Tool 2: Evidence Summary and Briefs

Key Purposes:

1. To improve understanding and applicability of BabyWASH in integrated programming and help identify gaps in current programming
2. To advocate for BabyWASH to senior leadership in your office
3. To develop capacity building materials for WV staff

BabyWASH Overview and Evidence Summary

The first 1,000 days of life are an incredibly vulnerable time period for both mother and child.

For the mother, a healthy pregnancy is the foundation for better health outcomes, which can be improved through access to clean water and sanitation, as well as a decreased physical burden during water collection and being prepared for a "WASH safe" birth. The majority of maternal deaths occur during delivery and in the first week postpartum. Maintaining clean surfaces and reducing the risk of infection by having access to water and sanitation are vital throughout labour and delivery, the first month of life, and through the child's early life, especially as they begin to explore their environment. Almost half of the deaths for children under five occur in the first month of life. Many of these deaths are infection-related and preventable through improved WASH. Additionally, the growing body of evidence supporting environmental enteric dysfunction (EED) suggests that reducing environmental exposure to faecal matter in the 1,000-day period may vastly reduce stunting, and consequently chronic undernutrition, as well as improve cognitive development. This is currently best achieved by disrupting EED pathways through improved WASH and greater attention to the importance of early childhood development through healthy caregiver-child interactions as well as hygienic environmental changes.

The opportunities for the greatest impact on health and nutrition outcomes for mother and children have been identified during these five "hotspots"

- Pregnancy
- Labour and delivery
- Newborn period
- Onset of mobility and exploration
- Onset of complementary feeding.

Targeted interventions during these time periods will have the greatest improvement on morbidity and mortality for mother and child.

Evidence Briefs

The briefs below summarize the evidence for each hotspot and provide the rationale for the selection of the priority interventions to be looked at from a hygiene lens. For more information on the evidence referenced in these briefs, please see the **Evidence Summary Table** in Appendix 6

Pregnancy: The Best Start to Life

Summary of evidence

Pregnancy is a particularly vulnerable time for both mother and her unborn child. Access to improved water sources and improved sanitation facilities are associated with decreased maternal morbidity and mortality[1]. Additionally, the physical burden of carrying water has been shown to increase the risk of uterine prolapse, inadequate weight gain during pregnancy, and spontaneous abortion[2]. Pregnant women require about 300 additional calories each day, compounding negative outcomes due to an increased physical burden of water carrying[3]. Additionally, environmental enteric dysfunction (EED) in women of reproductive age may cause inflammation during pregnancy and adverse birth outcomes such as foetal growth restriction and prematurity[4], one of the leading risk factors for neonatal mortality.

Summary of relevant interventions

Interventions at this point include both infrastructural improvement as well as behaviour change interventions. These interventions include:

- **Hand-washing with soap at key times** by the entire household, **including children**. Key times include 1. Before handling food, 2. Food preparation, 3. Before feeding, 4. After using sanitation facilities, 5. After handling faeces such as a child's, 6. After handling livestock.
- **Access to and use of improved water sources**. This intervention has moderately strong supporting evidence; however more rigorous research is needed to show impact in relation to water source distance. This may require infrastructural work to establish an improved water source closer to home, alleviating both distance walked and weight of water burden.
- **Access to and use of improved sanitation facilities** by the entire household. This intervention has moderately strong evidence to support its use. It is likely that this intervention will have a greater impact in conjunction with hand-washing with soap. Behaviour change interventions are vital in order to increase the effective use of WASH infrastructure and the sustained adoption of good sanitation and hygiene practices.
- **Birth Preparedness.** This intervention may involve the entire household, and ensures the mother has access to sufficient water, sanitation facilities, hygiene supplies, a plan for delivery, as well as clean birthing provisions prior to birth.

