Primary and booster vaccination with an inactivated poliovirus vaccine (IPV) is immunogenic and well-tolerated in infants and toddlers in China

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A B S T R A C T

Introduction: Replacing live-attenuated oral poliovirus vaccines (OPV) with inactivated poliovirus vaccines (IPV) is part of the global strategy to eradicate poliomyelitis. China was declared polio-free in 2000 but continues to record cases of vaccine-associated-poliomyelitis and vaccine-derived-poliovirus outbreaks. Two pilot safety studies and two larger immunogenicity trials evaluated the non-inferiority of IPV (Poliorix®; GSK Vaccines, Belgium) versus OPV in infants and booster vaccination in toddlers primed with either IPV or OPV in China.

Methods: In pilot safety studies, 25 infants received 3-dose IPV primary vaccination (Study A, www.clinicaltrial.gov NCT00937404) and 25 received an IPV booster after priming with three OPV doses (Study B, NCT01021293). In the randomised, controlled immunogenicity and safety trial (Study C, NCT00920439), infants received 3-dose primary vaccination with IPV (N = 541) or OPV (N = 535) at 2.3, 4 months of age, and a booster IPV at 18-24 months (N = 470, Study D, NCT01323647: extension of study C). Blood samples were collected before and one month post-dose-3 and booster. Reactogenicity was assessed using diary cards. Serious adverse events (SAEs) were captured throughout each study.

Results: Study A and B showed that IPV priming and IPV boosting (after OPV) was safe. Study C: One month post-dose-3, all IPV and ≥98.3% OPV recipients had seroprotective antibody titres towards each poliovirus type. The immune response elicited by IPV was non-inferior to Chinese OPV. Seroprotective antibody titres persisted in ≥94.7% IPV and ≥96.1% OPV recipients at 18-24 months (Study D). IPV had a clinically acceptable safety profile in all studies. Grade 3 local and systemic reactions were uncommon. No SAEs were related to IPV administration.

Conclusion: Trivalent IPV is non-inferior to OPV in terms of seroprotection (in the Chinese vaccination schedule) in infant and toddlers, with a clinically acceptable safety profile.

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1. Introduction

Oral poliovirus vaccine (OPV) has been the mainstay of poliomyelitis control in many countries since the 1950s. Nonetheless, there are several disadvantages in continuing vaccination with OPV in countries where wild-type poliovirus has been eradicated. Despite its otherwise remarkable safety profile, OPV may rarely cause vaccine associated paralytic poliomyelitis (VAPP) due to reverse mutations in the RNA genome of the attenuated vaccine strains resulting in neurovirulence [1]. An estimated two to
four VAPP cases per 1000,000 birth cohort are expected to occur each year in countries using OPV only [1]. In addition, outbreaks of poliomyelitis caused by circulating vaccine-derived strains have been documented and remain a potential threat in countries where OPV continues to be used [2,3].

Inactivated poliovirus vaccines (IPV) have been available since the 1950s and enhanced IPV formulations with improved immunogenicity were introduced in the 1980s. The inactivation of IPV ensures that reverse mutations and neurovirulence are unable to occur. IPV is highly immunogenic administered as IPV alone or in mixed IPV-OPV schedules [4]. IPV manufactured by GSK Vaccines has been used alone or in combination with diphtheria, tetanus and pertussis vaccine antigens since 1996 [5]. The standalone IPV PolioRix™ (hereafter referred to as IPV; GSK Vaccines, Belgium) containing the three poliovirus types is currently licensed in more than 20 countries, and more than 12 million commercial doses have been distributed. Routine use of IPV and IPV combination vaccines has confirmed their positive benefit-risk profile in developed countries [4,6].

In 2015, wild-type poliovirus 1 remains endemic in Pakistan and Afghanistan [7]. For the first time, no wild-type polio cases have been recorded in Africa for more than 12 months [7]. Poliomyelitis due to wild-type poliovirus type 2 has not been documented since 1999 and poliovirus type 3 since 2012. In anticipation of the planned withdrawal of poliovirus type 2 from OPV, the World Health Organization (WHO) recommends that all children receive at least one IPV dose in order to maintain immunity to poliovirus type 2 [1]. In addition, the WHO recommends that an all-IPV schedule be considered in countries with high vaccine coverage and a low risk of importing wild virus [1].

