

## Practical Paper

# An opportunity not to be missed – immunisation as an entry point for hygiene promotion and diarrhoeal disease reduction in Nepal

Yael Velleman, Katie Greenland and Om Prasad Gautam

### ABSTRACT

Diarrhoea is a leading cause of death in children under 5 years of age, due mostly to failures to increase access to safe water and improve sanitation and hygiene practices (WASH). Rotavirus vaccines are a useful addition to existing diarrhoeal disease control measures. Recommendations are to introduce the vaccine in low-income settings. A study was conducted in Nepal to examine whether immunisation programmes offer a useful entry point for hygiene promotion as part of a comprehensive approach for diarrhoea control. Service-provider and recipient perspectives on integration were explored in focus group discussions with Female Community Health Volunteers and caregivers of infants in Kaski district, Western Region. Key health, WASH and disease surveillance informants (government, I/NGOs and donors) were interviewed at national, regional and district level. Incorporating hygiene promotion into the immunisation programme was acceptable and fits with the recommendations of the National Committee on Immunisation Practice. Implementation through routine immunisation was preferred over a vaccination campaign approach. Discussions concluded that this approach should be piloted as a next step to ensure the development of a strategy that can optimise hygiene promotion delivery and uptake, and ultimately contribute to the reduction of the burden of diarrhoeal diseases in Nepal.

**Key words** | diarrhoea, hygiene, immunisation, rotavirus, sanitation, vaccines

**Yael Velleman** (corresponding author)  
WaterAid,  
47-49 Durham Street,  
London SE11 5JD  
E-mail: [YaelVelleman@wateraid.org](mailto:YaelVelleman@wateraid.org)

**Katie Greenland**  
**Om Prasad Gautam**  
Environmental Health Group,  
Faculty of Infectious and Tropical Diseases,  
London School of Hygiene and Tropical Medicine,  
Keppel Street,  
London WC1E 7HT

### BACKGROUND

Diarrhoeal diseases are preventable and treatable, yet diarrhoea, almost 90% of which is caused by lack of safe drinking water, sanitation and hygiene (WASH) (Prüss-Üstün *et al.* 2008), remains a leading cause of death among children under 5 years of age globally (Liu *et al.* 2012). Major advances in diarrhoea case management have been made but prevention is hampered by failures to increase access to WASH services. Despite evidence to suggest that washing hands with soap can reduce childhood diarrhoea by 30–47% (Curtis & Cairncross 2003), it is inadequately practiced at critical times (Curtis *et al.* 2011). In 2010, 2.5 billion people lacked access to basic sanitation, and almost 800 million lacked access to safe drinking water (UNICEF and

World Health Organization Joint Monitoring Programme for Water Supply and Sanitation 2012).

Tackling diarrhoeal diseases requires a comprehensive package of preventive and curative interventions (UNICEF 2012a), which, if scaled up, can drastically reduce diarrhoea deaths globally (Fischer Walker *et al.* 2011). Rotavirus vaccination is a relatively new addition to this package, with the orally administered Rotarix<sup>®</sup> and RotaTeq<sup>®</sup> recommended by the World Health Organisation (WHO) for global routine immunisation (World Health Organization 2009). An increased pressure on low-income countries to adopt such new vaccines may lead to decreased emphasis on WASH for the prevention of all-cause diarrhoea. WASH interventions

are complex and often do not lie within the specific remit of the health system, while vaccines offer a visible and politically attractive solution. However, since rotavirus is responsible for just over one-third of diarrhoeal deaths globally (Tate *et al.* 2012), complete vaccine coverage could only prevent around one-third of diarrhoeal deaths. As recently noted, 'Recognising that some new vaccines do not address the entirety of major public health problems, more comprehensive disease prevention and control strategies are promoted where immunisation is just one element' (Okwo-Bele 2012).

Oral vaccine response can also be weakened if the recipient is experiencing WASH-related enteric infections (Levine 2010), including diarrhoea. Environmental enteropathy, a less-well studied syndrome, has been linked with poor sanitary conditions (Humphrey 2009), and it has been argued that a fundamental breakthrough in oral vaccine immunogenicity is likely to require reversing the effects of environmental enteropathy (Levine 2010). Rotarix<sup>®</sup> trials resulted in 49% efficacy in Malawi (Madhi *et al.* 2010), and Rotateq<sup>®</sup> trials in Ghana, Kenya and Mali demonstrated 39% efficacy against severe rotavirus gastroenteritis (Armah *et al.* 2010). Rotavirus vaccine delivery should be undertaken as part of a full package of diarrhoea control measures.