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[1] Cheng et al. 2012. *An ecological quantification of the relationships between water, sanitation and infant, child, and maternal mortality.* Environmental Health, vol. 11, no. 4. 1. https://ehjournal.biomedcentral.com/articles/10.1186/1476-069X-11-4

[2] Campbell et al. 2015. *Getting the basics right- the role of water, sanitation and hygiene in maternal and reproductive health, a conceptual framework*. Tropical Medicine and International Health. Volume 20 No 3 PP 252-267. http://researchonline.lshtm.ac.uk/2026604/

[3] WHO. 2001. *Healthy Eating during Pregnancy and Breastfeeding: Booklet for Mothers*. World Health Organization. http://www.euro.who.int/__data/assets/pdf_file/0020/120296/E73182.pdf

[4] Prendergast et al. 2015. *Assessment of environmental enteric dysfunction in the SHINE trial: methods and challenges*. CID. Supplemental Article. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4657593/

Labour and Delivery: A Clean Birth

Summary of evidence

Labour and delivery is a time when both mother and child are at great risk of unexpected complications, infection, and death. 11 to 17 percent of maternal deaths occur during birth, and many more in the first week post-partum[5]. Of the estimated 303,000 maternal deaths every year, approximately 10.7% or 32,400 are related to infection[5]. One study shows that women who give birth in unsanitary conditions are at a threefold risk of maternal mortality, in both home and facility births[6]. Another showed that women who bathe before delivery are almost three times less likely to develop sepsis[7]. Though this evidence is limited, availability of WASH services and practices in general during birth have been shown to be very important to health outcomes. Clean birth practices show moderately strong evidence of reducing neonatal sepsis death by 15% when delivered at home, and 27% when delivered at a facility[8]. Hand-washing by both mother and birth attendants decreases the risk of neonatal death by more than 40%[9], tetanus by more than 36%[10,11], and cord infection by 49%[12].

Summary of relevant interventions

Interventions for this time period target both facility and home births, with emphasis on hygiene for both mother and birth attendant. These interventions include:

- **Clean birth practices**, commonly known as the WHO's 6 Cleans: clean hands of attendant and mother, clean perineum (region from anus to vulva), clean delivery surface under the mother, clean blade for cord cutting, clean cord tying and clean towels to dry then wrap baby
- **Access to and use of improved sanitation facilities.** At healthcare facilities, this is defined as access to facilities that are not shared and are available in the delivery room. At home, specifically for rural communities, this is defined as facilities that are not shared with other families. This highlights the need for both infrastructural as well as behaviour change interventions in order to have the greatest impact.
- **Access to clean water** for mother during delivery and post-delivery. Though no precise standard currently exists for how much water is needed during clean labour and delivery, the WHO recommends 100 litres per intervention in the maternity unit. More research is needed to clarify or support this estimate.

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[5] Say et al. 2014. *Global causes of maternal mortality: a WHO systematic analysis*. Lancet Glob Health; 2: e323-33. http://www.thelancet.com/journals/langlo/article/PIIS2214-109X(14)70227-X/fulltext

[6] Benova et al. 2014. *Systematic review and meta-analysis: association between water and sanitation environment and maternal mortality*. Tropical Medicine and International Health. 19(4): 368-387 http://doi.org/10.1111/tmi.12275

[7] Winani et al. 2007. *Use of a clean delivery kit and factors associated with cord infection and puerperal sepsis in Mwanza, Tanzania.* Journal of Midwifery & Women's Health, vol. 52, no. 1, pp. 37-43. http://www.sciencedirect.com/science/article/pii/S152695230600451X

[8] Blencowe, H. et al. 2011. *Clean birth and postnatal care practices to reduce neonatal deaths from sepsis and tetanus: a systematic review and Delphi estimation of mortality effect*. BMC Public Health, 11(Suppl 3): S11 http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3231884/

[9] Rhee, Mullany, et al. 2008. *Impact of maternal and birth attendant hand-washing on neonatal mortality in southern Nepal*, Pediatr Adolesc Med, vol. 162, no. 7, pp. 603-08. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2587156/

[10] Umesh Parashar et al. 1998. *Topical antimicrobials applied to the umbilical cord stump: a new intervention against neonatal tetanus*," International Journal of Epidemiology, pp. 27:904-908. http://ije.oxfordjournals.org/content/27/5/904.long

[11] Bennett, et al. 1997. *Protective effects of topicl antimicrobials against neonatal tetanus*. International Journal of Epidemiology, vol. 26, no. 4. http://ije.oxfordjournals.org/content/26/4/897.full.pdf

[12] Mullany, Darmstadt et al. *Risk factors for umbilical cord infection among newborns of southern Nepal*. American Journal of Epidemiology, October 2006. http://aje.oxfordjournals.org/content/165/2/203.full

Newborn Period: A Strong Start to Life

Summary of evidence

About 40% of deaths for all children under five occur during the neonatal period, most of which are preventable[13]. Sepsis and infection related newborn deaths account for 15% of all newborn deaths annually -- or 420,000 newborns every year[14]. Sepsis has been shown with moderate strength to be reduced by 40% with clean postnatal practices[15]. Additionally, some evidence shows that the application of 7.1% chlorhexidine digluconate (delivering 4%) postnatally as one component of umbilical cord care reduces both neonatal mortality and cord infection[15]. Some studies show that having sufficient water quantity is necessary to prevent infection in both mother and child[16].

