wild-type poliovirus (WPV) or vaccine-derived poliovirus (VDPV) importation through an infectious traveller? (Australian citizens and residents included)* **B.** *What is the likelihood of poliovirus reintroduction associated with a failure in laboratory containment policies, practices or import regulations?*
Population susceptibility (S)	**C.** *Which population groups have the highest likelihood of exposure to poliovirus infection (vulnerable subpopulations)?* **D.** *How susceptible are vulnerable subpopulations to establishment of infection and outbreaks of poliovirus infection?* **E.** *What is the likelihood of sustained (ongoing) transmission of poliovirus occurring in the general population?* **F.** *What is the likelihood of environmental contamination due to suboptimal water, sanitation and hygiene (WASH) infrastructure, constituting a persistent source of poliovirus transmission risk to vulnerable subpopulations and the general population?* **Note:** the likelihood of cVDPV emergence associated with suboptimal immunisation coverage rates could be included as an additional focused risk question in countries or contexts where oral polio vaccine (OPV) is still utilised at the time of assessment (not applicable to Australia).
Detection capability (D)	**G.** *What is the likelihood of detection of an outbreak(s) of poliovirus infection being substantially delayed, or low-level sustained (ongoing) transmission remaining undetected?*
Response Capability (R)	**H.** *What is the likelihood of very delayed or unsuccessful containment and control, should outbreaks of poliovirus infection occur?*

1.5 Identify risk indicators, data sources and evaluation method(s) for each focused risk question

The eight focused risk questions which address the four key risk elements may be evaluated according to a set of specified risk indicators (Table 4). Each numbered indicator requires qualitative documentary evidence or quantitative data in a specified format, accessed from various sources. Systematic evaluation of the evidence for each indicator also requires a proposed methodology or approach, which varies according to the nature of the information to be evaluated (e.g. descriptive analyses of quantitative data, versus descriptive evaluation of the content, quality and completeness of documentary evidence – i.e. use of a mixed-methods approach).

Table 4: Risk indicators, data requirements and proposed evaluation method for each focused risk question (A – G)

Focused risk question	Risk Indicators	Data requirements, proposed format or evaluation method, and source(s)
A	1. Briefly describe the current epidemiological situation with respect to WPV and VDPV globally, and pertinent developments in the global polio eradication drive, particularly in the Asia-Pacific (WHO Western Pacific and Southeast Asia) regions. 2. Characterise the highest risk source regions globally, including listing high risk (endemic, outbreak and key at-risk) countries, as classified by the Global Polio Eradication Initiative (GPEI). 3. Identify polio risk countries[2] relevant to the Australian national context, as well as high risk population groups from these source countries most likely to import poliovirus into Australia.	▪ Literature review restricted to the current global epidemiology of poliovirus and pertinent developments in the global eradication initiative, including WHO or GPEI reports and surveillance data. ▪ UNICEF OPV immunisation coverage data and water, sanitation and hygiene (WASH) data. ▪ Identify criteria and generate a list of polio risk countries relevant to Australia, for which traveller arrivals data and settlement data will be requested from the Australian Government Departments of Home Affairs (DHA) and Social Services (DSS).
	4. Briefly describe Australia's offshore investment in global polio eradication efforts to as part of offshore risk reduction strategies.	▪ Qualitative evaluation and descriptive overview of Government policy, procedural documents or websites.
	5. Quantify the number and relative proportion of traveller arrivals to Australia from polio risk countries for the preceding five years.	▪ Descriptive analyses, e.g. tables or figures displaying recent trends (crude numbers and relative proportions) of traveller arrivals per year, per traveller class using Australian Government DHA data.
	6. Describe existing Government policies, procedures or requirements to mitigate the likelihood of poliovirus reintroduction by infectious travellers.	▪ Qualitative evaluation and descriptive overview of Government policy, procedural documents or websites. ▪ Semi-structured interviews or correspondence with relevant

[2] **Note: Polio risk countries** include all countries for which data is considered as part of the national risk assessment for Australia, whereas **polio high risk countries** are countries listed by the Global Polio Eradication Initiative (GPEI) under the "*Endemic*", "*Outbreak*" or "*Key At-risk*" categories.

Focused risk question	Risk Indicators	Data requirements, proposed format or evaluation method, and source(s)
		Australian Government Department of Health, Foreign Affairs and Trade (DFAT) or DHA staff.
B	7. List designated Poliovirus Essential Facilities (PEF) in Australia. 8. Briefly describe the national inventory of WPV, potentially infectious materials and associated verification procedures. 9. Briefly describe relevant laboratory quality assurance processes, standards and regulations which serve to strengthen appropriate poliovirus containment and to progress implementation of the *WHO Global Action Plan to minimize poliovirus facility-associated risk after type-specific eradication of wild polioviruses and sequential cessation of oral polio vaccine use* (**GAPIII**). **Note:** The assessment does not extend to evaluation of biosafety risk management for laboratory facilities, including PEFs.	▪ Qualitative evaluation and descriptive overview of information contained in annual Australian National Certification Committee for the Eradication of Poliomyelitis (NCC) progress reports to WHO Western Pacific Regional Certification Committee (RCC). ▪ Semi-structured interviews or correspondence with subject matter experts from the National Enterovirus Reference Laboratory (NERL) and National Authority for Containment (NAC). ▪ Qualitative evaluation and descriptive overview of documentary evidence provided by the Australian Government Department of Health, NERL, and/or NCC.
C	10. Describe key demographic characteristics (pertinent to poliovirus epidemiology) and settlement patterns in Australia of long-term or permanent arrivals from polio risk countries for the preceding five years.	▪ Descriptive analysis of DSS settlement data for long-term or permanent arrivals from polio risk countries. specifically: ❖ Age group upon arrival in Australia; and ❖ Settlement patterns (e.g. statistical area level 3 (SA3) of last known address of settlement). ▪ **Note:** assessment outputs may include, e.g. choropleth maps depicting localities of new migrant settlement, which may be overlayed with areas of suboptimal immunisation coverage and/or suboptimal surveillance performance to generate a polio risk map.
D	11. Briefly describe available information on the polio immunity profile of long-term or permanent arrivals from polio risk countries, relative to the Australian general population. 12. Describe the polio immunity profile of vulnerable subpopulations in Australia, including children and the Aboriginal and Torres Strait Islander community. 13. Describe any supplementary immunisation activities (SIAs), e.g. catch-up immunisation	▪ Qualitative evaluation and descriptive overview of Government policy, procedural documents or websites, outlining health care service provision to vulnerable subpopulations relevant to poliovirus. ▪ Semi-structured interviews or correspondence with relevant Australian Government Department of Health, DHA, DSS, DFAT staff.