The reach of immunisation programmes is well known and other programmes have attempted to utilise vaccination activities to increase their coverage and effectiveness. Examples include Immunisation Plus Days or Child Health Days in which interventions such as vitamin A supplements, insecticide-treated bed nets and child registration and weighing are delivered (UNICEF 2012b), as well as broader integration approaches directed at mothers, such as tetanus immunisation, preventive malaria treatment, antenatal care messages, maternal antihelminthic treatment and micronutrient supplementation (PMNCH 2006). Notably, systematic reviews of integrated immunisation approaches (Wallace *et al.* 2009, 2012) have revealed important information gaps on costs, comparison to vertical programme delivery and impact on immunisation services that should be addressed in future studies.

While WASH interventions do not effectively prevent rotavirus infection, incorporating hygiene promotion into immunisation programmes and targeting mothers of young children may produce greater health outcomes

than stand-alone vaccine delivery. Immunisation programmes could also serve as a useful entry point for a broader approach to improving sanitation and hygiene practices due to their established community-level reach; this, together with the health system's experience in generating demand for services, presents a mechanism by which a greater proportion of the population can be reached through sanitation and hygiene promotion (WaterAid 2011). Hygiene promotion in such a setting can also enhance the links between hygiene and health in a way that is hard to achieve through community-based hygiene promotion activities. Mothers of young children may be particularly susceptible to health-oriented hygiene messages or messages eliciting nurture or disgust, proven drivers of behaviour (Curtis *et al.* 2009).

Integration of hygiene interventions into immunisation has previously been studied in Kenya. A study utilising hygiene kits during vaccination resulted in improved hygiene practice and improved vaccination coverage (Briere *et al.* 2012), while another study comparing the distribution of hygiene kits during vaccination visits by nurses and by community workers, showed that both strategies resulted in improved hygiene indicators (Ryman *et al.* 2012).

Recognising the relatively small evidence base for the benefits of this specific approach and the knowledge gaps previously noted, we undertook a study in Nepal (Kathmandu and Kaski District, Western Region) to examine immunisation programmes and identify mechanisms for the incorporation of hygiene promotion, in particular in the event of the national introduction of a rotavirus vaccine. Nepal was selected because of its high diarrhoeal disease burden (severe outbreaks of cholera occurred in 2009 and 2012) and low levels of water and sanitation coverage, and its experience in implementing successful immunisation programmes. The study was conducted by investigators from the London School of Hygiene and Tropical Medicine and WaterAid, and funded by the UK Department for International Development through the Sanitation and Hygiene Applied Research for Equity (SHARE) consortium, and by WaterAid.

The aim of the study was to ascertain whether incorporating a hygiene promotion intervention into immunisation programmes is feasible and acceptable. An

operational definition of ‘hygiene interventions’ was adopted that included handwashing with soap at critical times; food hygiene; domestic hygiene; and solid and liquid waste management. More specifically, the study objective was to ascertain whether oral vaccination could offer an entry point for hygiene promotion interventions, in order to define options for piloting and scaling up. The study was designed to gather the views of front-line service providers and vaccine recipients to deliver and receive hygiene messages during vaccination delivery respectively, to gain an understanding of the perceptions of policy and programme implementation professionals from the health, WASH and diseases surveillance sector on such an approach, and to identify the exact approach and delivery mechanism through which the combination of hygiene promotion and vaccine administration could be undertaken.

## METHODS

The study involved field visits, focus group discussions (FGDs), semi-structured interviews with key informants and a stakeholder-debriefing meeting. Written consent was obtained from participants using a form in English or Nepalese. Language and culture were accommodated by employing a Nepalese researcher and procuring additional translation services. Ethical approval was obtained from the Nepal Health Research Council and the London School of Hygiene and Tropical Medicine.

### Field visits

Eight rural and urban vaccination booths in Kaski District were visited during the Polio National Immunisation Days 28–29 April 2012, during which the vaccine is administered orally by female community health volunteers (FCHVs). FCHVs are the pillars of Nepal’s community-based primary health-care system and act as referral links between health services and communities. They help deliver public health programmes, including family planning, maternal care, child health, vitamin A supplementation, de-worming and immunisation.

