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Polio Eradication and Health Systems in Karachi: Vaccine Refusals in Context

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ABSTRACT

Community and health worker engagement will be key to polio eradication in Karachi, Pakistan. In this study, the authors conducted participant observation, interviews, and a document review in SITE Town, Karachi, an area that in recent years has harbored poliovirus. SITE's diverse population includes large numbers of internally displaced persons who are disproportionately affected by polio and are more likely than other populations to refuse the polio vaccine. Vaccine acceptance and worker motivation in SITE Town were shaped by the discrepancy in funding and attention for polio eradication campaigns as compared with routine services. Parental vaccine refusals stemmed from a distrust of government and international actors that provided few services but administered polio vaccine door-to-door every month. Addressing this discrepancy could therefore be key to eliminating polio. The authors suggest short-term improvements to routine immunization and sanitation in key polio endemic areas, coupled with a long-term focus on sustainable improvements to routine immunization and broader health services.

The Global Polio Eradication Initiative (GPEI) has made remarkable progress in recent years. After the elimination of wild polio from India and Nigeria, there were only 106 cases of polio globally in 2015, the lowest in history. Achieving eradication now depends primarily on stopping transmission in the two remaining endemic countries, Pakistan and Afghanistan.

In Pakistan, recent improvements in operations and access led to a reduction in polio cases, from 328 wild and circulating vaccine-derived polio cases in 2014 to 55 in 2015. Yet, polio transmission stubbornly persists. Both vaccine refusals and operational issues contribute to immunity gaps in polio-endemic areas of the country (GPEI, 2015a; Independent Monitoring Board of the GPEI, 2015; SteelFisher et al., 2015). Stopping polio in Pakistan will likely require improving vaccine acceptance by parents and further motivating polio workers to seek out and vaccinate every child.

This article explores community and health worker engagement in polio eradication in Karachi. Drawing on research conducted in early 2012, we focus on SITE Town, an area that in recent years has harbored poliovirus (Table 1). Our aim is not to evaluate the effectiveness of the polio program but rather to qualitatively describe some challenges workers faced and explore why some parents refused polio vaccine. In SITE, vaccine acceptance and worker motivation were shaped by the discrepancy in funding and attention for polio eradication campaigns as compared with routine services. Addressing this discrepancy could therefore be key to eliminating polio.

SITE Town, Karachi

SITE is one of 18 towns that make up Karachi, a megacity of more than 20 million people in the province of Sindh (Figure 1). Named after the Sindh Industrial and Trading Estate, SITE was initially populated by industrial workers from across Pakistan. Now, SITE is also home to large numbers of internally displaced persons (IDPs) escaping military action. Most are ethnic Pashtuns from the Federally Administered Tribal Areas and Khyber-Pakhtunkhwa in Northwestern Pakistan.

These IDPs have had a chilly reception in Karachi. Major news outlets in the country fretted about the “influx of terrorists in the form of IDPs” (“Tight security on Sindh

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Table 1. Confirmed Cases of Wild Polio (WPV) in Karachi, 2011–2015.

Year	Polio cases in SITE town	Polio cases in Karachi
2011	2	9
2012	0	0
2013	0	8
2014	2	21
2015	0	7

Note: Although there were no confirmed cases in 2012, environmental surveillance picked up wild poliovirus in Karachi’s sewage in that year (Kazi, Murtaza, Khoja, Zaidi, & Ali, 2014).

borders to stop terrorists disguised as IDPs,” 2014). In 2014, the government of Sindh briefly made plans to block all IDPs from entering the province and then started a registration program; many IDPs experienced police harassment as well as discrimination in places such as hospitals (“IDPs under pressure in Pakistan’s Sindh Province,” 2014; “IDPs won’t be allowed into Sindh,” 2014; Khattak, 2013).

In a recent study, children in Karachi had lower rates of seroprotection against poliovirus than children in other parts of the country (Habib et al., 2013). The GPEI recently characterized its progress in Karachi as “volatile”: in evaluations of 2015’s campaigns, between 20% and 60% of sampled

areas failed to clear expected bars of quality (GPEI, 2015a). Within Karachi, IDPs are disproportionately affected by polio and are more likely than members of other populations to refuse polio vaccine.

