Strengthening routine immunization in Papua New Guinea: implications for post-polio renewal from a cross-sectional provincial assessment of front-line services

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Abstract

Background

Routine immunization programs face challenges in settings such as Papua New Guinea: dispersed rural populations, rugged geography, and limited resources for transport and health. Low routine coverage contributes to outbreaks such as measles and the polio that re-appeared in 2018. Diversion of resources to the necessary emergency response can risk further weakening of the routine system. We report on an in-depth local assessment that documented immunization service provision so as to review new national strategy, and consider how emergency polio responses could simultaneously strengthen routine immunization.

Methods

In East New Britain Province, over 2016 and 17, we carried out a cross-sectional assessment of 12 rural health facilities, staff and clients. The study was timed to follow implementation of a new national strategy for strengthening routine immunization. We used interview, structured observation, and records review, informed by theory-based evaluation, a World Health Organization quality checklist, and other health services research tools.

Results

We documented strengths and weaknesses across six categories of program performance relevant to national immunization strategy and global standards. We found a functional immunization service with an operational level of staff, equipment and procedures in place; but one that could reach only half to two thirds of its target population. Stronger routine services require improvement in: understanding of population catchments, tracking the unvaccinated, reach and efficiency of outreach visits, staff knowledge of vaccination at birth and beyond the first year of life, handling of multi-dose vials, and
engagement of community members. Many local suggestions to enhance national plans, including more reliable on-demand services, integration of other family health services and increased involvement of men.

Conclusions
The national strategy addresses most local gaps, but implementation and resourcing was insufficient. Emergency polio campaigns could support a stronger routine program by building local planning capacity, identifying new outreach sites, sharing intelligence on local population characteristics, integrating high-demand services and other vaccines, distributing educational materials, and modelling better involvement of trained lay health workers. Long-term strengthening requires a major increase in centrally-allocated resources, however there are immediate locally feasible steps within current resources that could boost coverage and quality of routine immunization.

Introduction

Stronger routine immunization programs are critical to the ambitious Global Vaccine Action Plan (2011-2020), however immunization coverage is not increasing as planned in many difficult settings challenged by expanding childhood cohorts, population displacement by conflict or natural disasters, and limited resources to overcome geographical and infrastructural challenges\(^1,2\). With the outbreak of polio in 2018, Papua New Guinea (PNG)’s immunization program faces the question familiar to fragile systems enduring a crisis, that is: how to manage a major, rapid emergency response while also planning for long-term strengthening of a program that has shown no increase in coverage over the past 15 years. The World Health Organization (WHO) and United Nations Children’s Fund (UNICEF) estimated PNG’s 2017 coverage at 62% for both the third dose of
diphtheria-tetanus-pertussis-containing vaccine (DTP3) and the first dose of measles-containing vaccine (MCV1), and at 60% for the third dose of oral polio vaccine\(^3\), contrasting with Western Pacific Regional averages of 97%\(^4\) for these antigens.

Measles, having been suppressed by regular supplementary immunization activities (SIAs) for eight years, returned to PNG in a major outbreak in 2014, and polio, after a twenty year hiatus, returned in 2018\(^5\). In that year, PNG was one of five countries experiencing outbreaks of circulating vaccine-derived poliovirus disease\(^6,7\), the rare mutated form that results from chronic under-immunization with the oral polio vaccine. This has required one of PNG’s largest public health emergency responses, led by the national government with support from Global Polio Eradication Initiative and other development partners\(^8\). In the short-term, the response entails repeated SIAs, with longer term plans for program reform, recognizing that it is sustained gaps in routine immunization services that are the primary cause of this form of polio\(^7\).

