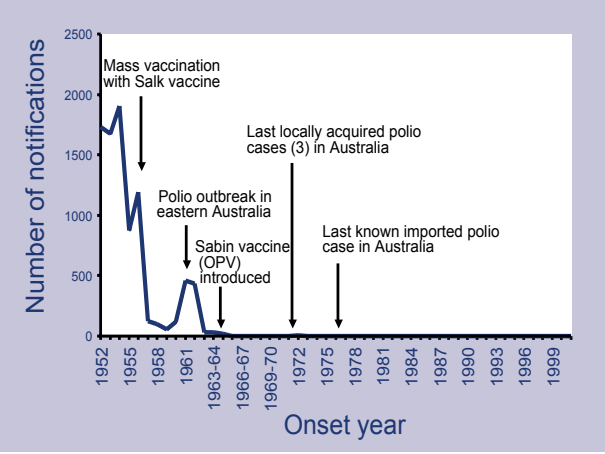
Editorial: Polio eradication in Australia and the world

Paul Roche, Jenean Spencer, Surveillance and Epidemiology Section, Department of Health and Ageing, Canberra

Vaccination prevents an estimated 650,000 cases of paralytic polio in each annual global birth cohort.[1] In October 2000, the World Health Organization (WHO) declared the Western Pacific region, including Australia to be polio-free.[2] This marks an important achievement for childhood health and is a true vaccination 'success story.' Since the creation of the Global Polio Eradication Initiative by the World Health Assembly in 1988, the estimated number of polio cases has fallen from 350,000 to less than 3,500, a decrease of more than 99 per cent.[3]

Mass vaccination against polio in Australia began in 1956 with the Salk inactivated polio vaccine (IPV) in a large publicly funded program.[4] The impact on the incidence of polio was dramatic (Figure).[5] The last laboratory-confirmed case of poliomyelitis in Australia was in 1967 and there were three clinically compatible cases notified in 1972.[6] The last known imported case of poliomyelitis was in 1977 (Figure). All cases notified since have been investigated and classified as cases of vaccine-associated poliomyelitis (VAPP). This includes a case in 1986, originally reported as wild polio, but recently re-classified as VAPP.[7]

Figure. Notifications of poliomyelitis, Australia, 1952 to 2001, by year of report



Certification of the eradication of polio required the documentation of the absence of circulating wild poliovirus (by surveillance for clinical polio and screening enteroviruses in laboratory specimens) as well as the monitoring of acute flaccid paralysis and vaccine-associated paralytic poliomyelitis. These surveillance activities and the continued vaccination of children against polio need to be sustained until global polio eradication is achieved. The paper by D'Souza in this issue[8] describes polio surveillance activities in Australia up to 2000. This editorial will discuss five areas of importance to polio eradication and highlight issues raised by the D'Souza's report.

Maintaining vaccine coverage

More than 90 per cent of all Australian children have received 3 doses of oral polio vaccine (OPV) by their 1st birthday and nearly 94 per cent of children by their 2nd birthday. (ACIR data: September 2001). However, antibody responses to poliovirus may be lower in some groups of vaccinated children within Australia, who may therefore be vulnerable to the imported virus.[9] Maintaining a high level of vaccine coverage is essential until global eradication of polio is achieved.

In 2001, 3 cases of paralytic polio occurred in Bulgaria among unvaccinated Roma children, 10 years after the last reported case of polio in that country. All 3 cases were identified as wild type and were genetically identical to wild-type virus from Northern India.[10] The importation of the virus into Europe struck the most vulnerable group with the lowest immunity.

Surveillance of acute flaccid paralysis

An important component of surveillance for polio is the continued monitoring of acute flaccid paralysis (AFP) in children under 15 years of age. Table 1 indicates the level of reporting in 2000 in Australia against 6 criteria for AFP surveillance. Acute flaccid paralysis surveillance data from the National Polio Reference laboratory at the Victorian Infectious Diseases Reference Laboratory,[11] suggests that Australia is meeting WHO standards in all but 2 criteria (Table 1).