Focused risk question	Risk Indicators	Data requirements, proposed format or evaluation method, and source(s)
	policies or programs targeting vulnerable subpopulations.	▪ Descriptive analysis of Australian Government Department of Health Immunisation Branch data. ▪ Qualitative evaluation of information or descriptive analysis of data contained in annual Australian NCC progress reports, NERL annual reports.
E	14. Describe the performance and delivery of the Australian National Immunisation Program (NIP) in relation to immunisation coverage against poliovirus. 15. Describe the polio immunity profile of the Australian general population. 16. Evaluate polio immunisation coverage at statistical area level (SA3) to identify localities of suboptimal coverage and/or suboptimal population immunity against poliovirus.	▪ Brief overview of results from the most recent National Polio Serosurvey Report (2012–2013) (draft publication from NCIRS). ▪ Descriptive analysis of Australian Government Department of Health Immunisation Branch data. ▪ **Note:** relevant outputs may include, e.g. choropleth maps depicting localities of suboptimal immunisation coverage, which may be overlayed with areas with suboptimal surveillance performance and localities of new migrant settlement to generate a polio risk map.
F	17. Briefly describe Australia's current water, sanitation and hygiene (WASH) infrastructure, including vulnerable subpopulation groups' access to these services, in relation to the system's capacity to minimise environmental contamination which may constitute a persistent source of poliovirus transmission risk.	▪ Qualitative evaluation and descriptive overview of Australian Government, NGO or academic documents, websites or research reports. ▪ Descriptive analysis of UNICEF Joint Monitoring Programme (JMP) data. ▪ **Note:** JMP captures the percentage of the population using improved drinking water sources and sanitation facilities by using nationally representative household surveys, censuses, and other data.
G	18. Briefly describe the components, structure, function and quality of the Australian Poliovirus Surveillance Program, including a descriptive analysis of recent non-polio acute flaccid paralysis (AFP) detection rates and other WHO-recommended poliovirus surveillance performance indicators at national and sub-national level for the preceding five years. **Note:** The assessment does not extend to a formal evaluation of the Australian poliovirus surveillance system.	▪ Qualitative evaluation of information or descriptive analysis of data contained in annual Australian NCC progress reports, NERL annual reports. ▪ **Note:** assessment outputs may include, e.g. choropleth maps depicting localities of suboptimal surveillance performance, which may be overlayed with areas of suboptimal immunisation coverage and/or localities of new migrant settlement to generate a poliovirus risk map.
	19. Briefly describe the key components, structure, function, and quality of Australia's	▪ Qualitative evaluation and descriptive overview of information, and/or

Focused risk question	Risk Indicators	Data requirements, proposed format or evaluation method, and source(s)
	supplementary surveillance activities, including enterovirus surveillance and environmental surveillance (ENV) programs.	descriptive analysis of data contained in NERL annual reports. ▪ Semi-structured interviews or correspondence with NERL SMEs.
	20. Describe requirements for poliovirus notification nationally in the context of the Nationally Notifiable Disease Surveillance System (NNDSS).	▪ Qualitative evaluation and descriptive overview of Australian Government Department of Health policies and agreements, procedural documents or websites.
	21. Briefly describe the most recent imported case detection and environmental detection events in Australia, including the public health response, relevant timelines and outcome.	▪ Qualitative evaluation and descriptive overview of Australian Government Department of Health procedural or response documents. ▪ NERL annual reports. ▪ Peer-reviewed literature documenting relevant events.
H	22. Briefly describe the outcome of recent evaluation of Australia's healthcare infrastructure, system and International Health Regulations (IHR) core capacities, specifically: ❖ Whether a legislative framework to implement the IHR (2005) is in place; and ❖ Capability and functions to prepare for, detect and respond to health security threats.	▪ Qualitative evaluation and descriptive overview of Australian Government Department of Health policy, procedural documents or websites; and/or ▪ WHO Joint External Evaluation (JEE) of IHR core capacities for Australia mission report.
	23. Briefly describe the purpose, structure and key components of Australia's Poliovirus Infection Outbreak Response Plan.	▪ Qualitative evaluation and descriptive overview of information contained in the Australian Poliomyelitis Outbreak Response Plan, including documenting relevant reviews and content updates.
	24. Briefly describe established processes, procedures and resources (e.g. expert committees) available to conduct rapid risk assessment and provide prompt advice on response plan activation; response strategies and frequency of exercises/meetings /correspondence to maintain polio outbreak response readiness.	▪ Qualitative evaluation and brief descriptive overview of information contained in the Australian Poliovirus Infection Outbreak Response Plan. ▪ Semi-structured interviews or correspondence with relevant NCC and Polio Expert Panel (PEP) members, Australian Government Department of Health staff and Communicable Diseases Network Australia (CDNA) members.
	25. Briefly describe in general terms, any environmental, public health, social, geopolitical, economic or other risk factors that could contribute to a sustained polio transmission risk or potentially undermine an outbreak response in Australia.	▪ Human Development or Global Peace indices. ▪ Include brief reference to conditions that allow poliovirus circulation to persist, and risk factors, e.g. natural disasters, geopolitical conflict,

Focused risk question	Risk Indicators	Data requirements, proposed format or evaluation method, and source(s)
		economic crises, or other epidemiological or socio-political factors that may change Australia's risk profile or potentially undermine an outbreak response.

1.6 Risk characterisation (bringing it all together)

Once data or documentary evidence for each of the 25 risk indicators have been compiled, analysed or evaluated and the outcomes documented (Step 7 in the risk assessment process), the following formula allows generation of a semi-quantitative risk characterisation estimate (RCE) which may be plotted in a risk matrix. The RCE comprises the plotted product of the four risk elements, as follows:

- RCE = Likelihood x Impact, where
- Likelihood score = $(w1*H*c1) + (w2*S*c2)$
- Impact score = $(w3*D*c3) + (w4*R*c4)$

Each risk element is weighted and confidence-assessed to derive the RCE (Table 5).

Table 5: Variables used to calculate the risk characterisation estimate (RCE)

Symbol	Description
w	A proportional weighting factor, which incorporates an estimate of the relative importance of the risk element in the overall risk characterisation[3]
c	A confidence coefficient score, which incorporates an estimate of confidence in the reliability, quality and completeness of information assessed for each element
H	Reintroduction hazard risk element score
S	Population susceptibility risk element score
D	Detection capability risk element score
R	Response capability risk element score

The **likelihood score** therefore comprises the sum of the weighted hazard and susceptibility assessment scores; whereas the **impact score** comprises the sum of the weighted detection and response scores. The final RCE comprises the plotted intersection of the respective likelihood and impact scores in a risk matrix as a point estimate (refer to Figure 1), with defined thresholds representing descriptive risk categories (**Very Low, Low, Moderate, High** and **Very High**). A Microsoft Excel-based tool was constructed to allow automated calculation and display the overall results of the risk assessment as a

[3] The weighting factor for each risk element was determined through a Delphi survey involving polio experts from the Australian PEP, NCC and the Australian Government Department of Health.

semi-quantitative RCE, and to allow qualitative risk characterisation (assignment of a defined level of risk based on descriptive risk categories – refer to Figure 2 and Table 14).

Section 1.6.4 provides further detail.

1.6.1 Risk element scores

The four key risk elements may be individually scored according to specified criteria relevant to the element, as defined through one or more focused risk questions and risk indicators. A summary of how the eight focused risk questions (Table 3) and 25 risk indicators (Table 4) relate to each of the four key risk elements is provided (Table 6).

Table 6: Risk elements, with relevant focused risk questions and risk indicators

Risk element	Focused risk question	Risk indicator number (1 – 25)
Reintroduction hazard (H)	A	1 – 6
	B	7 – 9
Population susceptibility (S)	C	10
	D	11 – 13
	E	14 – 16
	F	17
Detection capability (D)	G	18 – 21
Response capability (R)	H	22 – 25

Given that all possible combinations or variations in criteria that influence the risk elements cannot be predicted and some overlap is likely, the proposed qualitative descriptions corresponding with risk element scores are not intended to be rigid, but rather guidelines. Hence, the evaluator(s) should assign risk element scores based on the qualitative description that most accurately resembles conclusions that may be drawn from the outcomes for the risk element assessed, noting that different combinations of criteria may occur together. Therefore, scoring intervals are designed to be somewhat flexible, as integers ranging from 1–5 as follows: **very satisfactory (1), satisfactory (2), acceptable (3), inadequate (4)**, **very inadequate (5)**.