PNG had in 2015 introduced a strategy to improve routine immunization and reduce reliance on SIAs, termed the Special Integrated Routine EPI Strengthening Program (SIREP)\(^9,10\). This sought to improve program performance amidst the major challenges facing PNG’s health services such as a stretched health workforce, financial constraints, and dispersed rural populations with minimal road access\(^11\). SIREP developed four priorities: more efficient local planning based on locations of child populations, quarterly intensification of outreach services, improved local information systems (including child health books), and staff training to support new vaccine introductions (most prominently Inactivated Polio Vaccine (IPV) as well as pneumococcal and rubella vaccines). SIREP also aimed to integrate other care with vaccination, starting with distribution of age-targeted
vitamin A and anti-helminthic doses of albendazole\textsuperscript{12}. SIREP attempted to merge the program intensification often seen in emergency campaigns\textsuperscript{12} with internationally proven strategies for routine programming, such as those collated by WHO in “Reaching Every District (or Community)”\textsuperscript{13} approaches and the Global Routine Immunization Strategies and Practices framework\textsuperscript{14}. Our study used these innovations as a frame to investigate how routine immunization in PNG might be improved. We report on a detailed local assessment of routine immunization undertaken shortly before the polio outbreak, so as to discuss pathways to improvement, and how an emergency response to polio could contribute. This assessment aimed to interrogate local strengths and weaknesses in routine immunization, test whether the SIREP strategy was addressing these, and distinguish problems amenable to local change from those requiring central system reform.

Methods

\textit{Study concept and aims}

Our conceptual framework recognizes that, for coverage to increase, strategies to strengthen health system elements must ultimately enable changes in service delivery and uptake. Accordingly, this research focused on modifiable aspects of front-line services (see Figure 1).

[Figure 1 about here]

Study objectives were to measure current infrastructure, equipment and supplies for preventive care in infancy; assess what health workers know, think and do in relation to providing postnatal and infancy services; assess health workers’ responses to SIREP and
other initiatives; and identify opportunities for health system strengthening and improved quality of care.

**Study setting and timing**

Our study setting was East New Britain province (ENBP), part of a large island in PNG’s north-east, whose population (approximately 393,000) live in small towns and rural villages in highland and coastal topographies. Immunization is usually provided through urban clinics, small rural health centres, scheduled outreach to community sites, and hospital children’s outpatients. ENBP performs relatively better than other PNG provinces on some indicators (such as skilled attendance at childbirth), but immunization is similar to national estimates with 60% of children receiving DTP3 and 48% MCV1 in 2016. Our research was nested within a long-term multi-partner research initiative in ENBP termed Healthy Mothers Healthy Babies (HMHB) that examines broader issues of women’s and children’s health.

We carried out a cross-sectional assessment of health facilities, staff and clients from November 2016 to January 2017, timed to follow the initial rounds of SIREP training and implementation. Sites surveyed comprised 12 clinics providing immunization services, nine in fixed facilities and three community outreach sites; purposefully chosen as they are all linked to the health institutions providing approximately 80% of maternal and child health care in ENBP.

**Data collection tools and ethical considerations**

Table 1 summarises the mix of interview, focus group discussion, structured observation and records audit. All tools incorporated items testing core elements of the SIREP strategy, PNG’s national immunization plans and WHO standards for program monitoring, refined through consultation with national and provincial health managers.
We also adapted WHO’s 2015 Immunization Session Checklist\textsuperscript{17} into a structured observation tool, and used concepts from realist evaluation to deepen interview questions with probes seeking respondents’ views on context and mechanisms of change.

[Table 1 about here]

Data collection was carried out by trained local research officers using electronic tablets supplemented by paper-based note-taking. The research team included policy-makers and managers at national and provincial levels; however these investigators were excluded from front-line data collection or initial analyses, to avoid bias. Research officers were trained in qualitative data collection, including techniques to minimise social acceptability bias, and to assess and counter perceived power imbalance between themselves and interview subjects. All free-text interview responses were recorded verbatim, focus group discussions were documented by a dedicated note taker, and both were digitally recorded for cross-checking. Interviews were conducted in English and focus group discussions in Tok Pisin; both official languages of PNG.

	extit{Analysis}

Quantitative measures were reported as proportions with no further statistical manipulation, respecting the purposeful sampling in our design. Thematic analysis of qualitative data was carried out by the first author (after translation of focus group discussion data), then validated by three other investigators (including two Tok Pisin speakers). After coding for themes predetermined in our conceptual framework and design, data were re-examined for emergent themes. In 2017, for critique and validation, a detailed data report was provided to all investigators and a summary provided to national and provincial stakeholders; this also allowed early dissemination of policy implications. Following the polio outbreak in 2018, the data were re-examined for relevance to the emergency polio response, as reported here. Supplementary materials
are available detailing tables of all themes derived from interview and focus group discussions, and data structure for the observational tool.