Summary of relevant interventions

Interventions in this time period include:

- **Clean postnatal practices** are consistent with clean birth practices, aiming to reduce infection for mother and child:
    - **Hand-washing with soap at key times** by the entire household, **including children**,: 1. Before handling food, 2. Food preparation, 3. Before breastfeeding, 4. After using sanitation facilities, 5. After handling faeces such changing baby's diaper, 6. After handling livestock. In particular, care should be taken to wash hands prior to handling the newborn.
    - **Clean cord care.** There is strong evidence supporting clean and dry cord care but newer evidence that the application of 7.1% chlorhexidine digluconate (delivering 4%) applied immediately after birth and in the first 7 days in high burden neonatal mortality settings, reduces neonatal mortality and cord infection
    - **Personal hygiene for mother and child**. There is moderate evidence supporting the reduction of sepsis and other infections through this intervention.
- **Exclusive breastfeeding** for 6 months. Half of diarrhoea episodes and a third of respiratory diseases can be prevented by immediate exclusive breastfeeding for six months.[17] This is a critical intervention for improving child health.
- **Access to and use of improved water sources**. This intervention has moderately strong evidence to support its use, particularly for treating water at the point-of-use.
- **Access to and use of improved sanitation facilities** by the entire household. This includes proper disposal of child faeces, and interventions to limit child faeces in the home and in child play areas. Additionally, it is likely that this intervention will have a greater impact in conjunction with hand-washing with soap.

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[13] USAID. 2012. *Better Intrapartum Practices to Reduce Newborn Infection: The Problem of Newborn Infection*. MCHIP Brief. https://www.k4health.org/toolkits/eonc/better-intrapartum-practices-reduce-newborn-infection-meilleures-pratiques-pendant-le

[14] Liu et al. 2015. *Global, regional, and national causes of child mortality in 2000-13, with projections to inform post-2015 priorities: an updated systematic analysis.* Lancet; 385:430-40 http://www.who.int/immunization/diseases/tetanus/Lancet-2013-Global-child-mortality.pdf

[15] Blencowe, H. et al. 2011. *Clean birth and postnatal care practices to reduce neonatal deaths from sepsis and tetanus: a systematic review and Delphi estimation of mortality effect.* BMC Public Health, 11(Suppl 3): S11 http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3231884/

[16] Winani et al. 2007. *Use of a clean delivery kit and factors associated with cord infection and puerperal sepsis in Mwanza, Tanzania.* Journal of Midwifery & Women's Health, vol. 52, no. 1, pp. 37-43. http://www.sciencedirect.com/science/article/pii/S152695230600451X

[17] Victora, Cesar G et al. Breastfeeding in the 21st century: epidemiology, mechanisms, and lifelong effect. The Lancet. Volume 387, Issue 10017, 475 – 490 http://dx.doi.org/10.1016/S0140-6736(15)01024-7

Onset of Mobility and Exploration: The Need for a Clean Environment

Summary of evidence

The onset of mobility and exploration is estimated to begin around three months of age. It is characterized by increased movement and curiosity as motor and cognitive skills develop, and frequent hand-to-mouth behaviours that enable infants to investigate and learn about the environment. While this is healthy developmental activity, it amplifies the risk of contamination from the environment. Two hundred million children per year do not reach their developmental potential due to stunting, which negatively affects progression in cognitive, motor and socio-emotional skills[18]. These impairments translate to limited school achievement throughout childhood and lower societal functioning as adults, contributing to the poverty cycle. Environmental Enteric Dysfunction (EED) is believed to be an underlying cause of stunting, and may account for continued growth restriction unaffected by traditional diet and disease control interventions[19]. New and emerging studies suggest that limiting the main pathways for EED may greatly reduce EED, and consequently, stunting. Some studies show that children who live in "cleaner" (e.g., more sanitary and hygienic) households have reduced parasitic infections, less severe EED and greater linear growth[20]. Limited research suggests that the proper disposal of faeces (both human and animal) in the immediate household environment can reduce diarrhoeal disease in children by more than 30%[21]. Early evidence also suggests that EED may reduce oral vaccine efficacy, though more research is needed in this area[22],[23].