1.6.1.1 Hazard assessment score (H)

Table 7 provides scoring guidelines for focused risk questions **A – B** of the risk element, **Reintroduction hazard (H)**. This evaluates the likelihood of poliovirus reintroduction through two potential pathways namely poliovirus importation through an infectious traveller, or a failure of laboratory containment policies, practices or import regulations (hazard component).

Table 7: Reintroduction hazard assessment scoring guidelines

Score (H)	Qualitative Description
1	▪ Polio risk countries relevant to the national context well-defined and documented ▪ High risk population groups for poliovirus importation are very well-characterised (e.g. based on comprehensive and recent data on traveller arrivals from polio risk countries, including proportional arrival numbers, and length-of-stay data) ▪ No land borders with high risk (endemic, outbreak or at-risk) countries; and proportionally minimal traveller traffic from such countries ▪ Policies that serve as comprehensive and effective poliovirus importation risk reduction measures targeting high risk population groups are in place and enforced, including: ❖ Effective border and international traveller control measures, with very limited to no unauthorised arrivals from polio risk countries via any pathway (land, sea, air) ❖ Existence and enforcement of comprehensive policies, procedures or requirements to mitigate the risk of poliovirus reintroduction through infectious travellers ▪ Advanced national laboratory infrastructure and systems, including comprehensive inventories, verification procedures, laboratory standards and import regulations to maintain appropriate poliovirus containment, and GAP III implementation is well progressed
2	▪ Polio risk countries relevant to the national context are defined and documented ▪ High risk population groups for poliovirus importation are well-characterised (e.g. based on fairly comprehensive and recent data on traveller arrivals from polio risk countries, including proportional arrival numbers, and length-of-stay data) ▪ No land borders with high risk (endemic, outbreak or at-risk) countries; proportionally moderate traveller traffic from such countries ▪ Policies that serve as comprehensive and effective poliovirus importation risk reduction measures targeting high risk population groups are in place and enforced, including: ❖ Effective border and international traveller control measures, with limited unauthorised arrivals from polio risk countries via any pathway (land, sea, air) ❖ Existence and enforcement of policies, procedures or requirements to mitigate the risk of poliovirus reintroduction through infectious travellers ▪ Good national laboratory infrastructure and systems, including inventories, verification procedures, laboratory standards and import regulations to maintain and strengthen appropriate poliovirus containment, and GAP III implementation is feasible
3	▪ Polio risk countries relevant to the national context are not well-defined or documented ▪ High risk population groups for poliovirus importation can be described, however accurate characterisation of this population somewhat challenging (e.g. data on traveller arrivals from high risk countries, although collected, is incomplete, of variable quality and/or outdated) ▪ One or more land borders with polio at-risk countries (but not outbreak or endemic countries); proportionally moderate traveller traffic from these countries ▪ Policies that serve as poliovirus importation risk reduction measures targeting high risk population groups exist, but are not comprehensive and/or not consistently enforced, e.g.: ❖ Border and international traveller control measures in place; however unauthorised arrivals via one or more pathways do occur, including from high risk countries ❖ Some policies, procedures or requirements to mitigate the risk of poliovirus reintroduction through infectious travellers exist, but enforcement is inconsistent ▪ Acceptable national laboratory infrastructure and systems in place, including some verification procedures, laboratory standards and import regulations to maintain and strengthen poliovirus containment, but limited capacity to progress GAP III implementation

Score (H)	Qualitative Description
4	▪ Polio risk countries relevant to the national context are not defined or documented ▪ High risk population groups for poliovirus importation are inadequately described; and accurate characterisation of this population is very difficult or not possible (e.g. no or very limited, incomplete and poor quality data on traveller arrivals from polio risk countries) ▪ Land border with one or more polio at-risk or outbreak countries, with proportionally high traveller traffic from these countries ▪ Policies that serve as poliovirus importation risk reduction measures targeting high risk population groups exist, but are not consistently or effectively enforced, e.g.: ❖ Inadequate border and international traveller control measures, with limited control over a high volume of unauthorised arrivals via one or more pathways (land, sea, or air), including a significant proportion thought to originate from polio high risk countries ❖ Limited policies, procedures or requirements to mitigate the risk of poliovirus reintroduction through infectious travellers exist, and are inconsistently enforced ▪ Basic laboratory infrastructure or systems, inventories, processes or procedures in place to support poliovirus containment; very limited capacity to progress GAP III implementation
5	▪ Polio risk countries relevant to the national context are not defined or documented ▪ High risk population groups for poliovirus importation are unknown and not described; and accurate characterisation of this population is not possible (e.g. lack of data) ▪ Land border with one or more polio outbreak or endemic countries, with proportionally very high traveller traffic from these countries ▪ Policies that serve as poliovirus importation risk reduction measures are non-existent or not effectively enforced, e.g.: ❖ Very inadequate border and international traveller control measures, with very limited to no control over a high volume of unauthorised arrivals via multiple pathways (land, sea, or air), with a high proportion thought to originate from polio high risk countries ❖ No policies, procedures or requirements to mitigate the risk of poliovirus reintroduction through infectious travellers exist or are not enforced ▪ Very basic or no laboratory infrastructure or systems, inventories, processes or procedures exist to support poliovirus containment; and no capacity to progress GAP III implementation

1.6.1.2 Population susceptibility score (S)

Table 8 provides scoring guidelines for focused risk questions **C – F** of the risk element, **Population susceptibility (S)**. This evaluates the likelihood of poliovirus exposure, establishment of infection, outbreaks and sustained transmission (exposure component), including the performance and delivery of the national immunisation program (NIP) (exposure component).