Results

Key findings from all data sources are summarised under six categories (Table 2) that combine priorities addressed by the national SIREP strategy\(^5,11\), WHO program advice\(^17\) and the results of our thematic analysis. Findings were also categorised as either local strengths or areas needing improvement, with decisions on this allocation being made by the research team. A comprehensive table of findings and themes is available as Supplementary Material, Tables 1 and 2.

[Table 2 about here]

*Local service planning, infrastructure, supplies and staffing*

Findings demonstrated that services were largely provided as planned from static clinics and some outreach sites (Table 2). Several key aspects of SIREP were not yet implemented; there was limited intensification of outreach, no selective targeting of population concentrations, and minimal systems for tracking and finding under-vaccinated children. Infrastructure and supplies review showed a functional level of infrastructure, equipment and supplies across almost all operating clinics. New vaccines were being deployed in keeping with the SIREP strategy and, reassuringly, no expired or discontinued vaccines (such as trivalent oral polio vaccine) were found. However there were important unmet needs for renovation, equipment renewal, improved temperature monitoring, and availability of guidance documents. A significant gap was the absence of equipment to manage severe adverse events following immunization (AEFI). Overall staffing was within
WHO global standards for workload (30 vaccinees per staff member\textsuperscript{17}) at current levels of operation, noting a number of clinics with relatively few patients (25% seeing three or fewer).

*Staff knowledge and service delivery practices*

Interviews (Table 2) showed some staff recognising SIREP objectives, many staff understanding the essentials of safe and effective vaccination, and all staff reporting recent refresher training. Important knowledge gaps related to vaccines given at birth or in the second year of life, the links between vaccination and disease control, and proper handling of liquid multi-dose vials (with the risk that usable vials would be unnecessarily discarded). Structured observations tracking staff-patient interactions for 15 patients and applying the WHO Immunization Session Checklist to 11 immunization sessions (Figure 2) demonstrated that while most staff provided a clean and effective vaccination injection, there were gaps in provision of education, counselling of families, AEFI readiness, and the checking of vaccines for heat or freezing damage. Several missed opportunities for vaccination were noted, as listed in Table 2.

[Figure 2 about here]

Most staff at interview reported integration of other services with immunization (Table 2) as important, but observation found limited practice. Although national guidelines recommend integrated care for all infants\textsuperscript{18}, it was observed that: child illness care was provided alongside vaccination for approximately 50% of infants; while most infants were weighed, counseling on feeding or growth was uncommon; vitamin A and albendazole was distributed less often than scheduled; and no instances of integrating care for the mother were seen. Staff reported lack of time and personnel as the most important constraints.

*Community engagement*
As listed in Table 2, community engagement activities consisted of group education talks at 25% of clinics, but without use of pictorial, video, participatory, or take-home communication products. Local communities donated in-kind support to some clinics, but there was no structured engagement, nor use of trained community health volunteers. Small fees (generally between USD 0.3-1.0) for attendance, but not for specific vaccines, were seen in one third of clinics, but were not reported as a major barrier to access. Male parents or care-givers were rarely involved in immunization visits. Community members reported lack of support from family members as an occasional barrier to vaccination.

Locally generated ideas for improvement

All participants (staff in interviews and community members in discussions), when prompted were able to describe local strengths or suggest improvements. Common ideas proposed by staff included more personnel, stronger support for transport needed to do outreach, better community engagement, more active community education, involvement of male parents or care-givers, and offering desirable extra services for both mother and baby. When asked to rank priorities, staff rated reliable vaccine supply and renewal of equipment and infrastructure as more important than staff numbers or staff knowledge. Care-givers sought more frequent, reliable and 'on-demand' services, especially outreach, noting travel time and costs as a common barrier to uptake. Mothers, more often than staff, asked for the addition of family planning, promotion of reproductive health, and maternal illness care at immunization clinics.