Methods

The research described here, conducted in early 2012 with a brief follow-up in 2015, was part of a larger study examining the impact of polio eradication activities on health systems in a variety of contexts (Closser et al., 2012, 2014). The study protocol was approved by the Middlebury College Institutional Review Board. Our methodology included document review, interviews, and participant observation:

1. We collected documents about polio eradication, routine immunization (RI), and broader health services from a variety of sources in Karachi and Islamabad. Some were specific to SITE Town, while others described provincial and federal policy.
2. We conducted more than 40 semi-structured interviews in seven of SITE Town’s nine union councils and in government and United Nations offices in Islamabad. Interviewees came from a variety of levels of the health system, from community members to lady health workers (LHWs) to city- and national-level officials (Table 2).
3. We conducted participant observation in a polio campaign; in RI and other health activities; and at policy meetings in Karachi and Islamabad. We took detailed field notes.

We analyzed these data using NVivo software, using more than 50 codes to identify relevant themes. For this article, we focused on codes relating to community and health worker satisfaction with polio campaigns and with the broader health system.

Given that most of the information we draw on here is from just one part of Karachi and is about 4 years old, these findings should be interpreted not as a current description of dynamics across Pakistan, but as a snapshot

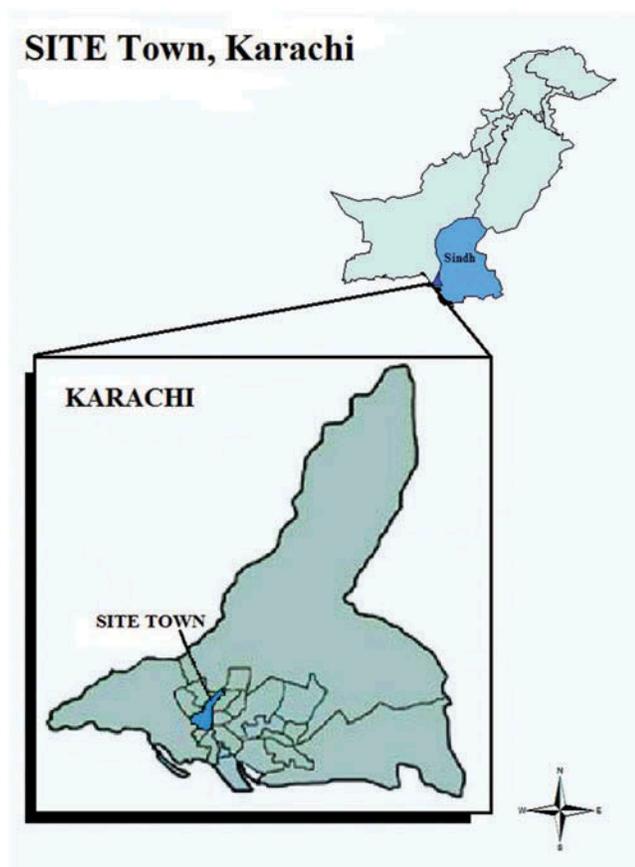


Figure 1. SITE Town, the study area in Karachi, Pakistan.

Table 2. Study Interviewees

Position	No. of interviewees (n)
Government, UNICEF, and WHO officials in Islamabad	4
Government, UNICEF, and WHO officials in Karachi	6
Medical officers (doctors) in SITE town	7
Vaccinators	7
Pharmacists	1
Lady health supervisors	4
Lady health workers	8
Employees hired only for polio	2
Parents of children targeted by polio campaign	5

in a particular time and place. Analyses rooted in the complexities of one particular context can effectively tease apart the factors underlying such complex phenomena as worker motivation and vaccine refusals. This approach was designed to maximize the validity of our findings (Bernard, 2011), with the associated limitation being that they may not be widely generalizable. That said, a broader analysis of vaccine refusals across multiple countries shows that dynamics similar to the ones described here underlie oral polio vaccine (OPV) refusal in a variety of contexts (Closser et al., 2016).

