



Published in final edited form as:

Lancet Infect Dis. 2017 July ; 17(7): 680–681. doi:10.1016/S1473-3099(17)30236-0.

Maximising the Impact of Inactivated Polio Vaccines

Elizabeth B. Brickley, PhD¹ and Peter F. Wright, MD¹

¹Department of Epidemiology, Geisel School of Medicine, Dartmouth College, Hanover, New Hampshire, USA

²Department of Pediatrics, Dartmouth-Hitchcock Medical Center, Lebanon, New Hampshire, USA

With the globally coordinated switch from the trivalent oral polio vaccine (OPV) to the bivalent OPV in April, 2016, the international public health community entered a new chapter in the endgame of polio. Although OPV has served as the cornerstone of polio eradication efforts over the last 30 years, trivalent inactivated polio vaccine (IPV) has re-ascended to prominence in the past year, now acting as the sole source of protective immunity against type 2 poliovirus in routine immunisation programs. Despite its immense public health value, the global supply of IPV is failing to meet demand. The October, 2016, meeting of the Strategic Advisory Group of Experts on Immunization cautioned that, “The IPV supply situation is further deteriorating; 50 countries are experiencing delays in supply or stock-outs, a situation which is likely to persist until 2018.”¹

Given the existing resource constraints, pragmatic solutions are urgently needed to maximize the impact of IPVs during the transitional and post-OPV immunisation era. In the *Lancet Infectious Diseases*, Birgit Thierry-Carstensen and colleagues² report on one such novel strategy in the form of reduced-dose IPVs administered intramuscularly with an aluminum hydroxide (Al) adjuvant. The three IPV-Al candidates were formulated at one-third, one-fifth, and one-tenth the concentration of standard IPV and administered to healthy children living in the Dominican Republic at 6, 10, and 14 weeks of age. The results of the well conducted phase II trial indicate that the antigen-sparing IPV-Als were able to achieve substantial (i.e., 75%) seroconversion against the three serotypes of polio after only two vaccine doses. Promisingly, after three doses, all three formulations of IPV-Als achieved more than 94% seroconversion to poliovirus types 1, 2, and 3, and the seroresponses were non-inferior to those of the standard IPV, which was administered unadjuvanted, but at up to ten-fold higher concentrations.

Enhancing the immunogenicity of IPVs is an important achievement in view of the on-going shortfalls in IPV production by global pharmaceutical firms. Moving forward, an antigen-sparing IPV with adjuvant would be a welcome addition to the expanding portfolio of alternative IPV approaches under development, which also includes fractional (i.e., reduced-volume) intradermal IPVs^{3,4} and enhanced potency high dose IPVs⁵ that may limit the number of serial doses required to uniformly induce immunity. Overall, dose-sparing IPV

Corresponding Author: Prof. Peter F. Wright, Department of Pediatrics, Dartmouth-Hitchcock Medical Center, One Medical Center Drive, Lebanon, NH 03756, USA, Peter.F.Wright@hitchcock.org, (603) 650-6063.

We declare no competing interests.

strategies have the potential to reduce costs of immunisation activities,⁶ facilitate the protection of individuals during outbreaks by enabling both prompt responses and high levels of coverage,⁷ and stretch dwindling vaccine supplies. However, selecting and then operationally optimizing an IPV strategy for a specific context will be challenged by a number of logistical barriers (e.g., scalability and costs of vaccine production/storage, availability of trained vaccinators, procurement of immunization devices) and immunological considerations (e.g., scheduling to mitigate interference by maternal antibodies, inducing seroprotection of an appropriate magnitude and duration).⁸

In preparing our global public health system to withstand shortages in IPV supply moving forward, it is also important to give due consideration to a limitation of all IPVs -- namely, that inactivated vaccines appear to have a limited capacity to induce intestinal immunity against polio. There is no question that serum antibodies produced in response to IPV are able to successfully protect vaccinees against paralytic polio by inhibiting viremia and entry into the central nervous system. Perhaps less appreciated is that with polio—and probably many other pathogens replicating at mucosal surfaces—a vaccine’s ability to induce mucosal immunity is tightly linked to the vaccine’s capacity to block viral shedding and, thereby, potential onward transmission. Mounting evidence from OPV challenge trials^{5,9,10} indicates that, when delivered in a primary vaccine series, IPV seems to have only limited effects on the duration and degree of viral shedding. By contrast, the intestinal immunity induced by live, oral vaccines is close to achieving the ideal of sterilising immunity.^{10–12} Ultimately, blocking transmission (e.g., via integrated OPV-IPV intestinal immune boosting strategies^{13,14} and the development of the more highly attenuated and genetically stable novel OPVs) and thus reducing IPV demand for outbreak control is also a paramount consideration for capitalising on the utility of IPV under the reality of existing supply limitations.