Discussion

Our findings depict a functional immunization service with an operational level of staff, equipment and procedures in place; but one that reaches just half to two thirds of its target population. The service strengths are similar to, or better than, many other sites in
PNG\textsuperscript{10}, and the service deficiencies are similar to those identified for other low- or middle-income settings\textsuperscript{1}. These findings point to a range of immediate opportunities to improve coverage and strengthen local service quality. We discuss these below and, in Table 3, synthesise them into ten actions, and note how an emergency polio response could potentially contribute to routine services. Table 3 also notes these actions’ relationship to PNG’s SIREP strategy; six of the ten proposed actions were embedded in the SIREP strategy, but insufficiently resourced or implemented in our study setting, while four actions go beyond the strategy.

[Table 3 about here]

\textit{Options for short-term improvements in existing services}

Within current resources, improvements in coverage should be achievable with a fuller implementation of the changes to local service planning envisaged in the SIREP strategy. This recognises that many clinics see few clients (25\% with 3 or less), and the fact that most planning is not yet tuned to where most children live. Other persisting gaps in knowledge and capacity that were prime targets of the SIREP strategy include improving catchment population data, increased frequency of service availability, a greater number of outreach points, and quarterly intensification of outreach. Change through improved local planning to reinvigorate outreach has proven successful in settings in Africa and Asia\textsuperscript{13} that share similar burdens of disease and health system constraints to PNG. In past programmatic research in PNG, alongside the country’s national coverage survey in 2004\textsuperscript{19} similar potential gains were identified. Reinforcement of SIREP training, already well recognised by front-line staff, appears a helpful starting point, but with a stronger commitment of resources to enable more outreach services. Such changes also meet many of the highest priorities expressed by family members in our study.
Our findings also indicate opportunities for increased community engagement and mobilisation; through increased group and individual counselling in the vaccination encounter and the creation and provision attractive, durable, “take-home” information products, aiming to build community demand for a timely, complete schedule of vaccination. Outreach can benefit from stronger, formalised involvement of local leadership, possibly with the deployment of trained lay health workers; such community resources can also help register and track children needing vaccination. Improved session practices, including ensuring managerial and stock support to enable staff to open multi-dose vials even for one child; and the institution of AEFI equipment and periods of observation (which also allows time for education). This mix of enhanced community engagement plus improved local planning has driven routine immunization improvements in difficult settings in sub-Saharan Africa\textsuperscript{20,21}, and vaccination support by trained lay health workers, termed “Village Health Volunteers” in PNG, has been proven in this country in the past\textsuperscript{22}.

\textit{Implications for the polio emergency response, and SIAs generally}

As noted in Table 3, an emergency polio response campaign could include actions to strengthen routine immunization. Internationally, the “micro-planning” used in polio and measles campaigns can inform local service planning\textsuperscript{13}; this was flagged in SIREP but not fully implemented, and planned sharing of campaign coordination staff and systems to support local managers will help catalyse change. Campaign records, if documented with a routine program perspective, could identify new outreach sites, map childhood populations to rebuild local clinic registers and catchment descriptions, and set benchmarks for sustainable, practical transport costs. Perhaps most importantly, the emergency response can begin to address a key gap in community engagement in the way
it carries out community mobilisation; to establish an expectation among local leaders and trained health volunteers that the need for their support extends beyond the polio response to the continuing routine program.

In 2018 campaigns focused solely on control of the polio outbreak; however, in 2019 more integrated campaigns may be feasible, with immediate support to broader immunization efforts by delivering additional vaccines (especially measles/rubella). Other practical support could address the planning and information gaps noted in our study, by distributing Child Health Record Books, staff immunization manuals, and other key knowledge resources needed by the routine program.

