Workforce interventions to deliver postnatal care to improve neonatal outcomes in low and lower-middle income countries: a narrative synthesis

Abstract

Reducing neonatal mortality rates in low and lower-middle income countries (LMICs) require postnatal interventions to be delivered through an appropriately prepared and supported workforce. This review examines health workforce interventions that deliver integrated packages of postnatal care to improve neonatal outcomes in LMICs. We conducted a structured search of peer-reviewed articles published during 2003-2014 which investigated the delivery of postnatal interventions by formal and lay health workers. We selected 13 studies and analyzed them using a narrative synthesis methodology. This review observed a wide divergence among studies regarding the outcomes as well as the approaches and duration of workforce training and staff supervision. Except four, all studies observed a significant reduction in neonatal mortality. On the other hand, teams of lay health workers appear to be more effective in improving neonatal outcomes. Further improvement in the performance of health care providers may require emphasis on workforce interventions such as competency assessment, the acquisition of appropriate skills and supervisory guidelines. Nevertheless, the heterogeneity and limited number of studies do not allow this review for definitive conclusions and we recommend the need for the harmonization of future studies, with uniformity of outcome measures and cost analyses.

Keywords: Human resources for health; health care provider; neonatal morbidity; neonatal mortality; postnatal intervention; supervision; training; workforce intervention.

Introduction

High neonatal mortality, i.e., deaths within the first 28 days of life, is a serious global health issue with approximately 2.76 million deaths each year.[1] Most of these deaths occur in low and lower-middle income countries (LMICs) where antenatal and postnatal care use is low and many women give birth without skilled attendants.[2] Thus health interventions, delivered by competent, motivated and well supported health workers can lower the neonatal mortality rates in LMICs.[3, 4]

Health interventions that play an essential role in reducing neonatal mortality include antenatal, intrapartum and postnatal care. Key antenatal interventions include tetanus toxoid immunization, syphilis screening and treatment, antibiotics for UTI/STD/asymptomatic bacteriuria, prevention and treatment of pre-eclampsia/eclampsia and malaria prevention.[3] Studies examining different components of antenatal care have observed a significant reduction in neonatal mortality up to 69%.[5-10] Crucial intrapartum interventions include clean delivery practices, vaginal and newborn skin antisepsis, antibiotics for preterm premature rupture of membranes, corticosteroids for preterm labour and caesarean section.[3] One study has indicated that evidence-based intrapartum intervention packages (at 90% coverage) can prevent two to three times more neonatal deaths than those of antenatal care.[3] Finally, important postnatal intervention packages include resuscitation of newborn baby, breastfeeding, prevention and management of hypothermia, kangaroo mother care and community-based pneumonia case management.[3] Studies indicate that home-based postnatal care interventions can prevent newborn deaths as high as 70%.[11-14]

The available information on the cost effectiveness of interventions at different phases of maternal and child health appear to be scarce in the literature. A study on the WHO Afro-D sub-region (Africa with high child and high adult mortality) showed that the average cost per neonatal and maternal years of life lost and years lived with disability was $47.12, $19.00 and $17.59 USD for antenatal, emergency obstetric and essential neonatal care, respectively.[3] Although, emergency obstetric care and essential neonatal care are components of intrapartum and postnatal interventions, this indicates that postnatal interventions can be a cost effective way to reduce neonatal mortality in LMICs.

Postnatal interventions in LMICs are delivered by a wide range of health workers including community health workers, midwives, nurses and doctors. Increases in the density of such health workers can improve infant and child survival.[15] Again, health workers' performance can be improved through multifaceted interventions including the provision of training, written guidelines and supervision, which, however, requires the assessment of training as well as identifying the contextual factors.[16-19]

Previous systematic reviews have assessed the effectiveness of community health workers/lay health workers to deliver curative and preventative interventions for maternal and child health (MCH).[20-23] However, there is no systematic review that examines workforce interventions to best support health workers in delivering postnatal interventions in LMICs. Against this background, this paper reports the findings of a narrative synthesis of peer reviewed articles to understand the effectiveness of the health workforce. We specifically aim to identify health workforce interventions that deliver integrated packages of postnatal care to improve the neonatal outcomes in LMICs.

Methods

Due to the heterogeneous nature of the methodologies of selected studies, this review used a narrative synthesis approach.[24] Thus we report the characteristics, context, quality and findings of selected research papers according to a standard format. Unlike a descriptive review, a narrative synthesis methodology uses a systematic approach involving structured summaries where the extracted data are elaborated upon and then contextualised.

Search protocol

A Population, Interventions, Comparators, Outcomes, Study design (PICOS) question was formed to guide this review.[25] The PICOS question was: how have the health care providers been trained and supervised to deliver integrated packages of postnatal care that have led to improved neonatal outcomes in LMICs. Health care providers in this review included both formal health workers (e.g. auxiliary nurses and midwives, registers nurses and midwives and doctors) and lay health workers (e.g. community health workers, village health workers and traditional birth attendants). Lay health workers had no formal professional or paraprofessional tertiary education and were usually provided on-the job training by formal health professionals.[20]

This study aimed to investigate health workforce interventions such as the provision of training, supervision and teamwork. We considered studies on neonates as participants who were born in LMICs. Relying on the WHO guidelines, an intervention was consider postnatal if it included any intervention listed in Table 1.[2] Studies considered in this review investigated the delivery of integrated packages of these interventions. Outcomes of interest included the neonatal mortality rate (NMR) and/or perinatal mortality rate (PMR) or morbidity. Randomized trials, quasi-experimental, observational and descriptive studies were eligible for inclusion.

[Table 1]

We concentrated only on recent health intervention programs and searched MEDLINE, PubMed, Scopus, ScienceDirect, Web of science, CINAHL and Google Scholar for peer-reviewed articles in English (Table 2).. We undertook this review in 2015 and like other reviews [26, 27]we selected a twelve year period (2003 to 2014) to ensure an analysis of the most contemporary research. The Medline MeSH subject headings were employed: 'postnatal intervention' or 'postnatal care' or 'postnatal check-up' and 'neonates' or 'newborn' or 'neonatal' and 'Developing countries', and augmented by the key words 'health personnel' or 'health care provider' or 'health worker' or 'lay health worker' or 'community health worker'.