### Focus group discussions

Four FGDs were conducted with 17 mothers/guardians of young children, five FGDs were conducted with 11 FCHVs in urban and rural settings in Kaski, and one FGD was conducted with 10 members of the Health Working Group–Association of International NGOs in Kathmandu.

### Key informant interviews

Semi-structured interviews were conducted with 25 high-level health, WASH and diseases surveillance professionals at central, regional and district level in Nepal. This was followed by a debriefing meeting to present and verify study findings.

## RESULTS AND DISCUSSION

### Acceptability and feasibility of integrating hygiene promotion and vaccination

The response from participants was highly positive; challenges raised during the study related to ‘how’ and not ‘whether’ this approach should be implemented.

### Views of front-line service providers – FCHVs

In all locations visited, FCHVs said they were motivated to carry out their work because they gain respect from community members. Their tasks include polio vaccination, assisting during routine immunisation (optional), providing vitamin A and iron supplements, oral rehydration solution (ORS) and family planning and post-natal advice. FCHVs felt that hygiene promotion falls under their role and that they would be able to carry out further activities if requested: ‘If a decision is taken by government to promote hygiene alongside vaccinations, then we will do it’ [Kaski municipality vaccination booth, Pokhara]. Challenges raised included the need for sufficient space, demonstration materials and refreshments for mothers/guardians attending promotion activities. FCHVs noted that no new volunteers would be needed to carry out this activity, but that further training would be required: ‘Anything we know, we can tell the

mothers; we cannot tell what we don't know. We forget without more training' [Ward 11, Sishuwa PHC, Lekhnath in Kaski District, Pokhara]. FCHVs also worried that hygiene promotion is not a tangible service (unlike vitamin supplements), and may be less valued by the community: 'If we give mothers too many messages [rather than tangible help], they blame us and say, "you take money but you don't give us anything"' [Ward 11, Sishuwa PHC, Lekhnath in Kaski District, Pokhara].

### Views of recipients (mothers/guardians)

Mothers/guardians were highly motivated to vaccinate, and reported that they would remain so even if travel or higher costs were involved (transport, food, absence from work). One participant said: 'I never compromise my child's health. I don't bother about the location of the booth and whether it is near or far, I prefer to vaccinate the child wherever it is. I would rather miss my work, but I won't miss the vaccination date to immunise my child' [Ward 8, Ward Office in Siddharth Chowk, Kaski District, Pokhara]. Most attended the booths having been told to do so by the FCHV, whom they trust and respect [Ward 17, Birauta in Kaski District, Pokhara]. All stated that they would be happy to stay longer after vaccination to receive information that would enhance their ability to protect their children from disease, such as hygiene promotion messages, or to improve their understanding of child health, disease prevention and vaccines. In that respect, one mother stated that 'if, in future, children suffer from serious illnesses, it would cost more than coming here [for vaccination] now' [Ward 17, Birauta in Kaski District, Pokhara]. Another noted that 'work is not more important than children – we would travel for any health message or vaccine' [Sarangkot Sub-Health Post, Kaski District, Pokhara]. One mother noted: 'I will be interested to hear about the messages related to the vaccine and its associated disease on the very same day so that I can remember better' [Ward 8, Ward Office in Siddharth Chowk, Kaski District, Pokhara]. They felt that FCHVs and local health workers could deliver such messages as they had undertaken promotional activities in the past [Ward 8, Ward Office in Siddharth Chowk, Kaski District, Pokhara].