In China, the last case of domestic wild-type poliomyelitis was reported in 1994 and the country was certified as polio-free by WHO in 2000. Since then, imported wild-type poliovirus outbreaks have been infrequently reported [8]. However, several outbreaks of vaccine-derived poliovirus infections have been reported during the last decade [2,3]. These outbreaks and the continuing risk of VAPP in vaccinees highlight the need to consider the risks associated with continued OPV use in the national poliomyelitis immunisation policy.

The Chinese poliomyelitis immunisation schedule comprises 3 doses of OPV at 2, 3 and 4 months of age, with one booster dose at 4 years of age. We conducted four clinical trials (two pilot safety studies: A and B, and a large randomised controlled study: C and D (extension of study C) to assess the immunogenicity, reactogenicity and safety of IPV when administered for primary vaccination according to the Chinese immunisation schedule, and as a booster in the second year of life.

2. Methods

The study protocols and associated documents were reviewed and approved by the Guangxi Institutional Review Board. The studies were conducted in accordance with the Declaration of Helsinki, Good Clinical Practice principles and all applicable regulatory requirements. Written informed consent was obtained from each subject’s parent/legally acceptable representative prior to enrolment.

Study A was conducted at the Cangwu Centre for Disease Control and Prevention, Longxu town, Cangwu County, Wuzhou City, Guangxi Province. Study B was conducted at the Wuzhou Centre for Disease Control and Prevention, Wuzhou, Guangxi. Study C and D were conducted in two centres: the Cangwu Centre for Disease Control and Prevention in Wuzhou City and the Mengshan Centre for Disease Control and Prevention, Mengshan Town, Mengshan County.

Studies A, B and C (NCT009337404, NCT01021293 and NCT-00920439, respectively) were conducted between 04 August 2009 and 05 July 2010. Study D (NCT01323647) was conducted between 23 April 2011 and 19 September 2011.

2.1. Study design and objectives

2.1.1. Pilot studies

Two open, single group, pilot safety studies were conducted to assess the safety and reactogenicity of IPV when administered as a 3-dose primary vaccination in infants (Study A) and as a booster dose in toddlers primed with three doses of OPV (Study B) (Table 1). The sample sizes were chosen to provide at least 20 evaluable subjects, as required by the Chinese Regulatory authority guidelines [9].

2.1.2. Confirmatory randomised controlled trial

Study C was a randomised, controlled trial to assess the immunogenicity, safety and reactogenicity of IPV when administered in a 3-dose primary vaccination schedule. The primary study objective was to demonstrate non-inferiority of IPV as compared to OPV in terms of the immune response to poliovirus types 1, 2 and 3 one month after the third vaccine dose (Table 1). A randomisation list was generated at GSK Vaccines, Belgium and was used to number the vaccines. Treatment allocation at the investigator site was performed using a central, web-based randomisation system. A blocking scheme ensured that balance between treatments (1:1 ratio) was maintained. The randomisation algorithm used a minimisation procedure accounting for centre [10]. Subjects vaccinated in Study C were invited to return at 18–24 months of age to participate in Study D in order to investigate antibody persistence after primary vaccination with IPV or OPV (Control group). Study D also assessed the immunogenicity, safety and reactogenicity of a booster dose of IPV administered to children who had received three priming IPV doses in Study C.

2.2. Participants

Participants in Study A and C were healthy infants between 60 and 90 days of age and born with a gestational age of 36 to 42 weeks. Participants in Study B and D were healthy toddlers 18 to 24 months of age. Toddlers participating in Study B had received three priming doses of OPV in the first year of life as per Chinese recommendations. Toddlers participating in Study D had received primary vaccination in Study C.

Infants and toddlers were excluded from participation if they had evidence of previous or intercurrent poliomyelitis disease or vaccination (other than the doses specified in the protocol of the booster studies). Children were excluded if they had a history of seizures or progressive neurological disease, any immunosuppressive condition, a history of allergic reactions likely to be exacerbated by any vaccine component, or major congenital defects or serious chronic illness. Administration of a vaccine not foreseen by the study protocol was not permitted within 30 days prior to vaccination, nor was its planned administration during the study period; with exception of combined diphtheria-tetanus-pertussis (DTP), Haemophilus influenzae type b (Hib) conjugate vaccine and hepatitis B vaccines. Children were excluded if they had received ≥14 days of immunosuppressants or other immune-modifying drugs since birth, immunoglobulins and/or any blood products since birth or their planned administration during the study period.