It is estimated that AFP incidence in the absence of polio should be approximately 1 per 100,000 in this population and this is the minimum rate that an effective surveillance system should be reporting. While this surveillance target is being met nationally, low AFP detection rates in Tasmania and the Northern Territory as reported in this issue, suggest that AFP surveillance is sub-optimal in these jurisdictions. Moreover, the review of hospital records described in the article shows that a number of AFP cases go unreported. For each case of AFP, reporting and investigations should be instigated within 48 hours and 2 faecal samples collected 24 hours apart within 14 days of the onset of paralysis to detect poliovirus. The major un-met criteria are the timely investigation of AFP cases and the repeat stool testing to detect poliovirus. It should be noted that reporting of AFP is not routine in all industrialised countries and a number of countries are not meeting WHO surveillance standards.[12] The recent experience in Australia is that increased awareness among paediatricians of the importance of AFP surveillance and the centralising of clinical and virological surveillance has improved performance against WHO targets.[11]

Laboratory surveillance of enteroviruses

Laboratory surveillance of enteroviruses from faecal samples is important to measure the circulation of polioviruses in the environment. Concern has been expressed that poliovirus may persist in the environment because of faecal shedding from children receiving the OPV. This route is known to be responsible for the infection of household members. Indeed one of the rationales for using the live OPV is the ability to build herd immunity rapidly by such indirect effects. Faecal shedding appears to be limited in healthy children to 2–3 months after receiving the vaccine, although case reports of long term faecal shedding of poliovirus from children with inherited immuno-deficiencies have been documented.[13]

Environmental sampling of sewerage samples in Israel and the Palestinian Authority after polio was eliminated identified wild-type polio in 17 of 2,294 samples collected between 1989 and 1997.[14] These samples were clustered in four 'silent outbreaks' (that is they were not associated with cases of polio) and occurred at times when population immunity as assessed by serological surveys was high. Most of the isolates were identified in communities with poor sanitary conditions. One of the 'silent outbreaks' coincided with an influx of Palestinians into the Gaza Strip from countries in which poliovirus was endemic and where vaccine coverage was low.

Table 1. AFP surveillance in Australia, 2000[10]

WHO surveillance target	Indicator	AFP surveillance performance in 2000
Non-polio AFP cases per 100,000 population aged less than 15 years	1/100,000 (minimum 40 cases per annum)	48 cases (1.2/100,000) 43 cases with follow-up data
Percentage of routine surveillance sites that provide routine reports (including zero reports) on time	>80%	98% of reports provided to the Australian Paediatric Surveillance Unit each month
Percentage of AFP cases that are investigated	>80%	88% completed first and second questionnaires and/or collected 2 faecal samples
Percentage of AFP cases that are investigated within 48 hours of notification	>80%	48% investigated for clinical details and stool collection within 48 hours of notification
Percentage of AFP cases with a follow up examination for residual paralysis at 60 days after the onset of paralysis	>80%	88%
Percentage of AFP cases with 2 adequate stool samples	>80%	31%

While the study demonstrated the potential for polioviruses to circulate in sewerage, the lack of association with clinical cases leaves the significance of the findings for polio eradication uncertain. It should be noted that infection with the poliovirus is asymptomatic in 95 per cent of cases. Given the costs and complexity of such surveillance it is unlikely that this kind of surveillance can be instituted in many countries.

Most countries, like Australia, use opportunistic screening of faecal samples for polioviruses. The Virology and Serology Laboratory Reporting Scheme (LabVISE) has been used as the basis of surveillance in Australia. This scheme, which has been operating in its present form since 1991, reports only positive isolations and has reported 877 isolates of poliovirus in the 10 years, 1991 to 2000. These comprised 7 per cent of the 12,148 enterovirus isolated. LabVISE data are drawn from 15 to 20 laboratories, which include most major public hospital laboratories, but the numbers and types of poliovirus identified may not be fully representative of the national prevalence. Further, the proportion of enteroviruses that have been fully identified has been declining in recent years, making the value of enterovirus surveillance through LabVISE more uncertain.

There has been no circulating wild poliovirus in Australia for the last 30 years but laboratory stocks of poliovirus or material infected with poliovirus are potential sources of infection. Such laboratory material must be destroyed or contained as part of the global eradication program.[12] The Commonwealth Department of Health and Ageing is coordinating laboratory containment activities with the WHO. To date more than 70% of 2,200 organisations have responded to surveys and the process will be completed by June 2002.