[Table 2]

We initially retrieved 512 articles and screened these articles as per the PICOS question. Following the screening process, 43 articles remained and were examined in more detail. At this stage, studies were excluded (listed in Appendix A) for not being an integrated interventions package (10 articles), not satisfying the outcome of interest (12 articles), not associated with the appropriate postnatal intervention (4 articles), no stated intervention (2 articles), being pilot study (1 article for which the final study was included in this review) and being study protocol (1 article). Thus, a total of 13 articles were selected for quality assessment. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline was used to report the review process (Figure 1).[28]

[Figure 1]

Quality assessment

The quality of the selected articles were assessed using the Effective Public Health Practice Project (EPHPP) tool for quantitative studies.[29] The studies were scored as strong, moderate

and weak with regard to the selection bias, study design, confounders, blinding, data collection methods, withdrawals/drop-outs, intervention integrity and analyses. All 13 articles in our analysis either have no (eight studies) or one (five studies) weak rating in any of the components.

Data extraction and synthesis

Data was extracted systematically from the findings sections of all papers and directed by the PICOS question. The characteristics of all studies including the context and method were examined. Tables were used to collate aspects of the studies and the contents of the cells discussed among authors. A textual narrative approach to the analysis of the study findings was undertaken as described by Lucas et al.[30] This involved a commentary approach to the description and comparison of data that was grouped into various categories. These categories (type of health workers, workforce interventions and postnatal interventions) were informed by the literature and examined in relation to postnatal outcomes.[2, 31] Data was then synthesized by combining studies with similar types of health workers and patterns identified across and within articles. All the authors reviewed the selected articles.

Results

All 13 articles in this review were summarized in Table 3. Among these articles, nine focused on South Asia,[11-14, 32-36] three on Africa[37-39] and one on countries from Asia, Africa and Latin America.[40] The design of a majority of the studies (seven) was cluster randomized controlled trial (RCT).[12-14, 35, 36, 38, 39] Other study designs include cluster controlled trial (not randomized), quasi-experimental and active baseline (an improvement over the before/after controlled study design).[11, 34, 37] The remaining study had two parts; the first part involved a before-after the intervention design and the other part relied on a cluster RCT design.[40] In order to deliver the postnatal intervention packages, selected studies involved a range of

health workers including lay health workers (community health workers (CHWs), village health workers (VHWs), traditional birth attendants (TBAs), community mobilisers, unqualified medical practitioners, maternal and child health promotion workers, community-based surveillance volunteers (CBSVs), community health committees (CHCs), volunteers) and formal health workers (lady health workers (LHWs), auxiliary nurses, midwives, physicians). We categorized the health workers as 'individual lay health workers', 'teams of lay health workers', 'teams of lay and formal health workers' and 'formal health workers' and then presented our group-wise findings according to workforce interventions, performance including contribution to neonatal health outcomes and cost effectiveness.

Training and supervision

Individual lay health workers

Studies by Gill et al.[38] and Kirkwood et al.[39] investigated the contribution of individual lay health workers who conducted home visits in improving neonatal outcomes. Gill et al.[38] provided a one-week training to TBAs in the intervention area through interactive lectures, demonstrations and small group sessions. Before the final selection, TBAs had to successfully complete a one on one skill assessment. On the other hand, Kirkwood et al.[39] provided a nine-day training including a two-day refresher course to the CBSVs. The CBSVs were supervised through individual monthly meetings and group supervision meetings held in every two months.

Teams of lay health workers

Five articles[11, 12, 32, 33, 35] concentrated on workforce initiatives for teams of lay health workers in which VHWs/CHWs, together with the TBAs, contributed to the delivery of antenatal and postnatal care through home visits. VHWs in Bang et al.[11], who had 5 to 10 years of schooling, received a classroom based 36-day training program that was spread over a year

and practiced their skills in the community over the training period.[41] Moreover, they attended a three-day workshop on the management of babies who did not cry/breathe at birth.[42] In contrast, TBAs in the study were trained on clean and safe home deliveries and mouth-to-mouth resuscitation of babies.[42] CHWs in Baqui et al.[12] received a six weeks hands-on supervised training course in tertiary-care hospitals and in households. CHWs in Darmstadt et al.[35], who had at least 10 years of schooling, received a 36-day training course through didactic sessions, videos and practice on newborn babies in hospitals.[43] Moreover, TBAs in these studies received a two-day orientation program on the aim of the study and newborn care practices. Baqui et al.[12] additionally employed community mobilisers who promoted birth and newborn-care messages through group meetings and provided refresher training to government health workers. Intensive supervision was provided to health workers in all these studies that involved the provision of feedback and the evaluation of quality work performance.

Teams of lay and formal health workers

Five studies[13, 14, 34, 36, 40] investigated the contribution of team work by lay and formal health workers in reducing neonatal mortality. Baqui et al.[34] investigated services of maternal and child health promotion (*anganwadi*) workers, auxiliary nurse-midwives and community volunteers, of which the first two were government sponsored functionaries. All three groups in the intervention area that conducted home visits received six days training on maternal and newborn care .

Bhandari et al.[36] delivered intervention through both home visits and health centre and employed CHWs, auxiliary nurse midwives and government physicians in which the former two groups received eight days training while the latter group received 11 days training. Private healthcare providers and TBA's received six hours and four hours of orientation

training, respectively. Supervisors, with training on the program and supervision skills, supervised CHWs and nurse midwives.[36]

The study by Bhutta et al.[13] employed a team of LHWs, TBAs/Dais and CHCs and delivered intervention through home visits. Regular LHWs, who had at least 8 years of schooling, received trainings on preventive newborn care for a period of 15 months, including a three months didactic training and monthly refresher sessions. The LHWs in the intervention area received an extra six days of training on maternal and newborn care. The LHWs training was supervised by regular LHWs program supervisors and trainers. Community mobilisers from a local university helped LHWs to identify community volunteers, who were encouraged to form CHCs to assist the LHWs.[13]

Birth attendants who made home visits in Carlo et al.[40] (TBAs, nurses, midwives, and physicians) received three days of training before the baseline period and three days of ENC training after the baseline period. In the other part of the study, birth attendants additionally received three days training on a modified version of the American Academy of Paediatrics Neonatal Resuscitation Program.[40]

Kumar et al.[14] employed CHWs, newborn stakeholders and community volunteers. CHWs, who had at least 12 years of schooling, were trained using seven days of classroom and apprenticeship-based field exercises on ENC. In addition to daily and monthly program meetings, the performances of CHWs were assessed and monitored by supervisors through spot checks during their home visits.[14]

Formal health workers

The study by Carlo et al.[37] used a train-the-trainer model in which research nurses received a five-day training before the baseline period and a five-day training on ENC after the baseline

period who then trained the practicing midwives with 3 years of college degree in midwifery and worked in community health clinic. After the completion of the ENC training, research nurses again received five days training on neonatal resuscitation program and subsequently trained the practicing midwives.