Working in SITE Town's Health System

The polio program is one of many health promotion activities that Ministry of Health staff members implement. The government health system in SITE includes tertiary hospitals; health centers providing immunizations and other basic services; and a network of LHWs tasked with providing essential maternal and child health in the community, including family planning and management of common diseases such as diarrhea. This broader context of health work is the backdrop to workers' attitudes toward the polio program.

Many ground-level staff spoke of deep commitment to their work. After her daughter died from measles, one respondent became a LHW to ensure that this did not happen to other children. Another worker added, "It is my job, but it is also a way for me to help people and friends in my community."

Yet, a number of challenges made it hard to provide high coverage of health services such as RI. In the 2012–2013 Demographic and Health Survey, survey, only 52% of children in urban Sindh were fully immunized. In Karachi specifically, around 40% of children were fully immunized with the third dose of the diphtheria-tetanus-pertussis vaccine (DTP3) in the Pakistan Social and Living Standards Measurement (PSLM) survey (Figure 2).

One major challenge in SITE was a severe shortage of staff, from doctors to LHWs. A town-level official explained that although LHWs were critical to providing essential interventions, "we do not have that many of them. The requirement of LHWs that we have, government is not supporting it." In 2015, an official explained that although there were 22 routine immunization centers in SITE Town, there were only 13 vaccinators posted to fill them—a number clearly insufficient to reach the needs of a population of close to a million.

LHWs also mentioned medication stockouts as a challenge, noting that shortages frustrated their patients. One explained, "Every six months we get 4 boxes of paracetamol... but I serve a population of 1000 in more than 150 households." Another said, "The medicine comes late. People demand more medicine when we do not have it." They also mentioned the need to improve physical infrastructure; many facilities were visibly crumbling.

ROUTINE IMMUNIZATION: 2010

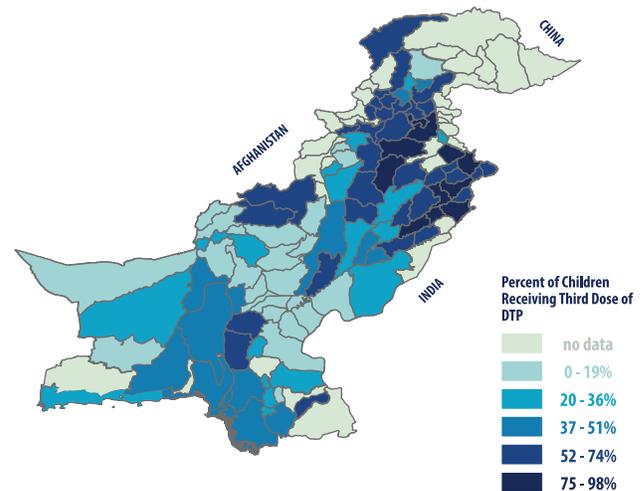


Figure 2. Routine immunization coverage nationally in 2010, reflecting the situation just prior to our field research. Coverage rates of DTP3 in Karachi in this survey, the PSLM, were around 40%. A different measure of immunization coverage, taken from nonpolio acute flaccid paralysis data on routine doses of oral polio vaccine, suggested that about 60% of children in Karachi were fully vaccinated. National coverage numbers in the PSLM have increased slightly since then, while other coverage estimates (see <http://www.gavi.org/country/pakistan/>) show flat or slightly decreasing coverage. See Figure 1 for the location of our study.

Low levels of national funding, combined with weak accountability at the provincial level, are problems across Sindh (Nishtar et al., 2013). One city-level official ascribed weaknesses in governance to the complex political situation in Karachi:

The MQM [a political party] controls Karachi and the PPP [another political party] controls interior Sindh. So they don't support or work together, but these health problems are big and have to be handled by the government, not bit by bit through other agencies. There are many Pakistani groups who would help, but they cannot get through the government bureaucracy. Lots of will, but blocked channels.

Thus, the root causes of these shortages are complex and political.

Challenges in Areas With IDPs

Staff and resource shortages in UCs with large numbers of IDPs were particularly acute. A worker explained that in UC 9, "There is actually no big hospital or government center in the area. There are only unlicensed 'doctors.'" Officials had made an effort to train unlicensed practitioners to provide routine immunization, but the results were disappointing.