### Views of policy makers, programme implementers, NGOs and donor agencies

Integration of hygiene promotion with vaccination was acceptable to all participants. Some noted that certain institutional changes and piloting would be required in order for the approach to be implemented, and these are specified later in this paper. Several noted the importance of hygiene, and referred to the need to prevent diarrhoeal outbreaks such as the 2009 outbreak, which resulted in 371 deaths. One decision maker noted that 'Diarrhoea is still epidemic in Nepal – we can utilise this opportunity to address it as well' [Ministry of Health and Population, Kathmandu]. Several donor agency respondents noted that hygiene promotion is a neglected intervention within WASH and health programmes, and that urgent action was required to implement the Nepal Health Sector Programme-II 2010–2015, which includes sanitation and hygiene promotion as a cross-cutting priority, as well as the new Sanitation and Hygiene Master Plan. Hygiene promotion through immunisation programmes had not been considered in the past, excepting the distribution of leaflets alongside polio vaccine delivery in Rautahat district in 2010. One high-level policy maker stated: 'Integration of WASH into oral poliovirus vaccination would contribute to reducing waterborne diseases [...] we have not thought of integrating WASH into vaccination programmes; this is a missed opportunity' [Ministry of Health and Population, Kathmandu]. Respondents were keen to see such approaches applied strategically, and warned that hygiene behaviour change requires an extensive programme and cannot be achieved overnight.

### Delivery mechanisms

Discussion centred on the relative advantages and disadvantages of integrating hygiene promotion into vaccination campaigns and routine immunisation. Both approaches are used in Nepal, and are described in [Table 1](#) to allow comparison.

*Vaccination campaigns* were noted to have a wider reach than routine immunisation since vaccines are administered nationwide on the same day. However, the campaigns occur infrequently and hygiene behaviours are deeply rooted – changing them could require frequent

**Table 1** | Vaccine delivery mechanisms in Nepal

Vaccination campaigns	Routine Immunisation
Lead by the Expanded Programme on Immunization (EPI), Child Health Division (CHD), Ministry of Health and Population (MoHP)	Delivered as part of EPI, CHD, MoHP, includes the package of childhood vaccines supplied nationwide by EPI
Children are immunised predominantly by FCHVs (oral vaccines only)	Children are immunised by trained health staff
Target group: 0 to <5 years children (e.g. polio)	Target group: Mostly children <1 year of age
Vaccination at 'vaccination booths', held in temporary locations or in health centres, accompanied by house-to-house visits the following day	Based on the routine immunisation schedule, mothers bring children at least five times within the first year of the child's life for vaccination at primary health centres, health posts, sub-health post, EPI clinic or health camps (mobile camps in mountain areas)
Take place once/twice a year	
Planning procedures: planning workshops at national, regional and district level; orientation for health staff, FCHVs, additional volunteers and committees; advocacy/briefing meetings at lower administrative structures; micro-planning at local and districts level.	
Social mobilisation through radio/television broadcasting, interpersonal communications by FCHVs, paintings, hoarding boards, IEC material distribution, use of loudspeakers	Regular social mobilisation takes place to raise awareness on immunisation
Campaign performance monitored by supervisors, government staff, and donor agencies.	Immunisation performance reported by local health institution. Annual progress produced for the Health Management Information System annual report

messaging sustained over a period of time. A campaign delivered twice a year would therefore be insufficient on its own. Children may not be accompanied by mothers but by siblings or grandparents, since vaccination booths are nearby, and vaccines are administered orally and are therefore not painful. When mothers do attend they may be in a hurry to leave. Policy makers and programme officials raised concerns about placing additional requirements on FCHVs when they are busy administering vaccines during campaigns. The lack of space at vaccination booths for gathering groups for promotional activities was also mentioned.

In contrast, *routine immunisation* provides frequent contact between mothers and health workers; mothers tend to attend immunisation clinics with their children, and to stay longer. Although promotion within both approaches was acceptable to mothers, some preferred routine immunisation as clinics occur more regularly and offer more chances of receiving messages even if one appointment was missed. Mothers stated that knowing in advance

about promotion activities would allow them to set aside sufficient time to participate, and preferred promotion information such as leaflets and posters to be accompanied by exercises or demonstrations. The space and setting of immunisation clinics was deemed conducive to promotional activities, and FCHVs, if in attendance (the FCHVs interviewed regularly attend clinics, although they do so voluntarily), have more time to undertake promotion activities. Promotion messages can be reinforced by health workers during vaccination (although such 'counselling' is not always consistently implemented). Some participants noted potential for resistance from health-care staff to the introduction of further responsibilities.