Circulation of vaccine-derived polioviruses

Concerns about environmental contamination with vaccine-derived poliovirus (VDPV) and the possibility of viral reversion to neurovirulence, prompted the WHO to commission a study on the transmission and persistence of poliovirus. The authors concluded that 'OPV viruses could persist under various plausible circumstances, and that this potential should be a major consideration when planning the cessation of OPV vaccination'.[15]

Concerns about viral reversion to neurovirulence have been bolstered recently by three separate reports. An outbreak of 21 cases of polio in the Dominican Republic and Haiti which began in October 2000,[16] has been shown to be associated with a vaccine-derived poliovirus type 1, which had recovered the capacity to cause paralytic disease. A retrospective study of polioviruses circulating in Egypt between 1982 and 1993 demonstrated that a vaccine derived poliovirus type 2 was associated with 32 cases of polio.[17] A third outbreak of paralytic disease associated with vaccine derived poliovirus occurred in October 2001 in the Philippines, where 3 children were infected with a poliovirus type 1 variant.[18] The occurrence of variant neurovirulent polioviruses in populations with low vaccination rates in three different geographic areas raise concerns that these could be more widely spread.

The significance of these events for global eradication of polio remains to be evaluated.[19] Increased vigilance may have uncovered what have been infrequent events occurring for some years. A review of more than 2,000 isolates from AFP cases globally has not revealed any additional variant vaccine-derived poliovirus strains.[18]

Stopping polio vaccination in Australia?

One of the main rationales for the polio eradication initiative was that an end to polio would mean financial savings for developing countries, by allowing the cessation of vaccination programs. Globally, these savings were calculated to be US$1.5 billion per annum.[3] However, even before the advent of variant vaccine derived viruses causing polio disease, experts were divided on the vaccine strategies that should be implemented post-eradication.[13]

Some of the advantages and disadvantages of some of the proposed post-eradication vaccination strategies are shown in Table 2. Discussions have revolved around whether it would be 'safe' to discontinue polio vaccination entirely or whether vaccination should continue, either with the cheap live OPV or with the inactivated and more expensive IPV. The advantages of IPV over OPV are that live vaccine viruses would not be released into the environment and the development of variant viruses would be halted. In addition, IPV has not been shown to cause vaccine associated paralytic polio (VAPP) which affects approximately one in 2.4 million OPV recipients.[20]

However, the IPV vaccine is more expensive and must be delivered by injection. Serological studies in developing countries have shown that IPV is much less effective in developing protective

immunity.[3] These disadvantages were important in the initial choice of OPV over IPV in the global polio eradication initiative. New polio vaccines are a distant possibility for the post eradication world. More research is needed to assess the relative value of each strategy. However, recent events indicate that polio vaccination should continue, probably with OPV in use through the developing world and IPV being increasingly used in the wealthier nations.

Alternative polio vaccination strategies need to be considered including the 'pulsed vaccination' of smaller cohorts of children in place of universal vaccination.[21] The Commonwealth Government is currently considering proposals to replace OPV with IPV in the Australian standard vaccination schedule. New vaccines in which IPV is combined with childhood vaccines such as diphtheria, tetanus and pertussis are an option.

Global polio eradication is an issue that will continue to affect Australian polio vaccination policies and surveillance activities. The recent emergence of neurovirulent vaccine derived polioviruses show that complacency about polio is not an option.

Table 2. Some advantages and disadvantages of proposed strategies for future polio vaccination

Strategy	Advantages	Disadvantages	Comments
Coordinated discontinuation of OPV use worldwide after certification of global polio eradication	• Cessation of vaccination estimated to save US$1.5 billion per annum • Cease vaccination when world immunity is maximal, perhaps after global immunisation days	• Potential for transmission of vaccine-derived polioviruses causing disease in susceptible newborns • Need to retain capacity for vaccine production and stockpile vaccine in case of epidemics	• Ethical issues if some countries switch to IPV since developing countries may not be able to afford IPV vaccination
Replacement of OPV with IPV	• Preserve individual immunity • Low risk of VAPP • Eliminate environmental contamination with vaccine derived polio and attendant risks of polio reversion to wild type characteristics of transmission and neurovirulence	• Costly option requiring injection and changes to child vaccination schedule • Seroconversion rates induced by IPV low in developing countries • No financial benefit from polio eradication: indeed a new financial burden for developing countries	• IPV vaccine manufacturers would need to greatly boost production to meet demand • IPV vaccine manufacturers would have bio-security concerns as the last repository of live polioviruses • Increased risks of bloodborne viruses due to increased injections
Development of a new poliovirus vaccine	• Development of new live virus with low risk of causing VAPP	• Major hurdles to regulatory approval • Very large field trials required to prove efficacy in a world where polio is very rare	• Basic research required to identify candidate vaccines • Little financial incentive for vaccine manufacturers to develop new vaccines