Table 8: Population susceptibility assessment scoring guidelines

Score (S)	Qualitative Description
1	▪ Effective performance and comprehensive delivery of the National Immunisation Program (NIP) ▪ Very high polio immunity in the general population ▪ The demographic characteristics and settlement patterns of long-term or permanent arrivals from polio risk countries is very well described (e.g. based on comprehensive and recent data characterised by age group upon arrival, and settlement location) ▪ Polio immunisation coverage rates of long-term or permanent arrivals from polio risk countries and other vulnerable subpopulations (e.g. indigenous groups) is very high ▪ Appropriate supplementary immunisation activities (SIAs) or policies targeting vulnerable subpopulations are in place and effectively implemented, with high uptake ▪ Localities of suboptimal polio vaccination coverage or suboptimal population immunity have been identified at high resolution, and documented for targeted public health action ▪ Well-developed WASH infrastructure accessible to the entire population
2	▪ Satisfactory performance and delivery of the NIP, although some improvements (e.g. in efficiency or geographic coverage) are possible ▪ High polio immunity in the general population ▪ The demographic characteristics and settlement patterns of long-term or permanent arrivals from polio risk countries is well described (e.g. based on fairly comprehensive and recent data characterised by age group upon arrival, and settlement location) ▪ Polio immunisation coverage rates of long-term or permanent arrivals from polio risk countries and other vulnerable subpopulations (e.g. indigenous groups) is high ▪ Appropriate supplementary immunisation activities (SIAs) or policies targeting vulnerable subpopulations are in place and implemented, with good uptake ▪ Localities of suboptimal polio vaccination coverage or population immunity have been identified at moderate to high resolution, and documented for targeted public health action ▪ Well-developed WASH infrastructure accessible to the majority, however improved service delivery and/or infrastructure required in some high risk regions/communities/vulnerable subpopulations
3	▪ A functional NIP, with reasonable performance and delivery, however some improvement (e.g. in efficiency or geographic coverage) required ▪ Polio immunity in the general population is variable or patchy, with some subpopulations or geographic regions having suboptimal or low immunisation coverage rates ▪ Demographic characteristics and settlement patterns of long-term or permanent arrivals from polio risk countries is described, but difficult to verify (e.g. data limitations) ▪ Polio immunisation coverage rates of long-term or permanent arrivals from polio risk countries or other vulnerable subpopulations (e.g. indigenous groups) is variable or patchy, and/or difficult to verify (e.g. data limitations) ▪ Supplementary immunisation activities (SIAs) or policies targeting vulnerable subpopulations exist, but implementation or uptake is variable, patchy or difficult to verify (e.g. data limitations) ▪ Localities of suboptimal polio vaccination coverage or immunity can be identified, but only at moderate resolution, or are difficult to verify (e.g. data limitations) ▪ Developed WASH infrastructure, however access is variable and not available to a significant proportion of the population, including in high risk regions/communities/ vulnerable populations

Score (S)	Qualitative Description
4	▪ Suboptimal performance and delivery of the NIP, with significant improvement (e.g. in efficiency or geographic coverage) necessary ▪ Low polio immunity in the general population ▪ Demographic characteristics and settlement patterns of long-term or permanent arrivals from polio risk countries is only superficially described, and not verified (e.g. data limitations) ▪ Polio immunisation coverage rates of long-term or permanent arrivals from polio risk countries and other vulnerable subpopulations (e.g. indigenous groups) is low and/or difficult to verify (e.g. data limitations) ▪ Supplementary immunisation activities (SIAs) or policies targeting vulnerable subpopulations exist, but implementation or uptake is inadequate or cannot be verified (e.g. data limitations) ▪ Localities of suboptimal polio vaccination coverage or suboptimal population immunity can be identified only at very coarse resolution, and/or not verified (e.g. data limitations) ▪ Rudimentary or inadequate WASH infrastructure for a significant proportion of the population, including in high risk regions/communities/populations
5	▪ No NIP, or severely inadequate performance and delivery, or cannot to be implemented (e.g. due to armed conflict) ▪ Very low polio immunity in the general population ▪ The demographic characteristics and settlement patterns of long-term or permanent arrivals from polio risk countries is unknown, and cannot be described or verified (e.g. lack of data) ▪ Polio immunisation coverage rates of long-term or permanent arrivals from polio risk countries and other vulnerable subpopulations (e.g. indigenous groups) is very low and/or cannot be verified (e.g. lack of data) ▪ Supplementary immunisation activities (SIAs) or policies targeting vulnerable subpopulations are non-existent, severely inadequate or cannot to be implemented (e.g. due to armed conflict) ▪ Localities of suboptimal polio vaccination coverage or suboptimal population immunity cannot be identified nor verified (e.g. lack of data), but likely to be very extensive) ▪ Rudimentary or inadequate WASH infrastructure for the majority of the population, including in high risk regions/communities/populations

1.6.1.3 Detection capability score (D)

Table 9 provides scoring guidelines for focused risk question **G** of the risk element, **Detection capability (D)**. This evaluates the likelihood of delayed detection of poliovirus infection or sustained low-level transmission due to suboptimal surveillance, resulting in a significant disease burden at population level and associated public health social, economic, reputational and political consequences (impact component).

Table 9: Detection capability assessment scoring guidelines

Score (D)	Qualitative Description
1	▪ Very high quality and performance of the national polio surveillance system, including comprehensive, sensitive AFP and supplementary surveillance components ▪ AFP surveillance consistently achieved very high performance as per WHO-recommended poliovirus surveillance performance indicators, over the assessment timeframe ▪ Comprehensive, sensitive supplementary surveillance components in place, including: ❖ Supplementary enterovirus surveillance (EV); AND ❖ Supplementary environmental surveillance (ENV) targeting high risk regions/communities/vulnerable subpopulations ▪ Surveillance system recently evaluated, and recommendations implemented ▪ Comprehensive legislative framework and efficient systems to support prompt notification ▪ Demonstrated capacity/track record of prompt detection and response to poliovirus imported case and environmental detection events
2	▪ High quality and performance of the national polio surveillance system, including sensitive AFP and supplementary surveillance components ▪ AFP surveillance consistently achieved high performance as per WHO-recommended poliovirus surveillance performance indicators over the assessment timeframe, although some improvements are possible ▪ Comprehensive supplementary surveillance components in place, including: ❖ Supplementary enterovirus surveillance (EV); AND ❖ Supplementary environmental surveillance (ENV), although some improvements in sensitivity are possible, e.g. improved targeting of high risk regions/communities/vulnerable subpopulations ▪ Surveillance system recently evaluated, but some recommendations not implemented ▪ Comprehensive legislative framework and efficient systems to support prompt notification ▪ Capacity for prompt detection and response to poliovirus imported case or environmental detection events, but no recent documented events to demonstrate effectiveness
3	▪ Functional, but suboptimal national surveillance program quality and performance, with scope for some improvements in sensitivity and coverage or additional supplementary surveillance ▪ AFP surveillance did not consistently achieve high performance as per WHO-recommended poliovirus surveillance performance indicators, over the assessment timeframe ▪ At least one supplementary surveillance component (EV/ENV) in place; however scope for improvement in sensitivity and coverage, and/or development and implementation of additional supplementary surveillance components ▪ Surveillance system not recently evaluated, and/or recommendations not implemented ▪ Legislative framework and systems to support prompt notification in place; although some improvements in implementation or efficiency are required ▪ Capacity for prompt detection and response to poliovirus imported case or environmental detection events, but no documented events to demonstrate effectiveness
4	▪ Suboptimal national surveillance program quality and performance, with significant scope for improvements in sensitivity and coverage ▪ Variable AFP surveillance performance over the assessment timeframe, as per WHO-recommended poliovirus surveillance performance indicators ▪ Limited capacity to develop and implement supplementary surveillance components; none currently in place

Score (D)	Qualitative Description
	▪ Surveillance system not recently evaluated, or never evaluated ▪ Limited legislative framework and systems to support prompt notification, or not implemented ▪ Limited capacity for prompt detection and response to poliovirus imported case or environmental detection events, without non-governmental or international assistance
5	▪ No national polio surveillance system in place, or very limited quality and performance with inadequate sensitivity and coverage, and significant scope for further development ▪ Consistent underperformance of AFP surveillance, as per WHO-recommended poliovirus surveillance performance indicators, over the assessment timeframe ▪ No gap analysis or surveillance plan, or very limited capacity to implementation a plan to support surveillance system development, including supplementary surveillance components ▪ Very limited or no legislative framework and systems to support prompt notification, or not implemented ▪ Very limited or no capacity for prompt detection and response to poliovirus imported case or environmental detection events, without non-governmental or international assistance

1.6.1.4 Response Capability score (R)

Table 10 provides scoring guidelines for focused risk question **H** of the risk element, **Response Capability (R)**. This evaluates the likelihood of a suboptimal outbreak response, or other external factors contributing to a failure of containment and control, resulting in a significant disease burden at population level and associated public health, social, economic, reputational and political consequences (impact component).