2.3. Vaccines and schedule

Each dose (0.5 ml) of IPV contained 40 Dalton (D) antigen units of inactivated poliovirus type 1, 8 D antigen units of inactivated...
poliovirus type 2 and 32 D antigen units of inactivated poliovirus type 3, with 2-phenoxyethanol as preservative. One IPV vaccine lot (AIPVB021B) was used for study A and B and a second lot (AIPVB023C) was used for Studies C and D. IPV was administered intramuscularly into the thigh using a 25 gauge needle of at least 1 inch (2.54 cm) length.

The Chinese OPV vaccine (lot 200909041, administered to the Control group in Study C) was cultured on Monkey Kidney Cells. Each dose (2 drops, 0.1 ml) contained a total amount of live virus of >10^6.15 Median Cell Culture Infective Dose (CCID50), with >10^5.0 CCID50 poliovirus type 1, >10^5.0 CCID50 poliovirus type 2 and >10^5.5 CCID50 poliovirus type 3.

Primary vaccination with IPV or OPV was administered at 2, 3 and 4 months of age (Studies A and C). Booster vaccination with OPV is not recommended under the Chinese vaccination schedule until 4 years of age. Booster vaccination with IPV was administered at 18–24 months of age in Studies B and D. Children in study D also received combined diphtheria-tetanus-acellular pertussis and Hib vaccine (DTPa/Hib, Infanrix™Hib, GSK Vaccines, Belgium), co-administered at separate sites to IPV in the IPV group, and administered alone to the Control group.

### 2.4. Safety evaluation (all studies)

The occurrence of redness, swelling, pain at the injection site, drowsiness, fever (axillary temperature >37.0 °C), irritability/fussiness and loss of appetite that occurred within four days (day 0–3) after each dose were recorded on diary cards. Symptoms were graded on a 3-point scale where grade 3 (severe) was defined as redness or swelling >30 mm, fever >39.0 °C, ‘cried when limb was moved/spontaneously painful for pain, drowsiness that ‘prevented normal activity’, ‘crying that could not be comforted/prevented normal activity’ for irritability/fussiness, and ‘did not eat at all’ for loss of appetite. The occurrence of gastrointestinal symptoms was additionally solicited in Study C. Grade 3 gastrointestinal symptoms (nausea, vomiting, diarrhoea and/or abdominal pain) were defined as ‘preventing normal activity’.

All other adverse events including events that required medical attention (defined as hospitalisation or an unscheduled visit to/from medical personnel, including emergency room visits) were recorded for each participant for 30 days after each vaccination (31-day follow up). Serious adverse events (SAEs) were captured from the first vaccination until one month after the last study vaccine dose.

### 2.5. Immunogenicity evaluation (Study C and D)

Blood samples were collected from a subset of children (the first 316 vaccinated in each group) before the first dose and one month post-dose 3 in Study C, from all children prior to booster vaccination in Study D, and from all children in the IPV group in Study D one month after the booster dose of IPV.

Serological assays were performed at the Chinese National Institute for Food and Drug Control laboratory in Beijing. Anti-poliovirus type 1, 2 and 3 antibodies were measured using a virus micro-neutralisation test adapted from the WHO Guidelines for WHO/EPI Collaborative Studies on Poliomyelitis [11]. The lowest dilution tested was 1:8. Titres were expressed in terms of the reverse of the 50% inhibitory dose. An antibody titre ≥ 8 was considered seroprotective.

### 3. Statistical analysis

Statistical analyses were performed using SAS® version 9.1 or later on Windows XP Professional, and StatXact-7.0 or later procedure on SAS.

The analyses of safety were performed on the Total vaccinated cohorts, which comprised all children who had received at least one dose of the study vaccine. The analysis of immunogenicity was conducted on the According-to-protocol (ATP) immunogenicity cohort who comprised all eligible children who complied with protocol-defined procedures and for whom data concerning the immunogenicity endpoint measures were available. The ATP persistence cohort in Study D included all children who had completed their full 3-dose primary vaccination course in Study C, who had not received non-study polio vaccination and for whom serological results were available at the persistence time point.

Seroprotection rates with exact 95% confidence intervals (CI) and geometric mean titres (GMTs) with 95% CIs were calculated for each of the three poliovirus antigens at each time point. Antibody titres below the cut-off of the assay were given an arbitrary value of half the cut-off for the purpose of GMT calculation.