Neonatal health outcomes

Individual lay health workers

Gill et al.[38] reported that trained TBAs, in comparison with existing services, contributed to a 45% reduction in NMR with maximum reductions occurring for the first 24 hours after birth. On the other hand, trained CBSVs in the Kirkwood et al.[39] contributed to reducing NMR by only 8%, compared with usual services.

Teams of lay health workers

Bang et al.[11] observed that VHWs played a significant role in the reduction of NMR by 70%, including early NMR (64%) and PMR (56%), compared to the usual care provided in the local health system. Further, Bang et al.[32] reported the contribution of VHWs in the reduction of neonatal morbidities through the delivery of intervention. The mean number of morbidities was found to decrease over the years (49.6%) alongside an increase in the delivery of multiple interventions, indicating a dose-response relationship.

Baqui et al.[12] observed a 34% reduction in NMR for the CHWs who worked through home visits but did not observe any contribution of community mobilisers. In a nested study from the same trial, Baqui et al.[33] find case fatality rates lower for CHWs treated cases (4.4%) compared with qualified medical providers (14.2%) and unqualified providers/no treatment (28.5%). Darmstadt et al.[35] found no contribution of CHWs (who worked with TBAs).

Teams of lay and formal health workers

Interventions in Baqui et al.[34] contributed to reduce NMR by 34% for the women who received at least one postnatal visit within 28 days , compared with the women who received no visit. In contrast, interventions in Carlo et al.[40] did not affect either the 7-day NMR or the perinatal death. Study by Bhandari et al.[36] concluded that the intervention significantly reduced neonatal deaths beyond the first 24 hours after birth by 14%. Interventions in Bhutta et al.[13] resulted in a significant reduction in NMR (15%) including early NMR (14%). ENC intervention in Kumar et al.[14] significantly reduced both neonatal deaths (54%) and perinatal deaths (41%). The study also observed a significant reduction in NMR (52%) for the ENC plus ThermoSpot group.

Formal health workers

ENC trained midwives contributed to reducing the 7-day NMR by 41%, compared to the regular trained midwives.[37] Midwives trained on neonatal resuscitation program also contributed to reducing NMR.

Cost effectiveness

Individual lay health workers

Gill et al.[38] did not report cost effectiveness of the program but referred to Sabin et al.[44] which estimated the cost of avoiding each neonatal death as $1,866, $591, and $3,024 for the base, optimistic, and conservative scenario, respectively. Note that Kirkwood et al.[39] did not report any cost effectiveness analysis.

Teams of lay health workers

An article, not included in this review, revealed that the cost of intervention package delivered by VHWs in Bang et al.[11] was US$5.30 per averted newborn death.[45] Estimated cost of the home-care intervention delivered by CHWs in Baqui et al.[12] was US$2,995

(including health-systems strengthening costs) per averted neonatal death. Note that Darmstadt et al.[35] did not report any cost of averting neonatal deaths.

Teams of lay and formal health workers

No study in this group included a cost effectiveness analyses.

Formal health workers

The intervention costs of the study by Carlo et al.[37] were $208 per life saved.[46]

[Table 3]

Discussion

Our systematic review revealed a range of workforce interventions to improve the health workers performance in delivering postnatal care to neonates. Key findings in this review demonstrated the differences among the studies with regard to the workforce interventions and associated neonatal outcomes (Table 4). For example, the duration of the training programs ranged from 6 days to 6 weeks, dispersed over a maximum period of 12 months. Differences in approaches to training, supervision and assessment as well as in the components of postnatal interventions also observed, resulting in the heterogeneity in findings across studies. Four studies did not find any significant impact, while other observed a significant reduction in NMR, with the rates varying from 8% - 70%.

[Table 4]

This review has investigated issues related to workforce intervention for different health cadres in LMICs which may have contributed to improved neonatal health. Such issues include training, supervisory mechanism, competency assessment, appropriate skill and

workforce challenges. Below, in connection to the studies under review, we categorise these issues as workgroup specific and general and discuss each separately.

Workgroup specific issues of health intervention

Individual lay health workers

Gill et al.[38] employed a single component intervention (training only), with competency assessment of TBAs and observed a significant reduction in NMR. In contrast, Kirkwood et al.[39] employed a multifaceted intervention (training and supervision) without competency assessment and did not observe any significant reduction in NMR. It indicates that, while individual lay health workers might play a role in the reduction of neonatal mortality, a better outcome might require competency assessment of the workforce. Nevertheless, the functions of the lay health workers and the delivered interventions were different between these two studies. Therefore, studies with more comparable interventions are essential to conclude about their effect on neonatal health.

Teams of lay health workers

All five articles in this group were supported by multifaceted workforce interventions but only Darmstadt et al.[35] considered the assessment of health worker competencies and employed a standardized guideline based supervisory monitoring. However, the study found no impact of intervention, which could be due to a skill miss-match, where CHWs received training in the management of neonatal sepsis while around 60% of deaths in the intervention area were attributed to birth asphyxia and prematurity. In contrast, Baqui et al.[12] found a significant reduction on NMR using a package of similar interventions. All other articles also observed a significant improvement in neonatal morbidity and mortality. Thus, the evidence supports the hypothesis that teams of lay health workers can contribute to preventing neonatal morbidity and mortality. This may be due to a shortage of adequately trained formal health

workers in LMIC. However, studies identified here need to be examined carefully before designing any workforce intervention.