In UCs with many IDPs, officials had trouble finding local workers, especially female IDPs, willing to take government jobs. Therefore, LHWs had to be hired from other areas, resulting in a lack of local connection and knowledge. One official described an attempt to solve these problems in UC 9:

[A government official] set up more centers but could not hire the staff to fill them. So they made a rotating system [bringing staff from other areas]. . . . But the staff hired were Urdu speaking in this Pashto speaking area. And when we go back and check on the centers, the people hired are not there [don't show up for work]. Implementation is a problem.

Thus, the areas that everyone agreed were most in need of improved RI were also the areas where improvements were most challenging to achieve.

Worker Motivation

Despite acknowledging the importance of their work, ground-level workers in SITE said that low and unreliable wages and a lack of accountability also made it difficult to stay motivated at their jobs. LHWs were particularly adamant that their pay (Rs. 9,000, about \$100/month) was too low; this was the sole source of income for many of their families.

One town-level official commented: “The problem is that the government has hired a lot of workers for vaccines who get a very low salary, and then they do not receive their salary for 4 or 6 months. This is bad for motivation. They get excited that they get a job and then they don't get paid. It is de-mobilizing and de-motivating.”

Workers also said that it was rare to be held accountable for work performance: “Here no one will say anything to the one who is doing a good job and working, or to the one who is not working at all.” Thus, despite being convinced of the importance of their work, many respondents said their motivation flagged.

The Polio Eradication Initiative in SITE

The GPEI delivers OPV in resource-intensive door-to-door campaigns. Areas with ongoing polio transmission have the most campaigns delivering OPV; in SITE Town, there were 8–12 each year (Figure 3). During the 55 campaign days that occurred the year we did our research, many workers in SITE focused solely on polio (Figure 4).

Nearly all workers asserted that polio eradication was an important and worthy goal. One explained when polio strikes a child, “their whole life is ruined, and their family is also affected.”

Overall, the polio program was the most robust health intervention in SITE Town. Respondents appreciated the relatively ample funding for polio, the functioning cold chain, and the reliable vaccine supply, which contrasted sharply with the resource shortages for routine work. One official said, “PHC/RI and polio are two different tiers. PHC/RI activities don't get the money or staff salaries.”

POLIO ERADICATION CAMPAIGN INTENSITY: 2010

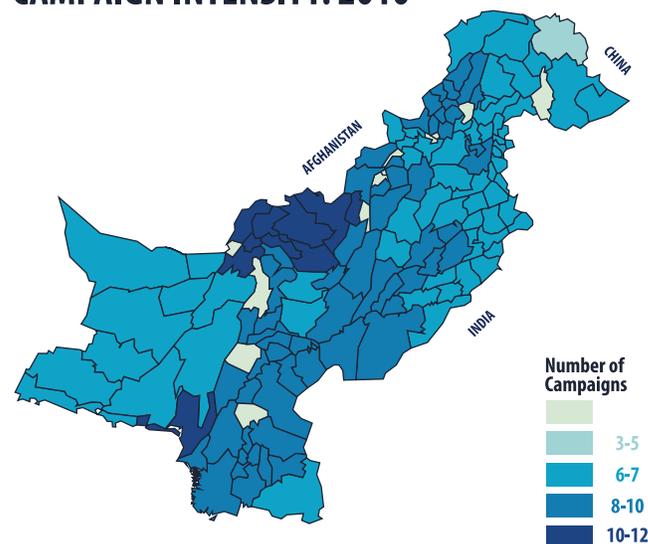


Figure 3. Number of polio campaigns in a given year in Pakistan in 2010, reflecting the situation just before our field research. Some subdistricts, including parts of SITE Town, had more campaigns than the average districtwide number shown here. After 2010, campaign intensity increased in many areas, with some communities visited up to 22 times in 2014. At present, the GPEI is rethinking the strategy of high numbers of campaigns because, as we argue here, this can contribute to worker and community dissatisfaction (Global Polio Eradication Initiative, 2015b). See Figure 1 for the location of our study.