One month after dose 3 in Study C, the standardised asymptomatic 95% CIs for the group difference in seroprotection rates (Control group minus IPV group) were computed. As agreed with the Chinese Regulatory Agency, non-inferiority was concluded if the upper limit of the 95% CI on the difference (Control group minus IPV group) in the percentage of seroprotected subjects was <10%.

In exploratory analyses, the 95% CIs for the GMT ratio between groups (Control group over IPV group) for each of the three poliovirus antigens were computed. In Study C the analysis
used an ANCOVA model including the vaccine group as fixed effect and the log-transformed pre-vaccination titre as the co-variable. The ANCOVA model was selected because infants received polio vaccination for the first time, and the ANCOVA method allowed adjustment for potentially variable pre-vaccination titres (‘adjusted GMTs’). In Study D, an ANOVA model on the logarithm transformation of the titres prior to the booster dose was used as all subjects had receive primary vaccination against poliovirus. Potential differences were highlighted if the 95% CI for the GMT ratio between groups did not contain the value ‘1’. Potential differences should be interpreted with caution as no adjustment for multiplicity for these comparisons was accounted for in the planning of the exploratory analyses.

To assess the impact of missing data due to children lost to follow-up on the results of Study D, a sensitivity analysis was performed using a general linear mixed model.

3.1. Sample size

In order to meet Chinese Regulatory guideline requirements for 20 subjects, 25 infants and toddlers were enrolled in the pilot studies (Study A and B).

With 284 children in the ATP immunogenicity cohort of each group in Study C, the study had 91% power to reach the primary objective assuming 90% seroprotection for each poliovirus type in the Control group, with alpha equal to 2.5%. Assuming that approximately 80% of these children participated in the extension study and that 10% would be non-evaluable, the expected 95% CI around a post-booster seroprotection rate of 97.6% in 395 children would be (94.8; 98.4).

4. Results

4.1. Pilot studies

25 children received at least one primary vaccination dose of IPV in Study A, and 25 received a dose of IPV at 18–24 months of age in Study B, after OPV priming according to the Chinese recommended schedule (Fig. 1).

Pain at the injection site was the most frequently reported solicited local symptom after primary vaccination (Study A), reported in 12.0% of children (Fig. 2). Irritability/fussiness was the most frequently reported general symptom (56% of children). After the booster dose (Study B), the most frequently reported solicited local and general symptoms were redness (20.0% of children) and fever (24.0% of children). No grade 3 local or general symptoms were reported in either study.

At least one unsolicited symptom during the 31-day (day 0–30) follow-up period after vaccination was reported in 60% of children in Study A and 40% of children in Study B. No grade 3 unsolicited symptoms and no SAEs were reported in either study.

4.2. Confirmatory studies

There were 1100 children who received primary vaccination with IPV or OPV in Study C. In Study D, a booster dose of IPV was administered to 470 children primed with IPV in Study C (Fig. 1). There were a similar number of males and females in the IPV and Control groups (Table 2).

4.3. Safety

4.3.1. Primary vaccination

Pain at injection site was the most frequently reported solicited local symptom after primary vaccination with IPV, reported in 20.5% of children in Study C (Fig. 2). Grade 3 pain was reported in 0.5% of children and grade 3 redness and swelling in 0.2% of children.

Irritability/fussiness was the most frequently reported solicited general symptom in both groups (44.4% in the IPV group and 39.3% in the Control group) (Fig. 2). The most frequently reported grade 3 symptom in both groups in Study C was irritability, reported in 1.8% and 1.6% of children in the IPV and Control group, respectively. Grade 3 fever was uncommon (0.4% of children in the IPV group and 0.5% in the Control group).

At least one unsolicited symptom during the 31-day (day 0–30) follow-up period after vaccination was reported in 28.2% (155/550) of children in the IPV group and 29.5% (162/550) in the Control group. Grade 3 symptoms were recorded in 0.7% (4/550) of children in the IPV group (bronchitis, nasopharyngitis, upper respiratory tract infection) and 0.5% (3/550) in the Control group (bronchitis, upper respiratory tract infection). None of the grade 3 symptoms were considered by the investigator to be causally related to vaccination. At least one symptom (solicited or unsolicited) that required medical attention was reported in 8.5% (47/550) of children in the IPV group and 8.0% (44/550) of children in the Control group.