Summary of relevant interventions

New studies supporting EED recommend WASH interventions that can disrupt the usual pathways to EED (faecal-oral exposure). These interventions include:

- **Hand-washing with soap at key times** by the entire household, **including children**. Key times include 1. After defecation/use of sanitation facilities, 2. After cleaning a child's faeces, 3. Before preparing food, 4. Before eating, 5. Before feeding a child, including breastfeeding or complementary feeding, and 6. After handling livestock. **In particular, care should be taken to wash the child's hands after exploratory play, where evidence suggests the greatest exposure to environmental pathogens, including faecal matter, occurs.**
- **Access to and use of improved sanitation facilities** by the entire household. This includes proper disposal of faeces, and interventions to limit faeces in the home and in child play areas. It is likely that this intervention will have a greater impact in conjunction with hand-washing with soap.
- **Provision of sanitary and age-appropriate play/teething objects and clean and protected play spaces**. Expert opinion encourages the use of exploratory and learning play to improve child development. This intervention prioritises clean and sanitary play objects and spaces.

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[18] Grantham-Mcgregor et al. 2007. *Developmental potential in the first 5 years for children in developing countries*. Lancet. Child development in developing countries http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(07)60032-4/fulltext

[19] Crane et al. 2015. *Environmental enteric dysfunction: An overview*. Food and Nutrition Bulletin. 36 (1 0): S76-S87. http://www.ncbi.nlm.nih.gov/pubmed/25902619

[20] Lin et al. 2013. *Household environmental conditions are associated with enteropathy and impaired growth in rural Bangladesh.* American Journal of Tropical Medicine and Hygiene 89. 130-137. http://www.ajtmh.org/content/89/1/130.

[21] Cairncross et al. 2010. *Water, sanitation and hygiene for the prevention of diarrhoea*. Int Journ Epi. 39:i193-i205. http://doi.org/10.1093/ije/dyq035

[22] Levine. 2010. *Immunogenicity and efficacy of oral vaccines in developing countries: Lessons from a live cholera vaccine. BMC* Biology. 2010; 8:129. http://bmcbiol.biomedcentral.com/articles/10.1186/1741-7007-8-129

[23] Naylor, C. et al. 2015. *Environmental enteropathy, oral vaccine failure and growth faltering in infants in Bangladesh*. Elsevier BioMedicine. http://doi.org/10.1016/j.ebiom.2015.09.036

Summary of evidence

Breastfeeding is incredibly important for a child's health, providing nutrition and a natural defence against many infections. Additionally, breastfeeding delays a child's exposure to an unclean environment, which increases their risk of infection, malnutrition, and death. At six months, not before, the child should begin complementary feeding and continue to breastfeed. Adequate complementary feeding can avert 6% of child death[24]. However, the introduction of dirty water or water stored in dirty containers as well as food that may not be hygienically prepared or fresh, introduces new pathways for infection and harm. Psychosocial stimulation is also an essential intervention as a study finds that it can mitigate the effects of stunting[25].

Summary of relevant interventions

WASH interventions are important for navigating the compounding risks during this time period. These interventions include:

- **Hand-washing with soap at key times** by the entire household, **including children**. Key times include 1. Before handling food, 2. Food preparation, 3. Before breastfeeding and complementary feeding, 4. After using sanitation facilities, 5. After handling faeces such as a child's, 6. After handling livestock. **For complementary feeding in particular, special care should be taken to hand wash at every key time, every day to protect the child from infection.**
- **Access to and use of improved sanitation facilities** by the entire household. This includes proper disposal of child faeces, and interventions to limit child faeces in the home and in child play areas. It is likely that this intervention will have a greater impact in conjunction with hand-washing with soap.
- **Access to and use of improved water** by the entire household.
- **Education on the provision of fresh and hygienically prepared complementary foods**. This intervention has been shown to improve height gain, Height for Age (or HAZ scores) and weight gain in food secure populations, as well as Weight for Age (or WAZ scores) and significantly reduced the rates of stunting in food insecure populations.
- **Maintaining a clean eating area as well as a clean and protected play area**. As stated previously, though evidence is weak, expert opinion supports domestic hygiene in order to limit the pathways for EED and other diminishing illnesses. Appropriate play and stimulation is essential for child development and needs to be done in as hygienic an environment as possible.