Eradication of polio is tantalizingly close. In the final steps toward eradication and for the post-eradication era, there is a need for as many arrows in the quiver as possible, and it would be valuable to add aluminum hydroxide-enhanced IPV to that arsenal.

References

1. World Health Organization Weekly Epidemiological Record Geneva: 2016 56184
2. Rivera L, Pedersen RS, Pena L, et al. Immunogenicity and safety of three aluminum hydroxide adjuvanted vaccines with reduced doses of inactivated polio vaccine (IPV-AI) compared to standard IPV: a phase II, observer-blinded, randomised and controlled dose investigation trial in young infants in the Dominican Republic. *Lancet Infect Dis.* 2017
3. Resik S, Tejada A, Lago PM, et al. Randomized controlled clinical trial of fractional doses of inactivated poliovirus vaccine administered intradermally by needle-free device in Cuba. *J Infect Dis.* 2010; 201(9):1344–52. [PubMed: 20350164]
4. Mohammed AJ, AlAwaidy S, Bawikar S, et al. Fractional doses of inactivated poliovirus vaccine in Oman. *N Engl J Med.* 2010; 362(25):2351–9. [PubMed: 20573923]
5. Saez-Llorens X, Clemens R, Leroux-Roels G, et al. Immunogenicity and safety of a novel monovalent high-dose inactivated poliovirus type 2 vaccine in infants: a comparative, observer-blind, randomised, controlled trial. *Lancet Infect Dis.* 2016; 16(3):321–30. [PubMed: 26719058]
6. Hickling J, Jones R, Nundi N, D Z. Improving the Affordability of Inactivated Poliovirus Vaccines (IPV) for Use in Low- and Middle-Income Countries: An Economic Analysis of Strategies

- to Reduce the Cost of Routine IPV Immunization Seattle: Program for Appropriate Technology in Health (PATH); 2010
7. Bahl S, Verma H, Bhatnagar P, et al. Fractional-Dose Inactivated Poliovirus Vaccine Immunization Campaign - Telangana State, India, June 2016. *MMWR Morb Mortal Wkly Rep.* 2016; 65(33):859–63. [PubMed: 27559683]
 8. Estivariz CF, Pallansch MA, Anand A, et al. Poliovirus vaccination options for achieving eradication and securing the endgame. *Curr Opin Virol.* 2013; 3(3):309–15. [PubMed: 23759252]
 9. O’Ryan M, Bandyopadhyay AS, Villena R, et al. Inactivated poliovirus vaccine given alone or in a sequential schedule with bivalent oral poliovirus vaccine in Chilean infants: a randomised, controlled, open-label, phase 4, non-inferiority study. *Lancet Infect Dis.* 2015; 15(11):1273–82. [PubMed: 26318714]
 10. Hird TR, Grassly NC. Systematic review of mucosal immunity induced by oral and inactivated poliovirus vaccines against virus shedding following oral poliovirus challenge. *PLoS Pathog.* 2012; 8(4):e1002599. [PubMed: 22532797]
 11. Asturias EJ, Bandyopadhyay AS, Self S, et al. Humoral and intestinal immunity induced by new schedules of bivalent oral poliovirus vaccine and one or two doses of inactivated poliovirus vaccine in Latin American infants: an open-label randomised controlled trial. *Lancet.* 2016; 388(10040):158–69. [PubMed: 27212429]
 12. Wright PF, Connor RI, Wieland-Alter WF, et al. Vaccine-induced mucosal immunity to poliovirus: analysis of cohorts from an open-label, randomised controlled trial in Latin American infants. *Lancet Infect Dis.* 2016
 13. John J, Giri S, Karthikeyan AS, et al. Effect of a single inactivated poliovirus vaccine dose on intestinal immunity against poliovirus in children previously given oral vaccine: an open-label, randomised controlled trial. *Lancet.* 2014; 384(9953):1505–12. [PubMed: 25018120]
 14. Jafari H, Deshpande JM, Sutter RW, et al. Polio eradication. Efficacy of inactivated poliovirus vaccine in India. *Science.* 2014; 345(6199):922–5. [PubMed: 25146288]