Teams of lay and formal health workers

Among the five studies in this group, three employed multifaceted interventions[13, 14, 36] while two included a single component intervention.[34, 40] None of these studies described the assessment of health worker competencies and guidelines for supervisory activities and only two studies observed a significant reduction in the overall NMR.[13, 14] A lack of linkages between lay and formal health workers might be responsible for the weak performance of the team. Again, comparable studies are needed to make any conclusive remarks as the team composition and workforce interventions vary across the studies.

Formal health workers

Only Carlo et al.[37] employed formal health workers and used a single component workforce intervention. It suggests that training may play a significant role in reducing NMR. While the finding is consistent with a recent study on midwifery training, more comparable researches are required to conclude about the role of training.[46]

General issues of health workers intervention

Multifaceted interventions are more effective in improving performance compared to the single component interventions.[19, 47] With the exception of four studies, all studies included in this review employed multifaceted interventions. Supervision is also important to improve the health worker's performance.[19, 48-50] Quality supervision that involves support, feedback and monitoring, can improve health workers' job satisfaction, motivation and professional development which ultimately enhances their performances.[19, 49] A majority of the studies in our review emphasized on intensive supervision that included feedback and evaluation of

work quality. While, guideline and staff participation can improve supervision, only Darmstadt et al.[35] mentioned about them.[48]

Competency assessment was also an important component of training packages.[47] In our review, only two studies[35, 38] reported the use of competency assessment of health workers as part of CHWs and TBAs training. A recent review on training resources for CHWs found that nearly half of the training packages, did not include competency assessment.[47] Acquisition of appropriate knowledge and skills required to detect relevant clinical signs may enhance the performance of health workers. A miss-match between clinical skills training and health needs could have occurred in the study by Darmstadt et al.[35], which found no impact of intervention.

Workforce challenges in LMICs such as heavy workloads, night visits, travelling outside the local area, familial opposition and dissatisfaction with pay might affect the performance of health workers directly and also indirectly through workforce turnover.[51, 52] For example, CHWs in Baqui et al.[12] only attended 5% of deliveries due to a lack of timely communication, long commuting distances and a high volume of work. Similar difficulties were also experienced by CHWs in Darmstadt et al.[35]

Limitations

We identified a number of limitations of this review. Firstly, little information was available on how the workforce was managed in some studies included in this review. Some papers do not describe workforce interventions in detail and information concerning workforce components was sought from related papers that report on other aspects of the same study. Secondly, most of the studies did not include an analysis of the cost of the interventions and programs which are required to identify what workforce interventions are cost effective in delivering postnatal cares. As a result, we focused on neonatal health outcomes to draw

conclusions about the effect of interventions. Thirdly, selected studies may suffer from a publication bias as most of the published studies only report positive results. Finally, the results rely on a relatively small number of studies that makes it difficult to draw definite conclusions.

Conclusions

This review examines a variety of health workforce interventions with a range of health workers, trained in delivering the postnatal care for improving neonatal health in LMICs. We find that further improvements in the performance of health care providers require more emphasis on workforce intervention components such as competency assessment, acquisition of appropriate skill, quality supervision and workforce challenge. In our review, teams of lay health workers appear to be more effective in reducing neonatal mortality and morbidity compared with other groups. This indicates that employing lay health workers can be a good way to combat against neonatal mortality in weak health system. However, the heterogeneity and limited number of available studies do not allow for definitive conclusions regarding the impact of workforce interventions.

This review highlights the importance of training guidelines and points towards the need for developing standard training guidelines for the health workers. We also recommend including cost-benefit analyses in future studies which are important to evaluate and compare the effectiveness of the interventions. Harmonization of future studies, with uniformity of outcome measures and cost analyses, can be useful in comparing the impact of workforce interventions in reducing the neonatal mortality in LMICs. This would allow data from different sources to be combined and compared to facilitate a better understanding of appropriate intervention measures. A useful point is that most of the studies in this review

rely on the Asia Pacific region which makes our study more relevant for designing workforce interventions in the area, where a vast number of neonatal mortality occurs.

Appendix A

Table A1: Characteristics of excluded studies

Reference	Reasons for exclusion
1. Ahmed S, Mitra SN, Chowdhury AM, Camacho LL, Winikoff B, Sloan NL. Community Kangaroo Mother Care: implementation and potential for neonatal survival and health in very low-income settings. Journal of Perinatology. 2011; 31:361-7. 2. Arifeen SE, Mullany LC, Shah R, Mannan I, Rahman SM, Talukder MRR, et al. The effect of cord cleansing with chlorhexidine on neonatal mortality in rural Bangladesh: a community-based, cluster-randomised trial. The Lancet. 2012; 379:1022-8. 3. Jokhio AH, Winter HR, Cheng KK. An intervention involving traditional birth attendants and perinatal and maternal mortality in Pakistan. New England Journal of Medicine. 2005; 352:2091-9. 4. Lawn JE, Mwansa-Kambafwile J, Horta BL, Barros FC, Cousens S. 'Kangaroo mother care'to prevent neonatal deaths due to preterm birth complications. International journal of epidemiology. 2010; 39:i144-i54. 5. Mullany LC, Darmstadt GL, Khatry SK, Katz J, LeClerq SC, Shrestha S, et al. Topical applications of chlorhexidine to the umbilical cord for prevention of omphalitis and neonatal mortality in southern Nepal: a community-based, cluster-randomised trial. The Lancet. 2006; 367:910-8. 6. Mullany LC, Katz J, Li YM, Khatry SK, LeClerq SC, Darmstadt GL, et al. Breast-feeding patterns, time to initiation, and mortality risk among newborns in southern Nepal. The Journal of nutrition. 2008; 138:599-603. 7. Rao P, Udani R, Nanavati R. Kangaroo mother care for low birth weight infants: a randomized controlled trial. Indian pediatrics. 2008; 45. 8. Sharma D, Gathwala G. Impact of chlorhexidine cleansing of the umbilical cord on cord separation time and neonatal mortality in comparison to dry cord care-a nursery-based randomized controlled trial. The Journal of Maternal-Fetal & Neonatal Medicine. 2013:1-4. 9. Soofi S, Cousens S, Imdad A, Bhutto N, Ali N, Bhutta ZA. Topical application of chlorhexidine to neonatal umbilical cords for prevention of omphalitis and neonatal mortality in a rural district of Pakistan: a community-based, cluster-randomised trial. The Lancet. 2012; 379:1029-36. 10. Tielsch JM, Darmstadt GL, Mullany LC, Khatry SK, Katz J, LeClerq SC, et al. Impact of newborn skin-cleansing with chlorhexidine on neonatal mortality in southern Nepal: a community-based, cluster-randomized trial. Pediatrics. 2007; 119:e330-e40.	Not being an integrated interventions package
1. Azad K, Barnett S, Banerjee B, Shaha S, Khan K, Rego AR, et al. Effect of scaling up women's groups on birth outcomes in three rural districts in Bangladesh: a cluster-randomised controlled trial. The Lancet. 2010; 375:1193-202. 2. Darmstadt GL, Saha SK, Ahmed A, Chowdhury M, Law PA, Ahmed S, et al. Effect of topical treatment with skin barrier-enhancing emollients on nosocomial infections in preterm infants in Bangladesh: a randomised controlled trial. The Lancet. 2005; 365:1039-45. 3. Darmstadt GL, Saha SK, Ahmed ANU, Ahmed S, Chowdhury MA, Law PA, et al. Effect of skin barrier therapy on neonatal mortality rates in preterm infants in Bangladesh: a randomized, controlled, clinical trial. Pediatrics.	Not associated with the appropriate postnatal intervention