[24] Jones et al. 2003. *How many child deaths can we prevent this year?* Lancet. Vol 362. http://www.who.int/maternal_child_adolescent/documents/pdfs/lancet_child_survival_prevent_deaths.pdf

[25] Gertler et al. 2014. *Labor Market Returns to an Early Childhood Stimulation Intervention in Jamaica*. Science 344(6187): 998-1001. http://www-ncbi-nlm-nih-gov.ezproxy.bu.edu/pmc/articles/PMC4574862/

APPENDIX 6: Evidence Summary Table

This table presents an evaluation of the evidence that was used to select the 7-3-7 BabyWASH interventions, identified per hotspot period. The evaluation criteria are meant to organise the evidence by strength and represent a general, not exhaustive, evaluation system. The evaluation criteria are as follows:

Strong: systematic review/ meta analysis OR consistent results across studies with varied locations/populations which are:
1. randomized 2. large-scale 3. contain a control group

Moderate: Missing 1 criteria from above.

Observational/ Expert opinion: Missing 2+ criteria above, recommendations based on observational studies or expert opinion

Emerging: indicates studies covering EED. May not necessarily reflect poor quality evidence, but rather the emerging nature of the topic results in few studies to compare results or reflects an ongoing study

BabyWASH Evidence Evaluation					
	Pregnancy	**Labour & Delivery**	**Newborn Period**	**Onset of Mobility and Exploration**	**Onset of Complementary Feeding**
Evidence	--Increased access to improved water sources and sanitation is significantly associated with decreased child and maternal mortality[i] --The physical burden of carrying water increases the risk of uterine prolapse, inadequate weight gain and spontaneous abortion[ii]. --EED in women of reproductive age may cause inflammation during pregnancy and adverse birth outcomes such as foetal growth restriction and prematurity[iii]	--11% of maternal deaths occur from sepsis during birth[iv] ----Clean birth practices reduce neonatal sepsis death by 15% at home and 27% in facility[v] --Hand-washing (a component of clean birth practices) by birth attendants and mothers decrease risk of neonatal death by more than 40%[vi], tetanus by more than 36%[vii] [viii], and cord infection by 49%[ix] (home or facility not specified) -Women who give birth in unsanitary conditions are at a threefold increased risk of maternal mortality, in both home and facility births[x]. --Women who bathe before delivery are almost three times less likely to develop sepsis[xi]	--40% of deaths for children under 5 occur in the neonatal period[xii]. 15% of all neonatal deaths are due to sepsis[xiii]. --44% reduced risk of neonatal death (all-cause mortality) from early initiation of breastfeeding. Similar reductions for infection-related neonatal deaths. For sepsis-related deaths, there is a 58% reduced risk of neonatal death with early initiation of breastfeeding.[xiv] --Sepsis related deaths specifically account for 7% of newborn mortality. Sepsis has been shown to be reduced by 40% with clean postnatal practices (WHO 6 Cleans)[v] --Access to sufficient water[A] is necessary to prevent infection in both mother and child[xi]. -Application of chlorhexidine post-natally as a means of cord care has been shown to reduce neonatal mortality and cord infection[v]	--200 million children each year do not reach their developmental potential due to stunting.[xv] --EED is strongly associated with stunting.[xvi] --Around half of diarrhoea episodes and a third of respiratory infections can be prevented by breastfeeding.[xvii] --Children in "clean" households have reduced parasitic infections, less severe EED and greater linear growth[xviii] --Proper disposal of faeces can reduce diarrhoeal disease by more than 30%.[xix] --Evidence suggests that EED is the likely underlying cause of stunting and accounts for residual stunting unaffected by diet and disease control interventions[xx] --EED may reduce oral vaccine efficacy[xxi] [xxii] --Children participating in active exploratory play consume high quantities of E. coli via soil and chicken faeces[xxiii] [xxiv] --The Lancet series on Child Development highlight the importance of improved ECD interventions such as stimulating learning and exploratory play, and improved child-caregiver relationships.[xxv] [xxvi]	