Figure 4. A child receives oral polio vaccine during a campaign.

The discrepancy between polio and other services was particularly acute in UC 9. Because that area had recently seen two polio cases, they had 12 door-to-door campaigns in the year of our research. Thus, the area our respondents said had the poorest routine immunization in SITE Town also had the most intense campaign schedule.

Worker Motivation for Polio

Despite their conviction that eradicating polio was a worthy goal, many respondents said security issues, low and late pay, relentless pressure, and dealing with refusals in repeated campaigns left them fatigued.

“The biggest problem is of security,” a doctor said. “I was at the dispensary preparing results and I was looted of my wallet at gunpoint. The LHWs with us were rid of their money and jewelry.” An LHW whose purse was stolen in this incident commented ruefully, “They probably thought I make a lot of money by working in the polio campaign.”

Polio-specific issues of pay were also de-motivating, especially coupled with workers’ existing dissatisfactions about pay. Workers were given a stipend of Rs. 250 (about \$3) per day for work on polio campaigns—about half of the local daily wage for unskilled labor and, commented one supervisor, “neither enough for rent nor food.” Chronic delays in payments, often disbursed as late as 6 months after a campaign, exacerbated frustrations.

Especially given the low pay, relentless pressure to achieve results in campaign after campaign wore on workers. One supervisor said of his experience, “They [my workers] are checked by the area in charge, the UC officer, WHO, UNICEF... So they are checked a lot but paid very little. They get 250 rupees and then 10 shoe hits.”

Yet, another supervisor added: “we have a group of very loyal and dedicated workers who try their best to take care of their work.” Most supervisors praised their staff for hard work in challenging circumstances.

Polio Vaccine Refusals

One LHW said that “dealing with refusals—because it is often very difficult to convince people to take the vaccine” was her most time consuming activity during campaigns. Interacting with refusal parents could be frightening, as in the case of a male health worker who was hit in the face by an angry father. Understanding the reasons for refusals is important not only because they directly reduce vaccination coverage, but also because refusals have a negative effect on polio workers’ motivation. While refusal families were overall a small minority, they were clustered in specific areas (cf. UNICEF, 2013), and most of our interviewees mentioned dealing with refusals as a job frustration.

Refusals in SITE were frequently fueled by parental frustration with the emphasis on polio in the absence of broader government services. An LHW said, “They complain that the government has other responsibilities towards them... and they ask, why do you not give us that?” A town-level official observed:

We get asked why do we repeatedly go for the polio campaigns; why are we worried about polio. The people say: we have so many other problems. The people have their own

priorities, first is water and living in difficult situations, groceries and sanitation. They don’t have their basic needs. And the polio campaign has gone on for more than 10 years.

Another added:

The households served by the polio program are upset because they require other goods and services—wheat, sugar, milk—but do not receive them. They do not want to accept only polio drops. It doesn’t make sense to them. Polio vaccine should be incentivized by providing other goods along with it.

One LHW noted, “One complaint is that before a month even ends, another polio campaign starts.” The attention and emphasis given to polio campaigns led to credibility issues in the context of generally poor government services.

IDPs and Vaccine Refusal

Distrust of polio vaccine was particularly marked in IDP communities. These groups, who had heard loud and clear from the provincial government that they were not welcome; who frequently lived in areas such as UC 9 with poor government services; and who had fled their homes because of government and international military actions, had ample reason to distrust any program promoted heavily by the national and provincial governments and international actors.

Many workers we interviewed expressed distaste for working with IDPs. One said, “First of all, they are coming from the outside, and they are spreading germs and diseases in this area because they are the carriers of these germs. So they create a problem for us. On top of that they do not listen to us and are refusal cases.” Such attitudes likely exacerbated many IDPs’ distrust.

In the context of IDPs’ understandable distrust of the health system, rumors were common, particularly that the vaccine caused infertility and was “American.” One LHW said, “The mothers ask us whether the polio vaccine has come from America and whether the Americans have added family planning medicine to it.” Workers also noted that the fake vaccination campaign involved in the search for Osama bin Laden caused difficulties. One said, “We tell them that if they will give polio vaccine to their children, they will be saved from being disabled. Some people do not understand, saying that it is the American police.”