Adapted from Wood (2000)[12] and Technical Consultative Group (2002).

References

1. Aylward RB, Hull HF, Cochi SL, Sutter RW, Olive J-M, Melgaard B. Disease eradication as a public health strategy: a case study of poliomyelitis eradication. *Bulletin of the WHO* 2000;78:285–297.
2. WHO. Major milestone reached in global polio eradication: Western Pacific Region is certified polio-free. *Commun Dis Intell* 2000;24:304.
3. Technical Consultative Group. 'Endgame' issues for the global polio eradication initiative. *Clin Infect Dis* 2002;34:72–77.
4. Gidding HF, Burgess MA, Kempe AE. A short history of vaccination in Australia. *Med J Aust* 2001;174:37–40.
5. Hall, R. Notifiable Diseases Surveillance, 1917 to 1991. *Commun Dis Intell* 1993; 17:226–236.
6. Department of Health and Aged Care. National documentation for certification of poliomyelitis eradication in Australia. Canberra: Commonwealth of Australia, 2000.
7. Kennett M, Brussen KA, Wood DJ, van der Avoort HG, Ras A, Kelly HA. Australia's last reported case of wild poliovirus infection. *Commun Dis Intell* 1999;23:77–79.
8. D'Souza RM, Kennett M, Watson C. Australia declared polio free. *Commun Dis Intell* 2002;26:253-260.
9. Hanna JN, Sexton WL, Faoagali JL, Buda PJ, Kennett ML, Brussen KA. Immunity to hepatitis B, poliomyelitis and measles in fully vaccinated Aboriginal and Torres Strait Island children. *J Paediatr Child Health* 1995;31:345–349.
10. CDC. Imported wild poliovirus causing poliomyelitis — Bulgaria. *MMWR* 2001;50:1033–1035.
11. Kelly H, Brussen KA, Morris A, Elliott E. Acute flaccid paralysis surveillance in Australia. *Bulletin of the WHO* 2001;79:1169–1170.
12. Anon. Performance of acute flaccid paralysis (AFP) surveillance and incidence of poliomyelitis, 2000–2001. *Weekly Epidemiological Record* 2001;76:80–83.
13. Wood DJ, Sutter RW, Dowdle WR. Stopping poliomyelitis vaccination after eradication: issues and challenges. *Bulletin of the WHO* 2000;78:347–357.
14. Manor Y, Handsher R, Halmut T, et al. Detection of poliovirus circulation by environmental surveillance in the absence of clinical cases in Israel and the Palestinian Authority. *J Clin Micro* 1999;37: 1670–1675.
15. Fine PE, Carneiro IA. Transmissibility and persistence of oral polio vaccine viruses. Implications for the global poliomyelitis eradication initiative. *Am J Epidemiol* 1999;150:1001–1021.
16. CDC. Outbreak of poliomyelitis — Dominican Republic and Haiti, 2000–2001. *MMWR* 2001;50:147.
17. CDC. Circulation of a type 2 vaccine-derived poliovirus — Egypt, 1982–1993. *MMWR* 2001;50:41–42.
18. CDC. Acute flaccid paralysis associated with circulating vaccine-derived poliovirus — Philippines, 2001. *MMWR* 2001;50:874–875.
19. Henderson DA. Countering the post eradication threat of smallpox and polio. *Clin Infect Dis* 2002;34:79–83.
20. CDC. Poliomyelitis. www.cdc.gov/nip/publications/pink/polio.pdf.
21. Vastag B. At polio's end game, strategies differ. *JAMA* 2001;286:2797–2799.