A possible *combined approach* would involve accompanying vaccine introduction with mass-media communication on vaccine purpose, reinforced through other social mobilisation approaches in areas where access to mass media is limited. Another option would be to initiate hygiene promotion through campaigns, followed by incorporation into routine immunisation. Additional mechanisms beyond the

immunisation programme that can reinforce or support hygiene promotion include monthly mothers' groups gatherings, interpersonal communication, youth groups, school clubs, etc. Information, education and communication (IEC) materials such as posters/leaflets, although useful, were not an option preferred by FCHVs, mothers and some donors. The feasibility of placing printed materials on walls for long periods, usefulness of leaflets for illiterate audiences and the impact of such methods were questioned by FCHVs and mothers. Several donors also pointed out the distribution problems of printed materials and the low potential for impact on changing behaviours without knowing the recipients' motives and context. 'We prefer group discussions like this or messages from FCHVs rather than just leaflets or posters, which are in many cases not available and sometimes difficult to read and understand' [FGD in Pokhara Municipality among mothers]; 'Due to lack of sector harmonisation and coordination between different institutions working in hygiene promotion, many institutions use their own promotional materials which are often not similar and use different messages, which might confuse mothers in the community' [INGO respondent, INGO focus group discussion].

### **Institutional arrangements, roles and responsibilities**

Participants felt the Government, and specifically the Ministry of Health and Population (MoHP), should play a strong leadership role to ensure programme sustainability. This view was expressed predominantly by officials and programme implementers (rather than mothers or FCHVs) at central and district levels, and was shared across government and non-government agencies. The leadership of government and non-government agencies on this issue was therefore not questioned. Several institutional 'homes' within MoHP were suggested, as well as institutional delivery structures at central, regional, district and local levels. It was suggested that the MoHP should also provide strategic and programmatic guidelines – a prerequisite for programme implementation – to indicate MoHP prioritisation and mandate implementation responsibilities. A curriculum for staff and FCHV training should also be developed. Close collaboration between the health, education, WASH, and other sectors is essential, most crucially at

lower levels of administration, and will require all actors working towards joined strategic objectives.

Respondents also noted several barriers to implementation. These included the availability and sustainability of financial resources, over-burdening FCHVs and health workers, added complexity of hygiene promotion where FCHVs do not attend immunisation clinics, absence of local leadership and ownership, possible over-reliance on overstretched local organisational structures and the lack of an enabling environment for improved hygiene practices, notably water shortages or lack of access to water. All these barriers must be addressed from the outset if a successful programme is to be designed and implemented effectively.

The potential for bias in this investigation should be acknowledged:

*Selection bias:* mothers/carers attending vaccination booths at the time of the investigation are more actively engaged in care seeking and therefore may be more positive in considering new health programmes, regardless of cost considerations. Attempts were made to address this bias by triangulating information gathered from this group with that received from other respondent groups. Formative research followed by pilot implementation targeted at a broader population will provide more information on the perceptions and motivation of this group.

*Interviewer bias:* there was a small risk that the investigators' own views on the viability of the proposed approach would be apparent to study respondents, and would generate an artificially positive response. This was addressed by a neutral phrasing of the study aim and objectives, by conducting a broad discussion on diarrhoeal disease in Nepal rather than on vaccines per se at the outset of the focus group or interview and by interrogation of responses provided.

---

### **CONCLUSION AND RECOMMENDATIONS**

Key actors in Nepal displayed sufficient interest to warrant piloting this approach and developing an appropriate hygiene promotion intervention.

Participants felt the approach could help to avoid miscommunication about the rotavirus vaccine being a 'diarrhoea' vaccine. Aside from diverting attention from

WASH, this misunderstanding could undermine the immunisation programme itself if children still suffered from diarrhoea after rotavirus vaccination. Similar concerns have been raised in relation to typhoid vaccination by the WHO Strategic Advisory Group of Experts on Vaccines and Immunisation (World Health Organization 2010). This reinforces the recommendation by the Nepal National Committee on Immunisation Practices, that 'vaccine introduction for enteric vaccines (rotavirus, typhoid, cholera) should be one component of an integral child health programme to decrease morbidity and mortality from diarrhoeal disease, including safe water, hygiene, sanitation, nutrition and IMCI' (Government of Nepal 2012). Rotavirus vaccine introduction is provisionally planned for 2016, following disease burden surveillance and serotyping.

The approach requires addressing a number of barriers: clear definition of institutional responsibilities and operational guidelines, financing mechanism to avoid budgetary constraints to collaboration and inter-sectoral coordination structures at all administrative levels. Critically, all actors should operate under a joint objective. All involved should have a shared understanding of the action required to generate sustained behaviour change. Whilst immunisation can provide a useful *entry point* for hygiene promotion, a comprehensive strategy to control diarrhoeal disease must be broader than any individual approach. Suggestions made on specific delivery aspects should be viewed as a starting point for discussion, rather than as an exhaustive list.