One concern is that the 2018 cycle of emergency polio campaigns may re-awaken fears that SIAs generate perverse incentives whereby health staff provide immunization when crisis-driven subsidies are available. Prior to 2018 there had been waning political and managerial commitment to the regular SIAs that had been essential to disease control in PNG. In reality, our interview data did not find any evidence of such perverse incentives in operation. Moreover, there is global evidence, especially for measles/rubella SIAs, that they can boost routine programs; but only if they accommodate the needs of routine immunization in the way they harmonise their planning, invest in suitably generic equipment, share staff and intelligence, use broadly supportive communications, and minimise unsustainable monetary incentives. The degree to which the polio response met these ideals in PNG should be a key element of their evaluations and provide new thinking on how the regular SIAs that PNG will require in the medium-term could best interact with the long-term need for far stronger routine programs. PNG’s past experience with SIAs suggest they had most success when they maximised district-level control of timing and operations, and of which package of services to integrate.
**Longer-term issues**

It is clear that changes limited to the front-line are insufficient and central reforms of management, a country-led technical advisory group, procurement and financing, and national re-equipping are also needed and have been repeatedly advised\(^{10,11,26}\); these were largely beyond the scope of our research. Our findings do illuminate the need for new thinking on the immunization workforce; in interviews staff consistently mentioned lack of personnel as an important constraint on extending outreach or integrating new services, in contrast to our observations that staffing was more than adequate for the clinics actually operating. Expanding services will eventually require an expanded cadre of vaccinators, but prior to that our findings suggest a need to expand immunization responsibilities among existing staff, in pursuit of greater efficiency. This could be coupled with the reestablishment of commitment to the national immunization program goals across all staff levels, as one contribution to a revitalisation of immunization professionalism.

One aspiration of the SIREP strategy, and of global immunization programs\(^{27}\), is the greater integration of other services with vaccination; seen to a limited degree in our study by the distribution of vitamin A or albendazole. Our community discussion findings reflect a demand for integration that goes beyond this, prioritising relatively complex services such as maternal illness care, or family planning counselling and provision. These require time and skill that seem difficult within current staffing and infrastructure limits that we have mapped, and would seem to need an integration strategy such as service co-location rather than simply adding tasks to current vaccinators. Testing models to address maternal as well as infant needs through routine contacts in the first year after childbirth, appears profitable and important. If integrated service provision prioritises care that
families want, this may help build demand for and confidence in immunization services, as well as meeting their felt needs.

Limitations and strengths

Our sample was restricted to functioning services and families who were willing and able to use those services so our study primarily relates to improving outcomes within existing services. Our data collection took place over the fourth and first quarters of the year, when wet weather events could bias perceptions of access. Despite careful training in unobtrusive observation and non-leading interviewing, there may be some observer effect and/or social acceptability bias affecting the validity of our findings. Study strengths include the assessment of a representative sample of functioning services, as well as the use of a broad mix of methods and attempt at more detailed interviewing than is the norm in previous service evaluations.

Conclusions

Our assessment of front-line immunization services in rural PNG found opportunities to boost coverage and quality, even within current resources, especially through better population-based local planning, and stronger community engagement. Many, but not all, were contained in PNG’s recent national strategy (SIREP) for routine program strengthening; however there was insufficient resourcing of and commitment to this approach. The 2018 polio outbreak, a product of sustained low routine vaccination coverage, presents a major interruption to program strengthening efforts. We have identified a number of ways that an emergency polio response can contribute to routine immunization services.

List Of Abbreviations

AEFI, adverse events following immunization; DTP3, diphtheria-tetanus-pertussis-containing vaccine third dose; ENBP, East New Britain Province; EPI, Expanded Programme
on Immunization; HMHB, Healthy Mothers Healthy Babies research program; IPV, inactivated polio vaccine; MCV, measles-containing vaccine; PNG, Independent State of Papua New Guinea; SIA, supplementary immunization activity; SIREP, Special Integrated Routine EPI Program; UNICEF, United Nations Children’s Fund; USD, United States dollar; WHO, World Health Organization.

Declarations

Ethics approval and consent to participate

All participants provided written informed consent, with measures taken to ensure confidentiality. The study was approved by the PNG Institute of Medical Research Institutional Review Board (IRB: 1603), the PNG Medical Research Advisory Committee (MRAC: 16.22), the East New Britain Provincial Government (PEC: 12/2016), and The Alfred Hospital Ethics Committee, Melbourne (333/16).