Table 10: Response capability assessment scoring guidelines

Score (R)	Qualitative Description
1	▪ Very high level of outbreak response preparedness ▪ Very high IHR core capacities, independently verified (e.g. WHO JEE) ▪ Comprehensive Poliomyelitis Outbreak Response Plan, regularly reviewed and updated ▪ Established processes, procedures, resources (e.g. expert committees) and capability available to conduct rapid risk assessment and promptly provide advice on response plan activation and coordination; regular exercises/meetings to review and maintain preparedness ▪ No imminent environmental, public health, social, geopolitical, or economic risk factors that could contribute to a sustained polio transmission risk or undermine an outbreak response
2	▪ High level of outbreak response preparedness ▪ High IHR core capacities, independently verified (e.g. WHO JEE) ▪ Comprehensive Poliomyelitis Outbreak Response Plan, review and update due ▪ Established processes, procedures, resources (e.g. expert committees) and capability available to conduct rapid risk assessment and provide prompt advice on response plan activation; occasional exercises/meetings to review and maintain preparedness ▪ No imminent environmental, public health, social, geopolitical, or economic risk factors that could contribute to a sustained polio transmission risk or undermine an outbreak response
3	▪ Moderate level of outbreak response preparedness ▪ Moderate IHR core capacities, as self-assessed or independently verified ▪ Improvements in structure of Poliomyelitis Outbreak Response Plan required, and/or content outdated and review overdue ▪ Some processes, procedures, resources and capability to conduct rapid risk assessment and provide advice on response plan activation and coordination, but currently inactive ▪ Some environmental, public health, social, geopolitical, or economic risk factors that could contribute to a sustained polio transmission risk or undermine an outbreak response
4	▪ Limited outbreak response preparedness ▪ Limited IHR core capacities, as self-assessed or independently verified; reliant on non-governmental organisations (NGOs) or international assistance to support health system function ▪ Inadequate, incomplete or very outdated Poliomyelitis Outbreak Response Plan ▪ Limited processes, procedures, resources and capability to conduct rapid risk assessment and provide advice on response plan activation and coordination, and currently inactive ▪ Imminent environmental, public health, social, geopolitical, or economic risk factors that could contribute to a sustained polio transmission risk or undermine an outbreak response
5	▪ Very limited to no outbreak response preparedness ▪ Very limited to no IHR core capacities, as self-assessed or independently verified; highly reliant on non-governmental or international assistance to support health system function ▪ No Poliomyelitis Outbreak Response Plan ▪ No processes, procedures and resources available to conduct rapid risk assessment and provide advice on response plan development or implementation; other than through NGO or international assistance

Score (R)	Qualitative Description
	▪ Active and ongoing environmental, public health, social, geopolitical, or economic risk factors that could promote persistent environmental contamination or sustained polio transmission and undermine an outbreak response

1.6.2 Weighting factor

Not all components that influence infectious disease risk for any particular pathogen are necessarily equally important. For example, it may be considered that the likelihood of poliovirus importation is more or less important than population immunity which protects against sustained transmission in the general population, or national capacity to respond to and promptly contain an outbreak, etc. The weighting factor incorporates an expert-informed estimate of the relative importance of each of the four key risk elements, in terms of the proportional contribution to the overall poliovirus reintroduction and outbreak risk for Australia.

The sum of the four weighting factors should equal 1 (100%), with a minimum value of 0.05 per element, and with variation possible in 0.05 increments. Hence, the minimum possible weighting for an individual element is 0.05 (5%), and the maximum is 0.85 (85%).The weighting factor for each risk element was determined through an expert elicitation method, namely a Delphi survey involving 16 invited subject matter experts (SMEs), namely all members of the Australian Polio Expert Panel (PEP), National Certification Committee for the Eradication of Poliomyelitis (NCC) and selected expert medical advisers from the Australian Government Department of Health.

The online Delphi survey was conducted in two rounds using Qualtrics XM (3), an online survey tool. The first round requested experts to rank the four risk elements in order of importance, and to provide comment on a proportional weighting for each risk element in terms of its perceived relative contribution to the overall poliovirus reintroduction, outbreak and sustained transmission risk for Australia, which was proposed by the risk assessment team. Survey respondents were required to provide a justification for any alternative proportional weighting factors proposed for each risk element. In the second round, results from the first round of consultation were anonymised and circulated to provide an opportunity for participating SMEs to consider all proposed weightings and justifications submitted, and to revise their own estimates in light of others' submissions, if deemed necessary.

The response rate was very high, with 13/16 (81%) and 12/16 (75%) of all SMEs invited to participate, completing round 1 and 2 of the survey, respectively. Following two rounds of expert elicitation, the weighting for each element was finalised by reaching a majority agreement to use the calculated median value of the range of weighting factor point estimates received for each risk element (Table 11). Nevertheless, 6/13 (46%) of respondents proposed alternative weightings; to account for this, these were incorporated into a sensitivity analysis, to evaluate the impact of alternative weightings on variability in the final results of the assessment.

Table 11: Risk element weightings determined through an expert-informed Delphi method

Risk element	Weighting factor	Justification
Reintroduction hazard (H)	0.15	▪ Border-level polio importation risk reduction strategies are not the main determinant influencing whether potentially infectious persons travel to Australia from polio risk countries. ▪ Monitoring and enforcing compliance with existing border-level risk reduction strategies, and offshore investment in polio eradication are the main tools against offshore poliovirus hazards. ▪ International poliovirus circulation and outbreaks cannot be directly controlled, but traveller trends data can be monitored to inform and strengthen targeted surveillance sensitivity, preventative measures (e.g. booster vaccinations) and response preparedness efforts domestically. ▪ The number of laboratories holding poliovirus or potentially infectious materials, and the quality and standards of facilities and systems influence the likelihood of laboratory containment failure occurring.
Population susceptibility (S)	0.5	▪ High population immunity may prevent establishment of infection and outbreaks, and will prevent sustained transmission even if poliovirus reintroduction occurs. ▪ High population immunity may limit the population-level impact by interrupting transmission, even if detection and response capability is suboptimal. ▪ This element was consistently weighted most heavily during development of WHO regional risk assessment tools (1) ▪ This is a country's main defence against poliovirus transmission.
Detection capability (D)	0.3	▪ The more sensitive a surveillance system, the sooner a poliovirus event may be detected, the smaller the outbreak and associated impact. ▪ A strong surveillance system provides confidence in a country's ability to promptly detect and respond to a poliovirus event.
Response capability (R)	0.05	▪ Most of the political, reputational, economic (response and surveillance costs) and public health impact would already manifest once an emergency response to a polio outbreak is required. ▪ This is a nation's last line of polio defence and 'upstream', preventative risk reduction measures are preferred.