Piloting of the suggested approach should take place in various settings that reflect Nepal's diverse culture, geography, sanitation coverage levels and disease burden. Essential next steps will include assigning institutional responsibility and resources, and agreement on a set of activities. Importantly, establishing acceptability and feasibility is only the first step; once the approach is applied, it will be important to establish whether it generates the expected benefits to hygiene practices and vaccination programmes, and is cost-effective. Our study suggests that the proposed approach merits further investigation, and that its rigorous application could contribute to a fuller understanding of the costs and benefits of integrated versus vertical programmes. This discussion is particularly timely given the increased emphasis on the adoption of rotavirus

vaccines for routine immunisation. Failure to examine the possibilities of integration will constitute a 'missed opportunity' to enhance the health benefits of new and existing vaccines.

## DISCLAIMER

This material has been partly funded by UK aid from the Department for International Development (DFID). However, the views expressed do not necessarily reflect the Department's official policies. We declare that we have no conflicts of interest.

## REFERENCES

- Armah, G. E., Sow, S. O., Breiman, R. F., Dallas, M. J., Tapia, M. D., Feikin, D. R., Binka, F. N., Steele, A. D., Laserson, K. F., Ansah, N. A., Levine, M. M., Lewis, K., Coia, M. L., Attah-Poku, M., Ojwando, J., Rivers, S. B., Victor, J. C., Nyambane, G., Hodgson, A., Schödel, F., Ciarlet, M. & Neuzil, K. M. 2010 *Efficacy of pentavalent rotavirus vaccine against severe rotavirus gastroenteritis in infants in developing countries in sub-Saharan Africa: a randomised, double-blind, placebo-controlled trial. Lancet* **376** (9741), 606–614.
- Briere, E. C., Ryman, T. K., Cartwright, E., Russo, E. T., Wannemuehler, K. A., Nygren, B. L., Kola, S., Sadumah, I., Ochieng, C., Watkins, M. L. & Quick, R. 2012 *Impact of integration of hygiene kit distribution with routine immunizations on infant vaccine coverage and water treatment and handwashing practices of Kenyan mothers. J. Infect. Dis.* **205** (1), S56–64.
- Curtis, V. & Cairncross, S. 2003 *Effect of washing hands with soap on diarrhoea risk in the community: a systematic review. Lancet Infect. Dis.* **3** (5), 275–281.
- Curtis, V. A., Danquah, L. O. & Aunger, R. V. 2009 *Planned, motivated and habitual hygiene behaviour: an eleven country review. Health Educ. Res.* **24** (4), 655–673.
- Curtis, V., Schmidt, W., Luby, S., Florez, R., Touré, O. & Biran, A. 2011 *Hygiene: new hopes, new horizons. Lancet Infect. Dis.* **11** (4), 312–321.
- Fischer Walker, C. L., Friberg, I. K., Binkin, N., Young, M., Walker, N., Fontaine, O., Weissman, E., Gupta, A. & Black, R. E. 2011 *Scaling up diarrhea prevention and treatment interventions: a lives saved tool analysis. PLoS Med.* **8** (3), pe1000428.
- Government of Nepal 2012 National Committee on Immunization Practices: Final Recommendations. 25–26 March 2012 Meeting report.