Reference	Reasons for exclusion
2008; 121:522-9. 4. Manandhar DS, Osrin D, Shrestha BP, Mesko N, Morrison J, Tumbahangphe KM, et al. Effect of a participatory intervention with women's groups on birth outcomes in Nepal: cluster-randomised controlled trial. The Lancet. 2004; 364:970-9.	
1. Baqui A, Arifeen S, Darmstadt G, Ahmed S, Seraji H, Winch P, et al. Differentials in neonatal mortality in two adjacent rural areas of Bangladesh: lessons for neonatal health interventions. Global Public Health. 2008; 3:366-82. 2. Darmstadt GL, Hussein MH, Winch PJ, Haws RA, Gipson R, Santosham M. Practices of rural Egyptian birth attendants during the antenatal, intrapartum and early neonatal periods. Journal of health, population, and nutrition. 2008; 26:36.	No stated intervention
1. Baqui AH, Rosecrans AM, Williams EK, Agrawal PK, Ahmed S, Darmstadt GL, et al. NGO facilitation of a government community-based maternal and neonatal health programme in rural India: improvements in equity. Health policy and planning. 2008; 23:234-43. 2. Bari S, Mannan I, Rahman MA, Darmstadt GL, Serajil MHR, Baqui AH, et al. Trends in use of referral hospital services for care of sick newborns in a community-based intervention in Tangail District, Bangladesh. Journal of Health, Population and Nutrition. 2006; 24:519 - 29. 3. Callaghan-Koru JA, Seifu A, Tholandi M, de Graft-Johnson J, Daniel E, Rawlins B, et al. Newborn care practices at home and in health facilities in 4 regions of Ethiopia. BMC pediatrics. 2013; 13:198. 4. Darmstadt G, Kumar V, Yadav R, Singh V, Singh P, Mohanty S, et al. Introduction of community-based skin-to-skin care in rural Uttar Pradesh, India. Journal of perinatology. 2006; 26:597-604. 5. Darmstadt GL, El Arifeen S, Choi Y, Bari S, Rahman SM, Mannan I, et al. Household surveillance of severe neonatal illness by community health workers in Mirzapur, Bangladesh: coverage and compliance with referral. Health policy and planning. 2010; 25:112-24. 6. Darmstadt GL, Saha SK, Choi Y, El Arifeen S, Ahmed NU, Bari S, et al. Population-based incidence and etiology of community-acquired neonatal bacteremia in Mirzapur, Bangladesh: an observational study. Journal of Infectious Diseases. 2009; 200:906-15. 7. Kumar V, Kumar A, Das V, Srivastava NM, Baqui AH, Santosham M, et al. Community-driven impact of a newborn-focused behavioral intervention on maternal health in Shivgarh, India. International Journal of Gynaecology & Obstetrics. 2012; 117:48-55. 8. McClure EM, Carlo WA, Wright LL, Chomba E, Uxa F, Lincetto O, et al. Evaluation of the educational impact of the WHO Essential Newborn Care course in Zambia. Acta Paediatrica. 2007; 96:1135-8. 9. Mannan I, Rahman SM, Sania A, Seraji HR, Arifeen SE, Winch PJ, et al. Can early postpartum home visits by trained community health workers improve breastfeeding of newborns? Journal of Perinatology. 2008; 28:632-40. 10. Nalwadda CK, Waiswa P, Kiguli J, Namazzi G, Namutamba S, Tomson G, et al. High Compliance with Newborn Community-to-Facility Referral in Eastern Uganda:. An Opportunity to Improve Newborn Survival. PloS one. 2013; 8:e81610.	Not satisfying the outcome of interest

Reference	Reasons for exclusion
11. Opiyo N, Were F, Govedi F, Fegan G, Wasunna A, English M. Effect of newborn resuscitation training on health worker practices in Pumwani Hospital, Kenya. PLoS One. 2008; 3:e1599. 12. Syed U, Asiruddin S, Helal MS, Mannan II, Murray J. Immediate and early postnatal care for mothers and newborns in rural Bangladesh. Journal of health, population, and nutrition. 2006; 24:508.	
1. Bhutta ZA, Memon ZA, Soofi S, Salat MS, Cousens S, Martines J. Implementing community-based perinatal care: results from a pilot study in rural Pakistan. Bulletin of the World Health Organization. 2008; 86:452-9.	Pilot study for which the final study was included in this review
1. Mullany LC, El Arifeen S, Winch PJ, Shah R, Mannan I, Rahman SM, et al. Impact of 4.0% chlorhexidine cleansing of the umbilical cord on mortality and omphalitis among newborns of Sylhet, Bangladesh: design of a community-based cluster randomized trial. BMC pediatrics. 2009; 9:67.	Study protocol

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Declaration of Conflicting Interests

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3. Darmstadt GL, Bhutta ZA, Cousens S, Adam T, Walker N, de Bernis L. Evidence-based, cost-effective interventions: how many newborn babies can we save? *The Lancet*. 2005; 365:977-88.