Consent for publication

Not applicable.

Availability of data and material

Summary tables of qualitative findings by thematic coding are provided available as supplementary material. Additional datasets used for the current study are available from the corresponding author on reasonable request.

Competing interests

One author (MSR) provided technical advice to SIREP as part of employment with WHO.

Other authors declare no competing interests.

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Authors' contributions

CJM conceived and designed the study, oversaw data collection, led analysis and interpretation, and led the preparation of the manuscript. JGB, MJLS and OPMS provided major contributions to study design. CJM, OPMS, EP, PM, and LA undertook data collection. OPMS, NL, EP, PM, LA, MJLS, MSR, LMV, BAMcP and JGB contributed to study design, analysis, interpretation, and the preparation of the manuscript. All authors reviewed and approved the final version of the manuscript.

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Tables

Table 1: Data collection, respondents and tools

| Study subjects                      | Number | Details | Tools                                                                 |
|-------------------------------------|--------|---------|----------------------------------------------------------------------|
| Primary health care staff           | 6      | Health Extension Officer or Specialised Nursing Officer | Semi-structured interviews (mix of quantitative and qualitative fields) |
|                                     |        | 6       | Nursing officers                                                     |                                                                      |
|                                     |        | 6       | Community Health Worker (CHW)                                        |                                                                      |
| Family members                      | 67     | Caregivers of infants being vaccinated, 66 female 1 male | Focus group discussion (10 groups)                                  |
| Health clinics and their operations | 9      | Child or family health clinic, static                        | Audit of infrastructure and equipment                                |
|                                     |        | 3       | Mobile child health clinics (run by staff from the above sites)      | Observation of general clinic procedures (12 sites)                  |
|                                     |        |         |                                                                     | Observation using WHO Immunization Session Checklist (11 sessions)  |
|                                     |        |         |                                                                     | Observation of patient flow and staff-patient interactions (15 patients) |
Table 2: Key findings, categorised by study themes, encompassing SIREP and WHO

**program improvement priorities**

| Strengths in local systems | Opportunities for imp |
|----------------------------|-----------------------|
| **Local service planning and delivery**<br>Data sources: interview and audit | - Recent innovations recognised by most (14/18) staff: new vaccines or planning, with one mention of new quarterly outreach increasing efficiency<br>- Recent in-service training in SIREP reported by many (11/18) staff<br>- Static services available 5 days per week<br>- All clinics tallied vaccinations to report into national health information system<br>- 82% of clinics conducted as planned (annual total of 109 implemented of 133 planned) | - Outreach was lir areas<br>- Outreach planii population basis<br>- Many clinics with<br>- Estimation of co: only one clinic d<br>- No clinics with li: <br>- Local reasons fo of funds |
| **Infrastructure and supplies**<br>Data sources: interview, audit and observation | - Most clinics had road access, with two outreach clinics on walking trails<br>- Water supply in nine (of 12) clinics and electricity in eight (of 9) static sites<br>- Functional injection equipment, safety boxes and weight scales in all clinics<br>- 10 (of 12) clinics with appropriate, functioning cold chain equipment<br>- Supplies of all relevant vaccines (including IPV and PCV) and injection equipment present<br>- No expired or discontinued vaccines found | - Eight (of 12) clin<br>- No clinics with k<br>- Cold storage mo<br>- Half the clinics h vaccinated, non-<br>- Recording forms<br>- Lack of importar child health star |
| **Staff knowledge and staff practice during immunization sessions**<br>Data sources: interview and observation | - More than half of staff could correctly cite recently introduced vaccines (11/18) and handling of lyophilised multi-dose vials (15/18)<br>- Twenty staff (nurses and CHWs) across 12 clinics, vaccinating mean of 17 children per clinic falls below WHO maximums (30 per staff member);<br>- Core interactions (weight, screening and vaccination) done for 14 of 15 observed patients<br>- Observation against WHO session checklist (Figure 2) shows key elements of safe injection in over 80% sessions | - Less than half of target (3/18), st of liquid multi-di<br>- Some important for just two of 1st<br>- Waiting times in interaction (IQ<br>- Observation aga vaccines, client |
| **Missed opportunities for vaccination**<br>Data sources: interview, audit and observation | - Most staff (13/18) stated they would open a multi-dose vial for just one patient | - Due vaccination: <br>- Reasons for mis: vaccination, or ( <br>- Two (of 15) obse<br>- Thirteen (of 17 r time for vaccina |
| **Integration of other services**<br>Data source: interview and observation | - All staff noted a policy of integrating other care and vaccination<br>- Nine (of 18) staff cited at least one other care (usually childhood illness) regularly integrated<br>- Child illness care available in nine (of 12) clinics<br>- Child illness care accompanied vaccination in seven (of 15) observed patients<br>- Weight measured in all observed patients | - Four (of 18) staff<br>- Three clinics of vaccination<br>- No observation clo<br>- Three (of 15) pa receive albenda<br>- No observations <br>- Staff reported in |
| **Community engagement and family viewpoints**<br>Data sources: interview, observation and focus group discussion | - Three (of 12) clinics provided verbal group health education alongside vaccination sessions<br>- Three (of 18) staff reported support (for example food) provided by local communities<br>- No fees for vaccines reported or observed and families did not report fees as barrier to vaccination | - No reported use mobilization or €<br>- Six (of 12) clinic: <br>- Many families (6 timely attendan<br>- Many families (6 reliable clinic tin<br>- Some families (4 <br>- No male family r on male involve |
Notes: SIREP = Special Integrated Routine EPI Strengthening Program, IPV = inactivated polio virus vaccine, PCV = pneumococcal vaccine, MR = measles-rubella combination vaccine, IQR = Interquartile range