	Pregnancy	Labour & Delivery	Newborn Period	Onset of Mobility and Exploration	Onset of Complementary Feeding
Possible Interventions:	--Hand-washing by all household including children with soap/other agent at key times including food preparation, before handling food, before feeding, after using sanitation facilities, handling faeces, and livestock.[xxvii] --Access to improved water source[i] --Access to improved sanitation[i]	--Clean birth practices (WHO's 6 Cleans)[v] [xi] --Access to and use of sanitation facility[x] --Access to clean water for mother during, and post-delivery.[xxviii]	--Hand-washing by all household including children with soap/other agent at key times including food preparation, before handling food, before feeding, after using sanitation facilities, handling faeces, and livestock.[xxvii] --Exclusive breastfeeding for 6 months[xiv] --Access to improved water source[ii] --Treated water at POU[xxix] --Clean postnatal care practices[v] --Access to and use of improved sanitation facility by entire household[xx] [i]	--Hand-washing by all household including children with soap at key times including food preparation, before handling food, before feeding, after using sanitation facilities, handling faeces, and livestock.[xxvii] --Education on the importance of provision of freshly prepared (complementary) foods[xxx] [xxxi] [xxxii] --Provision of safe and hygienic age-appropriate toys for stimulation and development[xxv] [xxvi] --Education on improved caregiver-child interactions and support.[xxxiii] -- Access to and use of sanitation facility by entire household[x] [i] -- Clean eating area[xx] -- Clean and protected play space[xx]	
Short-term Impact	--Reduced risk of infection/sepsis		--Reduced risk of infection	--Reduced risk of infection, exposure to pathogens and EE, improved cognitive, social, emotional development	
Long-term Impact	--Reduced maternal and neonatal mortality and long-term morbidity			--Reduced stunting, nutritional impairments, immune functioning --Reaching greater developmental potential	

A - "Sufficient water" was not defined in reference to the evidence statement above. However, according to the World Health Organisation, 20 litres of potable water is sufficient per person per day for domestic purposes, drinking, cooking, and personal hygiene. The WHO also suggests that 100 litres of water is needed per intervention in a maternity unit in healthcare facilities, though no more specific information is available. However discussions with the soapbox initiative during this toolkit development stage suggest that this amount can be broken down to different usages ie: multiple hand-washing during labour and after delivery for skilled birth attendant staff, cleaning of instruments, the bed and the room after delivery, drinking water for labouring woman, washing the mother before and after the birth. More operational research is required to determine this standard requirement.

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[i] Cheng et al. 2012. *An ecological quantification of the relationships between water, sanitation and infant, child, and maternal mortality.* Environmental Health, vol. 11, no. 4. 1. https://ehjournal.biomedcentral.com/articles/10.1186/1476-069X-11-4

[ii] Campbell et al. 2015. *Getting the basics right- the role of water, sanitation and hygiene in maternal and reproductive health, a conceptual framework*. Tropical Medicine and International Health. Volume 20 No 3 PP 252-267. http://researchonline.lshtm.ac.uk/2026604/

[iii] Prendergast et al. 2015. *Assessment of environmental enteric dysfunction in the SHINE trial: methods and challenges*. CID. Supplemental Article. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4657593/

[iv] Say et al. 2014. *Global causes of maternal mortality: a WHO systematic analysis*. Lancet Glob Health; 2: e323-33. http://www.thelancet.com/journals/langlo/article/PIIS2214-109X(14)70227-X/fulltext

[v] Blencowe, H. et al. 2011. *Clean birth and postnatal care practices to reduce neonatal deaths from sepsis and tetanus: a systematic review and Delphi estimation of mortality effect.* BMC Public Health, 11(Suppl 3): S11 http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3231884/

[vi] Rhee, Mullany, et al. 2008. *Impact of maternal and birth attendant hand-washing on neonatal mortality in southern Nepal*, Pediatr Adolesc Med, vol. 162, no. 7, pp. 603-08. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2587156/

[vii] Umesh Parashar et al. 1998. *Topical antimicrobials applied to the umbilical cord stump: a new intervention against neonatal tetanus*," International Journal of Epidemiology, pp. 27:904-908. http://ije.oxfordjournals.org/content/27/5/904.long