Fears about police were especially acute in areas home to what respondents described as “anti-government elements.” One noted, “We have people here who have political affiliations and they do not want their information to be leaked out... There is a law and order problem and they think that we are police informers.”

Thus frustrations about the focus on polio, coupled with political anxieties, made polio vaccination in IDP communities particularly difficult. An LHW observed:

Vaccinations are happening... but many migrants from Pashto speaking areas, no matter how much we motivate them, do not take polio vaccines. And in some areas there

is a lot of garbage, open sewers where children are bathing. . . a child fell in an open sewer in UC 1 and got polio, even though he had polio vaccination. I often wonder how polio can be eradicated. I think apart from vaccination, we should keep children away from dirty water.

Refusals were clustered in areas with poor RI and poor sanitation.

Broader Health Services Are Important to Polio Eradication

The discrepancy between polio and other health services existed because the polio program was doing its utmost to vaccinate every child in a challenging environment. Through tireless commitment, the program repeatedly reached children who received few or no other health services. Yet, unfortunately, this discrepancy created problems for the polio program itself, contributing to refusals and to worker demotivation.

In this context, the standard techniques of social mobilization are unlikely to be completely effective. The reasons that parents refused vaccine were not primarily cultural (although refusals were concentrated in IDP populations), nor did they reflect a lack of education (although parents did have misconceptions). Rather, the root cause of refusals was a deep distrust of government and international actors that provided few if any desperately needed services, but administered polio vaccine door-to-door every month (cf. Coutinho & Banerjee, 2000; Renne, 2010; Taylor, 2015; Yahya, 2007).

Managers and workers alike said that making headway in cases of entrenched refusal was extremely difficult. One UNICEF employee described challenges in providing social mobilization:

If someone comes for RI in a center and the door is closed, it is bad. The management of basic services is a problem, and this happens. Also, as outsiders, we come to UC 9 at breakfast and have to leave before dinner as it is not a safe area for us. Out before dark.

Another worker explained:

We have approached the *maulvis* [religious leaders] asking them to make announcements regarding the campaign through their loudspeaker system, and even cited the *fatwas* [consensus statements of religious leaders] regarding polio work. However they refuse, saying the *fatwa* is about allowing the drops and not announcements during the campaign. [Laughs]. It is a strange situation indeed.

Another said, “Sometimes I feel that maybe we do not know the proper way to make people. . . agree with us that polio needs to be eradicated from our country.”

Pushing harder to get parents to accept polio vaccine is unlikely to change their minds; rather, increased pressure focused on this one issue may well lead to increased resistance (Factor, Williams, & Kawachi, 2013). An approach that targets the root causes of refusals is more likely to be successful.

Changes Since 2012: Promising Initiatives

In 2012, high-level staff said the polio program was increasing attention to RI. In 2016, these plans are in motion. Strengthening RI is now a core stated objective of the GPEI. The GPEI’s recent midterm review explains, “polio communications products are aiming to promote broader health at a time when many communities may be tiring of polio specific messages and multiple requests to vaccinate their children” (Global Polio Eradication Initiative, 2015b).

Within Pakistan, many initiatives to address the problems our interviewees identified are underway. A Pashtun-specific communications strategy has been developed. Worker training has been enhanced. And while implementation is still imperfect, a major effort aims to get polio workers paid on time.

Along with these interventions, refusals appear to be decreasing—a UNICEF study showed an 80% reduction in refusals in endemic high-risk areas nationwide as of 2014. Noting this, UNICEF pointed out that meeting community demands and building trust in vaccinators would be critical moving forward (UNICEF, 2014).

“Health camps” in Karachi’s highest risk areas now provide interventions including TT vaccine and delivery kits, as well as injectable and OPV. Evidence from similar camps in Nigeria suggests that they effectively deliver injectable polio vaccine (IPV) and reduce numbers of missed children, including refusals (Nigeria National Primary Health Care Development Agency, 2015); research on the effects of these camps in other contexts would be valuable. Health camps had reached nearly half a million people in Pakistan by mid-2015, and had delivered polio vaccine to nearly 10,000 completely unvaccinated children (Pakistan Ministry of Health, 2015).