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Table 1: Postnatal interventions for newborns

Postnatal interventions (newborn)	**Referral level**	**1st level**	**Community**
Immediate thermal care (immediate drying, warming, skin to skin, delayed bathing)	X	X	X
Initiation of exclusive breastfeeding (within first hour)	X	X	X
Hygienic cord and skin care	X	X	X
Neonatal resuscitation with bag and mask (professional health worker)	X	X	-
Case management of neonatal sepsis, meningitis and pneumonia	X	X	-
Kangaroo mother care for preterm and for less than 2000g babies	X	X	-
Management of newborns with jaundice	X	X	-
Surfactant to prevent respiratory distress syndrome in preterm babies	X	-	-
Continuous positive airway pressure (CPAP) to manage babies with respiratory distress syndrome	X	-	-
Extra support for feeding small and preterm babies	X	X	-
Presumptive antibiotic therapy for newborns at risk of bacterial infection	X	-	-

Source*:* A global review of the key interventions related to reproductive, maternal, newborn and child health (RMNCH)[2]

Table 2: Articles retrieved from the databases searched

Database	**Articles retrieved**
MEDLINE	59
PubMed	124
Scopus	173
ScienceDirect	87
Web of science	35
CINAHL	20
Google Scholar	14
Total	512

Table 3: Summary of studies included in the synthesis

Reference, objective, setting and study design	Types of health worker	Workforce interventions	Postnatal interventions	Findings
		Individual lay health workers		
Reference: Gill et al.[38] **Objective:** To determine whether training of TBAs to manage several common perinatal conditions could reduce neonatal mortality **Setting:** Lufwanyama, Zambia **Study design:** Cluster RCT	Traditional birth attendants (TBAs)	**Training:** TBA's in intervention area received one week training on a modified version of the neonatal resuscitation protocol through interactive lectures, demonstrations, small group sessions, and skills practice by infant manikins. They had to complete a one on one skill assessment satisfactorily. Moreover, refresher workshops held in every three to four months throughout the study period in both intervention and control area. TBA's in intervention area needed to attend competency assessment in every workshop. Members of the study team trained TBA's. **Supervision:** Not discussed.	• Promoted a modified version of the neonatal resuscitation protocol • Provided antibiotics (single dose amoxicillin) with facilitated referral of infants to health centres, if needed	1. The NMR reduced by 45% among live born infants delivered by intervention birth attendants than control birth attendants (RR: 0.55; 95% CI: 0.33, 0.90) 2. The maximum reductions in mortality were in the first 24 hours after birth (RR: 0.40; 95%CI: 0.19, 0.83) 3. The NMR during the first week of life reduced by 44% (RR: 0.56; 95% CI: 0.32, 1.01) 4. Deaths due to birth asphyxia, delivered by intervention birth attendants, were reduced by • 63% (RR: 0.37; 95% CI: 0.17, 0.81) and • 81% (RR: 0.19; 95% CI: 0.07, 0.52) within the first two days after birth.
Reference: Kirkwood et al.[39] **Objective:** To test home-visits strategy by assessing the effect on all-cause NMR and ENC practices	Community-based surveillance volunteers (CBSVs)	**Training:** CBSVs received a total of nine days training over eight months in three phases, including refresher training for two days. **Supervision:** Individual sessions held in each month	1. Made two home visits during pregnancy 2. Made three postnatal visit in the first week of neonate's life (day 1,3 and 7) • to promote ENC practices • to weigh and assess babies for danger signs	1. The NMR reduced by 8% in intervention zones compared to control zones (RR: 0.92; 95% CI: 0.75, 1.12) 2. The post day 1 NMR reduced by 15% in intervention zones compared to control zones (RR: 0.85; 95% CI: 0.64,

Reference, objective, setting and study design	Types of health worker	Workforce interventions	Postnatal interventions	Findings
Setting: BrongAhafo Region, Ghana **Study design:** Cluster RCT		with observation of home visit and supportive feedback. Group supervision meetings held in every two months.	• to refer if required	1.13)
		Teams of lay health workers		
Reference: Bang et al.[11] **Objectives:** To evaluate the effect of home-based neonatal care (HBNC) on neonatal and infant mortality **Settings:** Gadchiroli, India **Study design:** Clustered controlled trial (not randomized)	Female village health workers (VHWs) and trained traditional birth attendants (TBAs)	**Training:** VHWs, who had 5 to 10 years of schooling, received 36 days classroom based training, spread over a period of one year (three days in each month), including practicum periods in the community (about two births in each month). VHWs also attended a three-day workshop on managing babies who did not cry or breathe at birth, followed by a review and assessment workshop held after two months. TBAs in the intervention villages were trained on clean and safe home delivery, and on mouth-to-mouth resuscitation of babies. **Supervision:** Intensive field supervision (twice in a month) was conducted as an extension of training and support. **Teamwork:** VHWs worked with the cooperation of TBAs.	• Attended delivery, along with the TBAs • Encouraged the family and the TBAs for referral when necessary • Assessed the baby immediately after birth • Managed birth asphyxia, used bag and mask if necessary • Initiated early and exclusive breast feeding • Injected vitamin K1 mg, on the day of birth • Provided thermal care of the neonate • Took extra care if the baby was in high-risk status • Conducted repeated home visits (8–12 times) during neonatal period to ensure breast-feeding, thermal care, hygiene, and to monitor the baby for any infection • Provided early diagnosis and treatment of neonates with sepsis, including administration of two antibiotics – co-trimoxazole and gentamicin	1. The NMR in the intervention area declined from 62 (1993 to 1995) to 25 (2001 to 2003) per 1000 livebirths 2. The NMR increased in the control area from 58 (1993 to 1995) to 64 (2001 to 2003) per 1000 livebirths 3. The reduction in the intervention area compared to the control area was • NMR: 44 points (70%; 95% CI: 59, 81%) • Early NMR: 24 points (64%; 95% CI: 49, 79%) • Late NMR: 20 points (80%; 95% CI: 64, 95%). • Stillbirth rate: 16 points (49%; 95% CI: 31, 66%) • PMR: 38 points (56%; 95% CI: 44, 68%) 4. The cause-specific NMR (1995 to 1996 vs 2001 to 2003) decreased by • Sepsis: 89.8% (95% CI: 78.6, 101.0%) • Asphyxia:53.3% (95% CI: 23.8, 82.8%)