Table 3: Local actions to improve coverage or quality, and potential contribution of emergency polio responses, in rural Papua New Guinea

| Local actions                                                                 | Potential contribution of an emergency polio response                                                                 |
|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
| Local planning based on populations rather than geography*                    | Campaign coordinators help boost local routine planning capacity  
Map child populations and data-sharing                                         |
| Intensified quarterly outreach focused on higher clinic numbers properly resourced and implemented* | Identify new outreach points, especially with population clusters  
Clarify options and costs for transport                                         |
| System for tracking unvaccinated children*                                    | Mapping child populations and data-sharing                                                                            |
| Integrated SIAs with additional vaccines, matching local priorities*          | Involve district level in planning  
Local flexibility in an expanded package of campaign services              |
| Supportive supervision linked to refresher training including good communications and AEFIs * | Distribute resources to staff  
Use campaign monitoring to collect staff priorities for capacity development |
| Standardise every opportunity for vaccination, by policy, training and accessibility of vaccine supplies** | Not easily addressed by the polio emergency response                                                                     |
| Health communication products and programs to educate families on the complete vaccine schedule** | Distribute family-oriented communications material promoting catch-up vaccination                                     |
| Trained lay health workers (health volunteers) to track births and children, support outreach clinics and promote uptake at static clinics* | Campaign organisation that promotes local involvement  
Leverage campaign supports to enlist long-term interest and support            |
| Test models of integrated services, responsive to community preferences**     | Not easily addressed by the polio emergency response                                                                     |
| Review of staff roles and functions to optimise allocations and workload**    | Minimise incentives that discourage outreach as part of routine programs                                                 |

Note: *Actions already embedded in PNG’s SIREP strategy for strengthening routine immunization, **Actions going beyond the SIREP strategy. SIA, Supplementary Immunization Activity. AEFI, Adverse Event Following Immunization.

Figures
Figure 1

Conceptual model for researching changes to front-line service delivery
Health worker practices assessed against the WHO Immunization Session Checklist. Note: Structured observation of 11 immunization sessions, using the 2015 WHO Immunization Session Checklist17, which aims to avoid the most common programmatic errors reported by senior immunization managers in a WHO consultation. VVM = vaccine vial monitor, AD = Autodisable, BF = Breast-feeding

Supplementary Files

This is a list of supplementary files associated with the primary manuscript. Click to download.

Supplementary material.docx