12 SAEs were recorded in nine children in Study C: three children in the IPV group (diarrhea, herpes zoster, hydrocephalus) and six children in the Control group (bronchopneumonia, epilepsy, upper respiratory tract infection, bronchitis, enteritis and in one child, bronchopneumonia with abdominal distension, cardiac failure and respiratory failure). There were no fatal events in any study. None of the SAEs were considered by the investigator as causally related to vaccination, and all had resolved by the end of the study.

4.3.2. Booster dose

After the booster IPV dose, the most frequently reported solicited local symptom was pain (10.5%) with a maximum intensity of Grade 1 for 33 (7.1%) subjects (Fig. 2).

With the exception of fever, solicited general symptoms appeared to be reported less frequently after the booster dose than after primary vaccination (Fig. 2). The most frequently reported solicited general symptom after the IPV booster was fever (33.4% of children). Grade 3 fever was reported for eight children (1.7%).

At least one unsolicited symptom during the 31-day (day 0–30) follow-up period after vaccination was reported in 4.7% (22/470) of children in the IPV group. One grade 3 symptom (rash), reported in one child (0.2%), was considered by the investigator to be causally related to vaccination. At least one symptom (solicited or unsolicited) requiring medical attention was recorded in 6.4% (30–470) of children.

No SAEs were reported after booster vaccination with IPV in Study D. One SAE (fever), reported for a child in the Control group, was considered by the investigator as causally related to DTPa/Hib vaccination.

4.4. Immunogenicity

4.4.1. Primary vaccination

Non-inferiority of the immune response elicited by IPV versus Chinese OPV vaccine was demonstrated according to the pre-specified statistical criteria: the upper limit of the standardised asymptotic 95% CI on the group difference for the percentage of seroprotected subjects was <10% for all poliovirus types (Table 3).

One month after the third dose, 100% of children in the IPV group and at least 98.3% in the Control group had seroprotective antibody titres for each poliovirus type (Table 4). The anti-poliovirus GMTs were 30 to 300 times higher than the seroprotection cut-off in the two groups. Exploratory analyses suggested that the anti-poliovirus type 1 and 2 GMTs were higher in the Control group.
than the IPV group, and were higher in the IPV group for poliovirus type 3 (Table 3).

4.4.2. Antibody persistence

At 18–24 months of age the percentage of children with seroprotective antibody titres was at least 94.7% for each poliovirus type in the IPV group, and at least 96.1% in the Control group (Table 4). Exploratory analyses continued to indicate that persisting anti-poliovirus type 1 and 2 GMTs were higher in the Control group than the IPV group, and were higher in the IPV group for poliovirus type 3.

Results of the sensitivity analysis correcting for subjects lost between the primary study and the persistence time point showed that GMT ratios calculated using the model were similar to the observed GMT ratios for all three polioviruses (data not shown), indicating that subjects lost between the primary and the booster study did not affect the conclusions of Study D.

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**Fig. 1.** Study flow. *The parent/legal guardian of one subject withdrew consent before randomisation and vaccination. Note that blood samples were collected from a subset of children in Study C.

**Table 2**

Demographic features of participants.

<table>
<thead>
<tr>
<th>Study</th>
<th>Total vaccinated cohorts</th>
<th>ATP immunogenicity cohorts</th>
<th>ATP persistence cohort</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>N</td>
<td>Age</td>
</tr>
<tr>
<td></td>
<td>IPV group</td>
<td>Enrolled N=25</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Completed N=23</td>
<td>9.6 (1.4) wks</td>
</tr>
<tr>
<td>Study A Primary vaccination with IPV at 2, 3, 4 months</td>
<td>Total vaccinated cohort N=25</td>
<td>25</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Study B Booster vaccination with IPV at 18–24 months in OPV-primed toddlers</td>
<td>Total vaccinated cohort N=25</td>
<td>25</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Study C Primary vaccination with IPV or OPV at 2, 3, 4 months</td>
<td>Total vaccinated cohort N=550</td>
<td>550</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Control group</td>
<td>Total vaccinated cohort N=526</td>
<td>526</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Study D: Vaccination with IPV + DTPa/Hib or DTP/Hib alone at 18–24 months</td>
<td>Total vaccinated cohort N=470</td>
<td>470</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Control group</td>
<td>Total vaccinated cohort N=487</td>
<td>487</td>
<td>Mean (SD)</td>
</tr>
</tbody>
</table>

SD = Standard deviation, ATP = According to protocol, wks = Weeks, mos = Months.
4.4.3. Booster vaccination

One month after the booster vaccination all children in the IPV group had seroprotective antibodies for each poliovirus. Antibody GMT increased by at least 22-fold for each poliovirus, and post-booster GMTs were higher than those observed one month post-primary dose 3.