Reference, objective, setting and study design	Types of health worker	Workforce interventions	Postnatal interventions	Findings
			• Offered home-based care of LBW or preterm neonates • Performed weekly weighing, problem solving, advising and helping mother • Provided referral service when necessary	• Prematurity: 38.0% (95% CI: 4.3, 71.6%)
Reference: Bang et al.[32] **Objective:** To evaluate the effect of home-based neonatal care (HBNC) on neonatal morbidities by comparing the early period against the late period in the intervention arm of the trial **Settings:** Gadchiroli, India **Study design:** Clustered controlled trial (not randomized)	Female village health workers (VHWs) and trained traditional birth attendants (TBAs)	**Training:** VHWs, who had 5 to 10 years of schooling, received 36 days classroom based training, spread over a period of one year (three days in each month), including practicum periods in the community (about two births in each month). VHWs also attended a three-day workshop on managing babies who did not cry or breathe at birth, followed by a review and assessment workshop held after two months. TBAs in the intervention villages were trained on clean and safe home delivery, and on mouth-to-mouth resuscitation of babies. **Supervision:** Intensive field supervision (twice in a month) was conducted as an extension of training and support. A physician made home visits (in every fortnight) to all neonates to ensure quality and recorded parallel observations on 119 consecutive neonates independently to evaluate the quality. **Teamwork:** VHWs worked in cooperation with the	**In 1995-96,** • Attended home deliveries conducted by TBAs • Made eight home visits to observe the new born baby during the neonate period **In 1996-97** • VHWs advised and demonstrated mothers in neonatal care at home • Identified neonatal morbidities such as asphyxia, prematurity, birth weight <2000 g, sepsis, hypothermia, breast feeding problems, conjunctivitis, skin infections, umbilical sepsis and fever • Treated illnesses appropriately • Advised hospitalisation for serious illness **In 1997-1998** • Introduced intensive health education	1. The mean number of morbidities per 100 neonates in 1995-96, 1996-97 and 1997-98 was 228, 170 and 115 respectively (a reduction of 49.6%; p<0.001) and it showed a dose–response relationship with the multiple interventions in HBNC 2. The change in the incidence of morbidities was • **Infections**: from 61.6 to 27.5 (-55%; p<0.001) • **Care-related morbidities**: (asphyxia, hypothermia, feeding problems) from 48.2 to 26.3 (-45%; p<0.001) • **Low birth weight:** from 41.9 to 35.2 (-16%; p<0.05) • **Preterm birth and congenital anomalies**: remained unchanged

Reference, objective, setting and study design	Types of health worker	Workforce interventions	Postnatal interventions	Findings
		TBAs.		
Reference: Baqui et al.[12] **Objective:** To promote neonatal health through two service-delivery strategies - a home-care model and a community-care model **Settings:** Sylhet, Bangladesh **Study design:** Cluster RCT	Female community health workers (CHWs), female and male community mobilisers and female volunteers (usually TBAs)	**Training:** CHWs received a six weeks hands-on training in a tertiary-care hospital and in households. They again attended a three-day refresher training in middle of the intervention. TBAs in homecare and community care arm had attended a two-day orientation programme on cleanliness during delivery, maternal danger signs, and newborn care. Refreshers training were provided to government health workers in homecare, community care and comparison arm. **Supervision:** A group of six to eight CHWs were supervised by each field supervisor who, in every month, spent at least two days with each CHW to provide feedback on their work. In fortnightly group meetings, CHWs could also discuss the field problems with senior supervisors. **Teamwork:** CHWs and community mobilisers worked in homecare arm. Female volunteers were recruited in the community care arm and work with community mobilisers.	**Homecare arm:** **CHWs** • Made both antenatal and postnatal (1st, 3rd, and 7th days of birth) home visits to promote birth and newborn care preparedness • Assessed newborns and classified illnesses as very severe disease (VSD) or possible VSD • Referred to hospitals if required • Treated sick neonates at home if families were unable to comply with referral • Visited daily to complete the 10-day course of antibiotic therapy • Reinforced referral if neonates diagnosed with possible VSD with one sign **Community-care arm:** Female and male community mobilisers promoted birth and newborn-care messages through group meetings only	In the last 6 months of the 30-month intervention, 1. NMR 29.2 per 1000 live births (home-care arm) 2. NMR 45.2 per 1000 live births (community-care) 3. NMR 43.5 per 1000 live births (comparison arms) 4. NMR reduced by 34% in the home-care arm compared to comparison arm (adjusted RR: 0.66; 95% CI: 0.47, 0.93) 5. No mortality reduction was observed in the community-care arm (adjusted RR: 0.95; 95% CI: 0.69, 1.31)
Reference: Baqui et al.[33] **Objective:** To assess the relative	Community health workers (CHWs)and community mobilisers	**Training:** CHWs received six weeks hands-on training in a tertiary-care hospital and in households. They also received a three-day refresher training in middle of the	• Made both antenatal and postnatal (1st, 3rd, and 7th days of birth) home visits to promote birth and newborn care preparedness	1. Case fatality rate for VSD • 4.4% (95% CI: 2.0, 8.2%) if treated by CHWs • 14.2% (95% CI: 9.2, 20.5%) if treated by