1.6.3 Confidence coefficient score

World Health Organization guidelines note the importance of documenting the level of confidence in a public health risk assessment, and the reasons for any limitations. The confidence estimate (or alternatively, the level of uncertainty) will depend on the reliability, completeness and quality of the information evaluated, and the underlying assumptions made with respect to the hazard, exposure and context. The degree of confidence may be then be expressed using a descriptive scale that ranges from very low, low, moderate, high, very high (2). The confidence coefficient score incorporates into the calculation of each weighted risk element, an estimate of the reliability, quality and completeness of

information available to score each indicator of the focused risk questions at the time of assessment. The main value of confidence coefficient scores lie in the transparency that it affords the risk assessment process. The confidence coefficient score is incorporated as a proportional weighting and ranges on an ordinal scale from very high (0.2) to very low (1), each value corresponding with a qualitative description. The confidence coefficient score for each risk element will be assigned according to the qualitative description that most accurately describes the quality and completeness of information available at the time of assessment, noting that different combinations of criteria corresponding to different scores may occur together (Table 12). For this reason, the scoring intervals are designed to be somewhat flexible, and vary between **very high (0.2), high (0.4), moderate (0.6), low (0.8)** and **very low (1).**

Table 12: Qualitative descriptors corresponding to confidence coefficient scores

Confidence level	Qualitative Description	Confidence coefficient score
Very high	▪ Very limited to no evidence gaps ▪ Comprehensive, high quality, recent documentary evidence or data available at the time of assessment ▪ Comprehensive documentary evidence of functional, efficient structured monitoring processes, surveillance systems, and information technology infrastructure for appropriate record keeping to generate and store information ▪ Comprehensive documentary evidence of advanced laboratory and epidemiological capability and quality assurance processes to support surveillance, and readily available expert resources to review and verify the accuracy and completeness of information or data compiled ▪ Information required for indicator assessment is of high quality, comprehensive, readily available and recent (e.g. annual reports or data available for the relevant timeframe immediately preceding the assessment)	0.2
High	▪ Limited evidence gaps ▪ Good quality documentary evidence or data available at the time of assessment; information is minimally incomplete and fairly recent ▪ Good quality, minimally incomplete and fairly recent documentary evidence of functional structured monitoring processes, surveillance systems and/or information technology infrastructure for appropriate record keeping to generate and store information ▪ Good quality, minimally incomplete and fairly recent documentary evidence of appropriate laboratory and epidemiological capability and quality assurance processes to support surveillance, and access to expert resources to review and verify the accuracy and completeness of information or data compiled ▪ Information required for indicator assessment is of good quality, minimally incomplete, and fairly recent (e.g. annual reports or data available, but not for the entire relevant timeframe immediately preceding the assessment)	0.4
Moderate	▪ Moderate evidence gaps ▪ Documentary evidence and/or data is available at the time of assessment, however information is of variable quality, and/or somewhat incomplete and/or outdated ▪ Acceptable, but somewhat incomplete or outdated documentary evidence of structured monitoring processes , surveillance systems	0.6

Confidence level	Qualitative Description	Confidence coefficient score
	and/or information technology infrastructure for appropriate record keeping to generate and store information ▪ Acceptable, but somewhat incomplete or outdated documentary evidence of laboratory and epidemiological capability and quality assurance processes to support surveillance, and/or limited or intermittent access to expert resources to review and verify the accuracy and completeness of information or data compiled ▪ Information required for indicator assessment is of reasonable quality, however information is patchy or incomplete, and/or outdated or conversely, recent information is available but patchy and/or of variable quality	
Low	▪ Significant evidence gaps ▪ Very limited, and/or incomplete and/or poor quality and/or very outdated documentary evidence or data available at the time of assessment ▪ Limited and/or incomplete and/or poor quality documentary evidence of structured monitoring processes, surveillance systems and/or information technology infrastructure for appropriate record keeping to generate and store information ▪ Limited documentary evidence of laboratory and epidemiological capability and quality assurance processes to support surveillance, and/or inadequate access to expert resources to review and verify the accuracy and completeness of information or data compiled ▪ Information required for indicator assessment is lacking, or of suboptimal quality and/or very outdated (e.g. only incomplete, poor quality data available for assessment)	0.8
Very low	▪ Major and extensive evidence gaps ▪ No documentary evidence or data available to evaluate relevant risk indicators at the time of assessment ▪ No or very limited documentary evidence of structured monitoring processes (e.g. Government-administered process), surveillance systems, or information technology infrastructure for appropriate record keeping to generate and store information available[4] ▪ No or very limited documentary evidence of laboratory and epidemiological capability and quality assurance processes to support surveillance, and/or no or very limited access to expert resources to review and verify the accuracy and completeness of information or data compiled[5] ▪ Information required for indicator assessment is either completely unavailable, and/or based on crude speculation or conjecture only	1

[4] The purpose of a structured monitoring process, surveillance system, and information technology infrastructure for record keeping, will depend on the nature of the risk element under evaluation – e.g. immigration data for monitoring of traveller arrival trends, evidence of functional surveillance plans and systems for AFP or environmental surveillance, or existence of a functional electronic surveillance database to support national notification, record keeping and data analysis.

[5] Including but not limited to, access to accredited national reference laboratories, expert technical advisory committees and a National Certification Committee for the Eradication of Poliomyelitis (NCC).

1.6.4 Risk characterisation estimate (RCE)

The risk characterisation estimate (RCE) represents a semi-quantitative point estimate of the overall poliovirus reintroduction and outbreak risk for Australia covering the timeframe specified by the assessment (e.g. annually, five year intervals, etc.). The RCE may range from 0.02 – 4.5 for each component of likelihood and impact, and is derived through simple plotting of the respective likelihood and impact scores into a risk matrix, with defined thresholds representing descriptive risk categories (**Very Low, Low, Moderate, High** and **Very High**). The risk categories were determined through specifying cut-off criteria set at the 25th, 50th (median), 75th and 90th percentiles, respectively, of the distribution (range) of all possible combination of scores of the individual weighted risk elements (Table 13).

Table 13: Thresholds for Likelihood and Impact risk categories to plot the Risk Characterisation Estimate (RCE)

Range	Risk category
0.02–1.12	Very low
1.13–2.25	Low
2.26–3.38	Moderate
3.39–4.06	High
4.07–4.50	Very high

The RCE may then be plotted on a risk matrix to graphically depict the results of the assessment, and following intermittent repeated assessment, allow monitoring and visualisation of longer-term temporal trends in national polio reintroduction and outbreak risk. However, the RCE for a specified timeframe is not necessarily static and subject to change, depending on changes in the epidemiological variables (risk elements) that influence polio reintroduction and outbreak risk.