- Humphrey, J. H. 2009 Child undernutrition, tropical enteropathy, toilets, and handwashing. *Lancet* **374** (9694), 1032–1035.
- Levine, M. M. 2010 Immunogenicity and efficacy of oral vaccines in developing countries: lessons from a live cholera vaccine. *BMC Biol.* **8**, 129.
- Liu, L., Johnson, H. L., Cousens, S., Perin, J., Scott, S., Lawn, J. E., Rudan, I., Campbell, H., Cibulskis, R., Li, M., Mathers, C., Black, R. E. & Child Health Epidemiology Reference Group of WHO and UNICEF. 2012 Global, regional, and national causes of child mortality: an updated systematic analysis for 2010 with time trends since 2000. *Lancet* **379** (9832), 2151–2161.
- Madhi, S. A., Cunliffe, N. A., Steele, D., Witte, D., Kirsten, M., Louw, C., Ngwira, B., Victor, J. C., Gillard, P. H., Chevart, B. B., Han, H. H. & Neuzil, K. M. 2010 Effect of human rotavirus vaccine on severe diarrhea in African infants. *N. Engl. J. Med.* **362** (4), 289–298.
- Okwo-Bele, J. M. 2012 Integrating immunization with other health interventions for greater impact: the right strategic choice. *J. Infect. Dis.* **205** (1), S4–5.
- PMNCH, T. P. f. M. N. a. C. H. 2006 Opportunities for Africa's newborns: practical data, policy and programmatic support for newborn care in Africa. Retrieved 1 November 2012. <http://www.who.int/pmnch/media/publications/africannewborns/en/index.html>.
- Prüss-Üstün, A., Bos, R., Gore, F. & Bartram, J. 2008 *Safe Water, Better Health: Costs, Benefits and Sustainability of Interventions to Protect and Promote Health*. World Health Organisation, Geneva.
- Ryman, T. K., Briere, E. C., Cartwright, E., Schlanger, K., Wannemuehler, K. A., Russo, E. T., Kola, S., Sadumah, I., Nygren, B. L., Ochieng, C., Quick, R. & Watkins, M. L. 2012 Integration of routine vaccination and hygiene interventions: a comparison of two strategies in Kenya. *J. Infect. Dis.* **205** (1), S65–76.
- Tate, J. E., Burton, A. H., Boschi-Pinto, C., Steele, A. D., Duque, J., Parashar, U. D. & WHO-coordinated Global Rotavirus Surveillance Network 2012 2008 estimate of worldwide rotavirus-associated mortality in children younger than 5 years before the introduction of universal rotavirus vaccination programmes: a systematic review and meta-analysis. *Lancet Infect. Dis.* **12** (2), 136–141.
- UNICEF 2012a Immunisation: what is the 'plus' in immunization plus? Retrieved 1 November 2012. [http://www.unicef.org/immunization/index\\_immunizationplus.html](http://www.unicef.org/immunization/index_immunizationplus.html).
- UNICEF 2012b Pneumonia and diarrhoea: tackling the deadliest diseases for the world's poorest children. Retrieved 1 August 2012. [http://www.unicef.org.uk/Documents/Publications/UNICEF\\_pneumonia\\_diarrhoea\\_report.pdf?epslanguage=en](http://www.unicef.org.uk/Documents/Publications/UNICEF_pneumonia_diarrhoea_report.pdf?epslanguage=en).
- UNICEF/World Health Organization Joint Monitoring Programme for Water Supply and Sanitation 2012 Progress on Drinking Water and Sanitation, 2012 Update. Retrieved 1 August 2012. [http://www.wssinfo.org/fileadmin/user\\_upload/resources/JMP-report-2012-en.pdf](http://www.wssinfo.org/fileadmin/user_upload/resources/JMP-report-2012-en.pdf).
- Wallace, A., Dietz, V. & Cairns, K. L. 2009 Integration of immunization services with other health interventions in the developing world: what works and why? Systematic literature review. *Trop. Med. Int. Health* **14** (1), 11–19.
- Wallace, A. S., Ryman, T. K. & Dietz, V. 2012 Experiences integrating delivery of maternal and child health services with childhood immunization programs: systematic review update. *J. Infect. Dis.* **205**(Suppl 1), S6–19.
- WaterAid 2011 The sanitation problem: what can and should the health sector do? Retrieved 1 November 2012. [http://www.wateraid.org/documents/plugin\\_documents/the\\_sanitation\\_problem\\_what\\_can\\_and\\_should\\_the\\_health\\_sector\\_do\\_1.pdf](http://www.wateraid.org/documents/plugin_documents/the_sanitation_problem_what_can_and_should_the_health_sector_do_1.pdf).
- World Health Organization 2009 Rotavirus vaccines: an update. *Wkly Epidemiol. Rec.* **84** (50), 533–540.
- World Health Organization 2010 SAGE Meeting, November 2010 - Summary, conclusions and recommendations. Available: [http://www.who.int/wer/2011/wer8601\\_02.pdf](http://www.who.int/wer/2011/wer8601_02.pdf).

First received 10 August 2012; accepted in revised form 1 December 2012. Available online 25 February 2013