The polio campaign strategy in SITE’s high-risk UCs has also changed. Now, in a program called the Continuous Community Protected Vaccination, dedicated polio staff in these areas spend a week visiting houses and then a week finding missed children, in a continuous monthly cycle. They distribute “polio plus” kits along with polio vaccine. Pakistan’s National Emergency Action Plan calls this strategy a “success” (Government of Pakistan, 2015, p. 11).

Other initiatives, too, aim to broaden the services provided with polio vaccine. A grant from the Canadian government includes support for RI, maternal health, water and sanitation, and nutrition. Other water-supply initiatives are also being discussed in Karachi (UNICEF, 2015).

New Challenges

At the same time as these new interventions are being rolled out, the polio program in Karachi faces new challenges. Most seriously, polio workers have been targeted with ongoing lethal violence. In SITE, an educator providing polio vaccine was murdered (McNeil, 2013).

In 2015, SITE Town, and particularly UC 9, remained underserved by the government health system. There was still no government health facility in UC 9, and no government doctor in all of SITE Town that spoke Pashto.

In Pakistan as a whole, differing cultures and different hierarchies have made the collaboration between GPEI and RI staff challenging (Claycomb, 2015; Expanded Programme on Immunization & Global Polio Eradication Initiative, 2015). The result has been “sub-optimal implementation of RI strengthening activities” (GPEI, 2015b, p. 22).

Further complicating matters, some people we spoke to recently in SITE felt that the Continuous Community Protected Vaccination had, in contrast to its intention, functioned to increase refusals. One town-level official said that in a given house in a high-risk area in UC 9:

The team is going over there, the supervisor is going over there, the UC MO [Union Council Medical Officer] is going over there, the RSP [Religious Support Person] is going over there, the WHO people are going over there, so the person will hesitate. Why are you coming again and again and knocking on my door?

As a result of nonstop campaign activity, this official said, “In the high-risk UCs, they are hesitating, the public. They are refusing. . . The number of refusals is increasing.” This statement reflects the perceptions of just one individual and is not a conclusive finding. Given that the Continuous Community Protected Vaccination is currently being considered for use in other contexts, additional research is warranted.

Why Should the GPEI Do More to Spearhead General Health Efforts?

Many people in SITE Town want to provide better services in high-risk areas, and there are real barriers to achieving this. The issues involved are complex and political. The GPEI cannot change these realities and cannot build comprehensive health systems in a city such as Karachi.

Why, then, should the GPEI spend time and money on general health efforts—work that many within the polio program see as a distraction? One answer is in the GPEI’s 2013–18 Strategic Plan, which notes that high RI coverage is essential to eradication. The Strategic Plan commits to “working with immunization partners to strengthen immunization systems.” In Pakistan, it commits to working with local governments “to establish immunization services in the most vulnerable populations” (GPEI, 2013, pp. 51, 111).

In the longer term, the GPEI’s legacy process aims to provide support to broader health services. “The infrastructure required to eradicate polio is concentrated in many of the lowest performing low-income countries, which are the most challenging places to achieve other health objectives,” note polio eradication leadership in a recent article. They call for ensuring this infrastructure is “sustained and repurposed” for strengthening RI (Cochi, Hegg, Kaur, Pandak, & Jafari, 2016, pp. 281–282).

Also, our analysis suggests that in the short term, higher quality RI and health services may be critical for the narrow and immediate goal of eradicating polio. Because refusals grow out of a distrust of national and international institutions, exacerbated by a discrepancy in attention and funding for polio as compared with other health services, well-intentioned initiatives to “increase noise” around polio eradication may prove counterproductive (UNICEF, 2015). Given that polio eradication is already heavily politicized, standard social mobilization efforts such as media campaigns, and even door-to-door education focused on polio, may not make substantial inroads.

Folding polio vaccination into broader health activities in the highest risk areas could be a key strategy for eliminating the disease. Support for RI and other health initiatives in the short term could be enlightened self-interest on the part of Pakistan’s polio program.