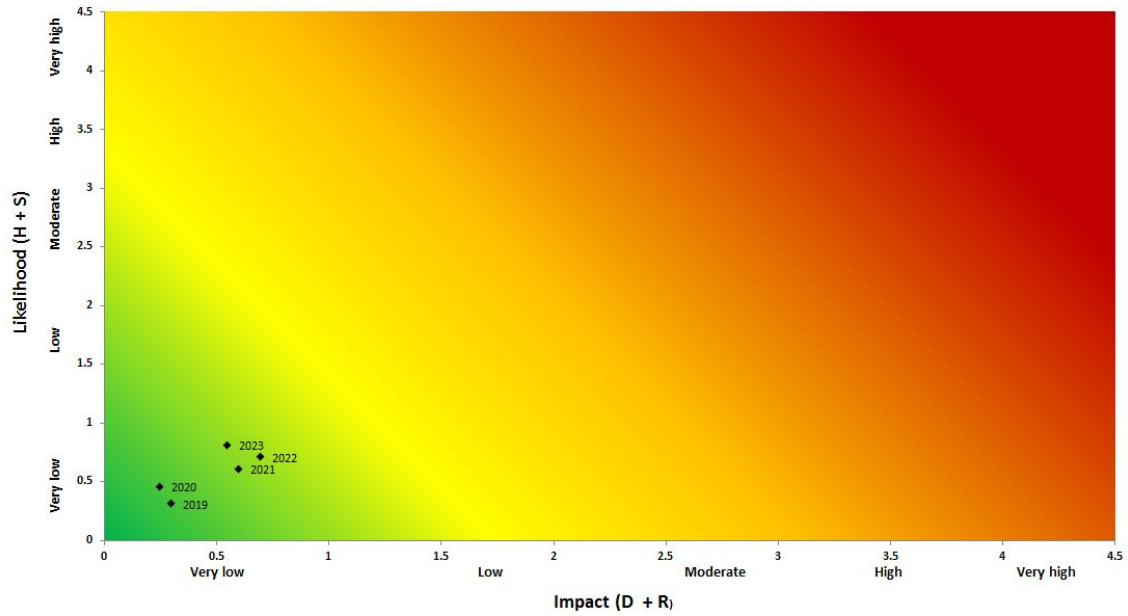

Figure 1: Polio risk matrix depicting five hypothetical risk estimates for assessments conducted in successive years or specified timeframes (e.g. at five year intervals)

The risk categorisation estimate (RCE) (i.e., the plotted intersection of the likelihood and impact scores) may also be qualitatively characterised, using a risk matrix with distinct cells corresponding to qualitative descriptors of polio reintroduction and outbreak risk (Table 14).

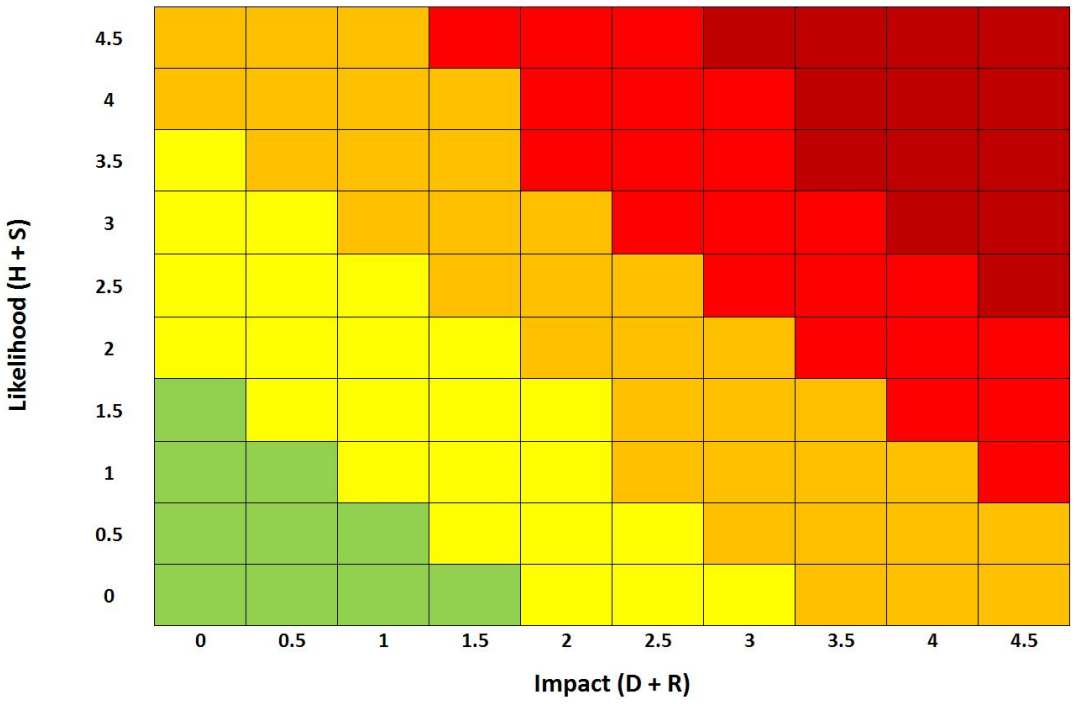

Figure 2: Qualitative risk matrix depicting distinct cells corresponding with qualitative descriptions of polio reintroduction and outbreak risk

Table 14: Qualitative description of polio reintroduction and outbreak risk categories

Risk category	Qualitative description
Very Low	▪ Very low probability of outbreaks of poliovirus infection, in the unlikely event that poliovirus reintroduction and establishment occurs during the assessment timeframe ▪ Outbreaks of poliovirus infection are highly likely to be prevented or rapidly detected, contained, and eliminated due to an effective combination of reintroduction risk reduction policies, very high immunisation coverage rates (involving no OPV use), a comprehensive and sensitive national polio surveillance system, and an advanced national response capability, including a comprehensive national polio outbreak response plan and access to expert laboratory and epidemiological resources ▪ A highly developed healthcare and WASH infrastructure accessible to the vast majority of the population contributes to the very low probability of a significant polio disease burden at population level, with a minimal national impact in terms of the public health, social, economic, reputational and political consequences ▪ National health systems core capacity, including capacity and investment in polio prevention, preparedness, surveillance, response capability, risk communication and stakeholder awareness is considered very high and appropriate relative to the very low risk level at the time of assessment
Low	▪ Low probability of outbreaks of poliovirus infection, in the unlikely but possible event that poliovirus reintroduction and establishment occurs during the assessment timeframe ▪ Outbreaks of poliovirus infection are likely to be prevented, or promptly detected, contained, and eliminated due to an effective combination of reintroduction risk reduction policies, high immunisation coverage rates (involving no OPV use), a functional and sensitive national polio surveillance system, and an effective national response capability, including a national outbreak response plan and access to expert laboratory and epidemiological resources ▪ A well-developed healthcare and WASH infrastructure accessible to the majority of the population contributes to the low probability of a significant polio disease burden at population level, with a limited national impact in terms of the public health, social, economic, reputational and political consequences ▪ National health systems core capacity, including capacity and investment in polio prevention, preparedness, surveillance, response capability, risk communication and stakeholder awareness is considered high and adequate relative to the low risk level at the time of assessment
Moderate	▪ Moderate probability of outbreaks of poliovirus infection, with reintroduction and establishment considered possible (or cVDPV emergence, where OPV is utilised) during the assessment timeframe ▪ Outbreaks of poliovirus infection may not be prevented, and/or delays or challenges in timely detection, containment, control and elimination may be expected. Prioritised public health actions and additional investment may be required to strengthen health systems core capacity, including polio preparedness and response capability to: reduce reintroduction risks; increase suboptimal or patchy immunisation coverage rates (or to reduce or cease OPV use); strengthen functional, but suboptimal surveillance system sensitivity and coverage; and to strengthen functional but suboptimal national response capability, including implementing risk communication strategies to target high risk population groups ▪ Suboptimal healthcare and/or WASH infrastructures for a significant proportion of the population may contribute to the moderate probability of a significant polio disease burden at population level, causing a manageable, but significant national impact in terms of the public health, social, economic, reputational and political consequences ▪ National health systems core capacity, including capacity and investment in polio prevention, preparedness, surveillance, response capability, risk communication and