[viii] Bennett, et al. 1997. *Protective effects of topicl antimicrobials against neonatal tetanus*. International Journal of Epidemiology, vol. 26, no. 4. http://ije.oxfordjournals.org/content/26/4/897.full.pdf

[ix] Mullany, Darmstadt et al. *Risk factors for umbilical cord infection among newborns of southern Nepal*. American Journal of Epidemiology, October 2006. http://aje.oxfordjournals.org/content/165/2/203.full

[x] Benova et al. 2014. *Systematic review and meta-analysis: association between water and sanitation environment and maternal mortality*. Tropical Medicine and International Health. 19(4): 368-387 http://doi.org/10.1111/tmi.12275

[xi] Winani et al. 2007. *Use of a clean delivery kit and factors associated with cord infection and puerperal sepsis in Mwanza, Tanzania.* Journal of Midwifery & Women's Health, vol. 52, no. 1, pp. 37-43. http://www.sciencedirect.com/science/article/pii/S152695230600451X

[xii] USAID. 2012. *Better Intrapartum Practices to Reduce Newborn Infection: The Problem of Newborn Infection*. MCHIP Brief. https://www.k4health.org/toolkits/eonc/better-intrapartum-practices-reduce-newborn-infection-meilleures-pratiques-pendant-le

[xiii] Liu et al. 2015. *Global, regional, and national causes of child mortality in 2000-13, with projections to inform post-2015 priorities: an updated systematic analysis.* Lancet; 385:430-40 http://www.who.int/immunization/diseases/tetanus/Lancet-2013-Global-child-mortality.pdf

[xiv] Debes, A. K., Kohli, A., Walker, N., Edmond, K., & Mullany, L. C. 2013. *Time to initiation of breastfeeding and neonatal mortality and morbidity: a systematic review.* BMC Public Health, 13(Suppl 3), S19. http://doi.org/10.1186/1471-2458-13-S3-S19

[xv] Grantham-Mcgregor et al. 2007. *Developmental potential in the first 5 years for children in developing countries*. Lancet. Child development in developing countries http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(07)60032-4/fulltext

[xvi] Crane et al. 2015. *Environmental enteric dysfunction: An overview*. Food and Nutrition Bulletin. 36 (1 0): S76-S87. http://www.ncbi.nlm.nih.gov/pubmed/25902619

[xvii] Horta et al. 2013. *Short-term effects of breastfeeding. A systematic review on the benefits of breastfeeding on diarrhoea and pneumonia mortality*. WHO. http://www.who.int/maternal_child_adolescent/documents/breastfeeding_short_term_effects/en/

[xviii] Lin et al. 2013. *Household environmental conditions are associated with enteropathy and impaired growth in rural Bangladesh.* American Journal of Tropical Medicine and Hygiene 89. 130-137. http://www.ajtmh.org/content/89/1/130

[xix] Cairncross et al. 2010. *Water, sanitation and hygiene for the prevention of diarrhoea*. Int Journ Epi. 39:i193-i205. http://doi.org/10.1093/ije/dyq035

[xx] Mbuya, M., Humphrey, J. 2015. *Preventing environmental enteric dysfunction through improved water, sanitation and hygiene: an opportunity for stunting reduction in developing countries*. Maternal & Child Nutrition. http://www.ncbi.nlm.nih.gov/pubmed/26542185

[xxi] Naylor, C. et al. 2015. *Environmental enteropathy, oral vaccine failure and growth faltering in infants in Bangladesh*. Elsevier BioMedicine. http://doi.org/10.1016/j.ebiom.2015.09.036

[xxii] Levine. 2010. *Immunogenicity and efficacy of oral vaccines in developing countries: Lessons from a live cholera vaccine. BMC* Biology. 2010; 8:129. http://bmcbiol.biomedcentral.com/articles/10.1186/1741-7007-8-129

[xxiii] Ngure F.M. et al. 2013. *Formative research on hygiene behaviours and geophagy among infants and young children and implications of exposure to faecal bacteria*. American Journal of Tropical Medicine and Hygiene 89, 709–716. http://www.ajtmh.org/content/89/4/709

[xxiv] Marquis G.S. et al. 1990. *Faecal contamination of shanty town toddlers in households with non-corralled poultry, Lima, Peru*. American Journal of Public Health 80, 146–149. http://ajph.aphapublications.org/doi/pdf/10.2105/AJPH.80.2.146

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