The introduction of IPV into Pakistan’s RI schedule means that RI is now more important than ever for polio eradication. A new communications strategy for polio centered on RI makes sense. But of course such a strategy will only work when coupled with the concurrent provision of RI services.

What More Can Be Done?

The strategies we propose here would supplement, not replace, efforts to build broad-based health systems. Sustainable RI provision and constructing water and sanitation infrastructure are complex, long-term projects. Other actors including Gavi, the World Health Organization, and provincial leaders are working on those fronts. We encourage GPEI’s increasing support of those programs.

Given the aforementioned political dynamics, progress in providing improved health services to Karachi’s IDP populations through these channels is likely to be incremental. In the short term, providing targeted services in polio-endemic areas could benefit the GPEI. It is worth evaluating the effect of such interventions on community acceptance of polio vaccine.

Here, we suggest some short-timeline strategies. We focus on three areas where targeted interventions could pay dividends for polio eradication: water, sanitation, and hygiene (WASH); LHW services; and routine immunization.

Targeted Improvements to Water and Sanitation

Improved WASH in endemic areas of Karachi could impact polio transmission by reducing fecal-oral transmission of poliovirus, and by preventing diarrhea that interferes with OPV efficacy (Grassly et al., 2006). More important, improved services would lessen the contrast between poor water and sanitation infrastructure and door-to-door provision of polio vaccine—a disparity that frustrated parents and contributed to refusals. We suggest the following strategies:

- *Water-supply improvements:* Water shortages are a serious problem in Karachi, and make maintaining good sanitation practices difficult (Hunter, MacDonald, & Carter, 2010). In

the highest transmission areas of Karachi, the GPEI should make water availability a high priority, for example by providing water tanker trucks.

- *Sanitation improvements:* Where possible, open sewers should be covered. In slum areas, provision of sanitation facilities should be a priority (Mara, Lane, Scott, & Trouba, 2010). The sanitation needs of Karachi outstrip the GPEI's resources, but targeted improvements in polio-endemic areas are possible.
- *Water treatment improvements:* Point-of-use water systems are effective in Karachi (Luby et al., 2001a). These systems could be provided during an OPV campaign, with follow-up provision of chlorine solution in subsequent campaigns. Education about the use of these systems could be integrated with polio messaging. Such integration of OPV and water treatment provision could help to ease the path for health workers who hear complaints about focusing only on polio. This would likely work best alongside the WASH improvements previously outlined.
- *Soap distribution:* Soap distribution and handwashing education are effective in Karachi (Luby et al., 2001b, 2006). Distributing soap during OPV campaigns would be relatively simple. This small intervention would likely have a significant impact on community engagement only if implemented alongside other WASH improvements.

Targeted Improvements to LHW Services

The challenges facing the health system in SITE Town are substantial, and the GPEI is not in a position to address most of them. Given that LHWs are such an essential part of polio eradication's workforce, helping them build trust is very important. We suggest support for LHW supplies, including medicines, in polio-endemic areas. Polio campaign trainings could be an opportunity to learn about area-specific shortages and follow through with essential supplies.

Targeted Improvements to Routine Immunization

Sindh's EPI Program is working with Gavi to improve RI. There are points where these agencies might have common interests with the GPEI:

- *Increased support for RI in health camps:* Currently, not all health camps provide RI; one report states that out of more than 14,000 people attending health camps in Karachi, fewer than 400 children received routine immunizations (Pakistan Ministry of Health, 2015). Legacy plans to transition these temporary camps into permanent facilities could help improve RI coverage in some of Pakistan's most poorly served areas.
- *Permanent routine immunization posts:* High-risk areas such as UC 9 should be provided with infrastructure and staff for RI. International and national pressure and funding for these improvements should be immediate.

Such steps could be pivotal in polio's last strongholds. India achieved an end to polio transmission while integrating communications with provision of additional health services in polio-endemic areas (Closser et al., 2014; Coates, Waisbord, Awale, Solomon, & Dey, 2013). Water, sanitation, and routine immunization improvements are not easy or cheap. In targeted areas of Karachi, they are doable. And they could play a critical role in eradicating polio.

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