Risk category	Qualitative description
	stakeholder awareness is considered acceptable, but not optimal relative to the risk level at the time of assessment.
High	▪ High probability of outbreaks of poliovirus infection, with reintroduction and establishment or VDPV emergence (where OPV is utilised) considered probable during the assessment timeframe ▪ Outbreaks of poliovirus infection are unlikely to be promptly detected, and containment and control is likely to face substantial challenges without external assistance ▪ Prioritised, timely public health actions and additional investment is required (e.g. funding, international assistance and coordination, training and capacity development) to effectively strengthen health systems core capacity, develop and implement policies to manage and reduce reintroduction or emergence threats, increase low and patchy immunisation coverage rates, strengthen suboptimal surveillance system sensitivity and coverage and to strengthen response capability, including developing and implementing appropriate risk communication strategies targeting high risk population groups ▪ An inadequate healthcare and WASH infrastructure for a significant proportion of the population contributes to the high probability of a significant polio disease burden at population level causing a substantial national impact in terms of the public health, social, economic, reputational and political consequences ▪ National health systems core capacity, including capacity and investment in polio prevention, preparedness, surveillance, response capability, risk communication and stakeholder awareness is considered inadequate relative to the high risk level at the time of assessment
Very High	▪ Severe and imminent polio risk, due to a very high probability of poliovirus reintroduction and establishment or VDPV emergence (where OPV is utilised) AND of outbreaks of poliovirus infection occurring during the assessment timeframe ▪ Outbreaks of poliovirus infection are highly likely to be characterised by prolonged detection delays or undetected low-level transmission, with health systems core capacity insufficient to prevent a failure of poliovirus containment and control without external assistance ▪ Urgent and substantial public health actions and additional investment is required (e.g. funding, international assistance and coordination, training and capacity development) to effectively strengthen health systems core capacity, develop and implement policies to manage and reduce reintroduction or emergence threats, increase very low polio immunisation coverage rates, strengthen inadequate surveillance system sensitivity and coverage and to strengthen response capability, including developing and implementing appropriate risk communication strategies targeting high risk population groups ▪ A deficient healthcare and WASH infrastructure for the majority of the population contributes to the very high probability of a significant polio disease burden at population level causing a very substantial national impact in terms of the public health, social, economic, reputational and political consequences ▪ National health systems core capacity, including capacity and investment in polio prevention, preparedness, surveillance, response capability, risk communication and stakeholder awareness is considered substantially inadequate relative to the very high risk level at the time of assessment

An Excel-based tool was developed to calculate and display the overall results of the assessment. The tool could also be used to display the results of annual rapid risk assessments (a requirement for annual progress reports to the RCC), or whenever change in epidemiological variables (which influence the risk elements) requires a rapid risk assessment to be repeated (e.g. the occurrence of a poliovirus event

in a neighbouring country, or in a country with significant permanent settler arrival volumes to Australia, etc.).

2. Polio risk country classification, for the Australian risk assessment

Countries for which traveller arrivals and settlement data were analysed for the risk assessment include all countries listed by the Global Polio Eradication Initiative (GPEI) under the following categories: Endemic, Outbreak or Key At-Risk. These countries were termed "polio high risk countries" for the purpose of the Australian national risk assessment. Further to the 24 "polio high risk countries" identified (as at January 2019), the risk assessment team identified 26 additional countries to be included in the assessment, which were listed based on the occurrence of at least two of the following risk factors (inclusion criteria):

- Potential for cVDPV emergence associated with the use of OPV, combined with low polio immunisation coverage rates (mean < 80%), as per UNICEF data for the preceding five years (4);
- Suboptimal health systems core capacities as evidenced by, e.g. JEE reports and/or suboptimal water, sanitation and hygiene (WASH) infrastructure (based on UNICEF data) (5, 6);
- Neighbouring geographical location, relative to Australia;
- Land border with a country classified by GPEI as a polio endemic, outbreak or key at-risk country;
- Current geopolitical events, including civil or international conflict, or other events (e.g. severe economic crises) that serve to undermine health systems core capacity, e.g. provision or access to primary health care services (including routine childhood immunisation programs), or cause unregulated population movements in the country or region.

3. Methodology assumptions and limitations

The methodology and findings of a risk assessment are subject to a number of assumptions and limitations. Principally, the RCE and associated qualitative risk statement is based on the assumption that all epidemiological variables (risk elements) that influence poliovirus reintroduction and outbreak risk remain static during the specified risk assessment timeframe. However, Australia's polio risk may shift substantially at any time and for various reasons including, e.g. reduced global investment in the polio eradication drive, regional conflict or economic crises degrading health system core capacities, declining population immunity due to vaccine hesitancy, or increased poliovirus circulation in communities from which Australia receives a large number of traveller arrivals. The results are therefore not intended for use as a polio risk forecasting tool, but rather to describe what occurred in the timeframe immediately preceding the assessment, as a baseline for comparison when rapid assessments are repeated annually, or more comprehensive assessments are repeated, e.g. in five year intervals.

Secondly, the assessment results are substantially influenced by the level of confidence in the quality and completeness of information and data used to evaluate the respective risk elements. The perceived quality of evidence used to inform the risk element scoring may be subject to bias, depending on the composition and frame of reference of the team tasked with conducting the scoring. Equally, the risk element scoring intervals were purposefully designed not to be overly rigid, but rather intended as guidelines to allow context-appropriate interpretation. Hence, the risk assessment team should assign risk element scores based on the qualitative description that most accurately resembles conclusions that may be drawn from the information assessed, noting that different combinations of criteria may occur together. However, this design feature means that some subjectivity in the scoring process remains. The weighting of risk elements through expert opinion is equally subjective. Nevertheless, an expert elicitation process may be considered the most accurate and valid estimation of the relative importance of the respective risk elements that is feasible without dedicated further research, and is a method frequently employed in qualitative risk assessment (2). An additional limitation pertains to calculation of the RCE, specifically the question of whether there is an assumption of independence of the various

risk elements, when in fact they are inter-dependent. For example, sustained transmission of poliovirus cannot occur, without virus reintroduction having first occurred, followed by exposure and infection of one or more susceptible individuals. Yet these elements are each individually evaluated, when in fact the variables that constitute each element are dynamic and interacting.

Finally, to minimise perceived bias in the risk characterisation results, the composition of the risk assessment team requires careful consideration. This will depend on the national context, available resources and expertise, and the intended end-users of the findings generated through the assessment. It is recommended that risk assessment teams incorporate expertise in the fields of epidemiology, virology, laboratory biosafety, immunisation and health systems from national government health departments and independent academic or research institutions.

4. References

1. Lowther SA, Roesel, Sigrun, O'connor, Patrick, Landaverde, Mauricio, Oblapenko, George, Deshevoi, Sergei, Ajay, Goel, Buff, Ann, Safwat, Hala, Salla, Mbaye,. World Health Organization regional assessments of the risks of poliovirus outbreaks. Risk Analysis. 2013;33(4):664-79.
2. World Health Organization. Rapid Risk Assessment of Acute Public Health Events Geneva 2012.
3. Qualtrics XM. Qualtrics XM Provo, Utah, USA: Qualtrics 2018.
4. United Nations Children's Fund (UNICEF). Immunization Coverage and System Performance Indicator Data: UNICEF 2018.
5. WASHWatch.org. World WASH data 2016.
6. United Nations children's Fund (UNICEF). A Snapshot of Water and Sanitation in the Pacific - 2015 Update 2015.