5. Discussion

Three primary doses of IPV were immunogenic in children vaccinated at 2, 3 and 4 months of age, with responses that were non-inferior to Chinese OPV in terms of seroprotection. The majority of children continued to have seroprotective antibodies for all three poliovirus types at 18–24 months of age, suggesting that IPV induced durable immunity. A booster dose of IPV elicited seroprotection in all subjects, as well as marked increases in GMTs consistent with an immune memory response. We observed lower GMTs, but not seroprotection rates, for poliovirus types 1 and 2 in children who received primary vaccination with IPV compared to OPV. Lower GMTs were also observed following IPV-containing than OPV-primary schedules in a recent study in Chinese infants [12]. Similar trends were observed in studies conducted using other IPV vaccines (alone or in combination) and schedules in other countries including the United States [13]. This difference is likely to be of little clinical importance in view of the high percentages of children who achieved the internationally-accepted seroprotective threshold [14], the large increases in titres observed after the booster dose and because the GMTs are 30 to 300 times the assay cut-off.

IPV was well tolerated with few grade 3 local or general symptoms reported after vaccination. In the controlled Study C, the occurrence of solicited general symptoms appeared to be similar...
in the IPV and OPV groups. The incidence of fever was higher after the booster dose of IPV than after primary vaccination, but grade 3 fever (≥39 °C) was uncommon.

Study C and D provide IPV immunogenicity and safety data in a large cohort of children compared with the recommended Chinese OPV vaccination schedule. A potential limitation of the studies is that safety of an IPV booster after OPV priming was only assessed in a small cohort in pilot Study C, and immunogenicity of an IPV booster after OPV priming was not evaluated. However, the immunogenicity and safety of IPV after OPV is well established, and at least one dose of IPV after OPV priming is recommended by WHO [1].

The current Chinese schedule recommends a booster dose of OPV at 4 years of age. In view of the somewhat lower titres achieved after primary vaccination with IPV compared to OPV, as well as the robust booster responses observed in our study after the 18–24 month IPV booster dose, administration of the IPV booster dose in the second year of life will help to ensure durable immunity against poliovirus in an all-IPV schedule.

IPV has successfully controlled poliomyelitis in countries where its continuous and exclusive use has occurred; such as Iceland, Sweden, Finland and the Netherlands. In the Netherlands and Sweden, importation of wild-virus and occurrence of wild type polio in unvaccinated religious groups has been successfully contained, demonstrating herd effects of IPV [15,16]. Importation of poliovirus type 1 to Israel (a sub-tropical country that has used IPV exclusively since 2005) in 2013 resulted in no cases of poliomyelitis, but evidence of transmission with virus detected from environmental and stool samples [17]. The long-term potential for continued poliovirus transmission in settings of high faecal-oral transmission or in sub-tropical and tropical settings where IPV is implemented exclusively is not known.

The role of IPV in poliovirus control will continue to increase as the world moves towards eradication [18]. This is reflected in WHO guidelines that now recommend at least one IPV dose be administered to all children, and by the growing number of countries transitioning from OPV to an all-IPV schedule [1]. As yet, success of IPV in preventing polio disease and transmission in developing countries and tropical settings has not been demonstrated. The results of four studies in infants and toddlers suggest that IPV is immunogenic with a clinically acceptable safety profile when administered at 2, 3, 4 and 18–24 months of age IPV could feasibly be incorporated into Chinese vaccination schedule with the advantage of eliminating the risk of VAPP and vaccine-derived poliomyelitis outbreaks.

Poliortex and Infanrix are trademarks of the GSK group of companies.
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Conflict of interest statement

MH is a freelancer contracted through Chiltern International, a for-profit company, by GSK to undertake this research. SK, OVM, KH and SR-G are employees of GSK group of companies and OVM and KH declare having GSK stocks. CGL reports having received a grant from GSK for undertaking serum testing as part of this study. Y Li, Y Liu, R–CL, HZ and XC have no conflicts to declare.

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