Reference, objective, setting and study design	Types of health worker	Workforce interventions	Postnatal interventions	Findings
effectiveness of neonatal infection management by CHWs, qualified medical providers, and other types of providers **Settings:** Sylhet, Bangladesh **Study design:** Nested in cluster RCT		intervention. TBAs in homecare and community care arm had received a two-day orientation programme on cleanliness during delivery, maternal danger signs, and newborn care. Refreshers training were provided to government health workers. **Supervision:** A group of six to eight CHWs were supervised by each field supervisor who, in every month, spent at least two days with each CHW to provide feedback on their work. In fortnightly group meetings, CHWs could also discuss the field problems with senior supervisors. **Teamwork:** CHWs and community mobilisers worked in home-care arm.	• Assessed newborns and classified illnesses as very severe disease (VSD) or possible VSD • Referred to hospitals if required • Treated sick neonates at home if families were unable to comply with referral • Visited daily to complete the 10-day course of antibiotic therapy • Reinforced referral if neonates diagnosed with possible VSD with one sign	qualified medical providers • 32.0% (95% CI: 14.9, 53.5%) if treated by other unqualified providers • 27.6% (95% CI: 18.5, 38.2%) if no treatment outside home 2. Compared with newborns who received no treatment/treated by untrained providers, the adjusted HR of death during the neonatal period was • 0.22 (95% CI: 0.07, 0.71) if treated by CHWs • 0.61 (95% CI: 0.37, 0.99) if treated by qualified providers
Reference: Darmstadt et al.[35] **Objective:** To evaluate a delivery strategy for newborn interventions **Setting:** Mirzapur, Bangladesh **Study design:** Cluster RCT	Community health workers (CHWs) and traditional birth attendants (TBAs)	**Training:** CHWs, who had at least 10 years of schooling, received 36 days training (with six days of field practice) through didactic sessions, videos and practice on sick and healthy newborn babies. CHWs started field work after the evaluation of their assessment on five neonates. They also received refresher training in each fortnight. TBA's in intervention union attended a two-day orientation session on the aims of projects, ENC practices and indicators for referral of newborns and mothers.	• Promoted antenatal care • Promoted birth planning • Distributed clean delivery kit • Promoted new born care preparedness (drying and wrapping the baby, immediate breastfeed after birth, delaying bathing, cord care and monitoring the baby for signs of infection) • Made 3 postnatal home visits (on days 2,5 and 8 after birth) to negotiate preventive care practices • Assessed newborns for illness	Adjusted mortality hazard ratio in the intervention arm, compared to the comparison arm 1. Baseline 1.02 (95% CI: 0.80, 1.30) 2. Endline 0.87 (95% CI: 0.68, 1.12)

Reference, objective, setting and study design	Types of health worker	Workforce interventions	Postnatal interventions	Findings
		Supervision: Field supervisors monitored CHWs through a standard checklist/guideline. In each union, one field supervisor met with six CHWs (about six hours in each fortnight) to review their work and to provide refresher training. **Teamwork:** Not discussed.	and referred to hospitals • Treated sick neonates at home if families refused to be referred	
Teams of lay and formal health workers				
Reference: Baqui et al.[34] **Objective:** To assess the impact of the newborn health component of a large-scale community-based integrated nutrition and health programme **Settings:** Uttar Pradesh, Northern India **Study design:** Quasi-experimental design	Auxiliary nurse-midwives, maternal and child health promotion (*anganwadi*) workers and community volunteers (change agents)	**Training:** All three types of health workers received a six-day training on the care of mothers and newborn babies. **Supervision:** Not discussed. **Teamwork:** Auxiliary nurse-midwives worked in health centres as well as made home visits. *Anganwadi* workers promoted maternal, newborn and child health from fixed sites (*anganwadi* centre) and through home visits. Change agents worked with *anganwadi* workers.	**Prenatal** Home visit by all three types of health workers to provide counselling on preventive care, nutrition, preparedness for child birth, and health-care utilization for complications **Delivery** Encouraged families to call auxiliary nurse-midwife or trained TBA to attend delivery **Postnatal** Auxiliary nurse-midwife, *aganwadi* worker and change agent visited immediately after birth to provide counselling on breastfeeding, ENC (thermal care, hygiene, clean cord care), maternal and newborn danger signs and health-care utilization, and follow-up visits for sick, premature or LBW neonates	1. NMR decreased by 34% within the group of women who received a postnatal visit within 28 days of delivery (NMR: 35.7; 95% CI: 29.2, 42.1) compared with the group who received no visit (NMR: 53.8; 95% CI: 48.9, 58.8) 2. NMR decreased by 25% within the group of women who received a postnatal visit within 3 days of delivery (NMR: 40.2; 95% CI: 31.8, 48.6) compared with those who did not receive any visit (NMR: 53.8; 95% CI: 48.9, 58.8)

Reference, objective, setting and study design	Types of health worker	Workforce interventions	Postnatal interventions	Findings
Reference: Bhutta et al.[13] **Objective:** To evaluate the effectiveness of a community-based intervention package, principally delivered through LHWs working with TBAs and CHCs, for reduction of perinatal and neonatal mortality **Settings:** Hala and Matiari subdistricts, Pakistan **Study design:** Cluster RCT	Lady health workers (LHWs), traditional birth attendants (TBAs/Dais) and community health committees (CHCs)	**Training:** Regular LHWs, who had at least 8 years of schooling, received a 15 months training on preventive newborn care, including a three months of didactic training and monthly refresher sessions. LHWs in intervention area received an extra six-day training. Dais had an optional three-day training programme on basic newborn care. Dias could also attend the community education session led by LHWs. **Supervision:** Regular LHWs programme supervisors and trainers supervised the LHWs training. Dias training programme was developed with the assistance of Directorate of Health staff. Community mobilisers from Aga Khan University, Pakistan helped LHWs in identifying community volunteers to form CHCs. **Teamwork:** LHWs were encouraged to work with TBAs as a team. CHCs were also formed to work with LHWs to promote maternal and newborn care.	• LHWs visited mothers twice during pregnancy, within 24 hours of birth and on days 3, 7, 14, and 28 after birth • LHWs worked on promotion of antenatal care and maternal health education, use of clean delivery kits, facility births, immediate newborn care, identification of danger signs, and promotion of careseeking	1. NMR reduced by 15% in intervention clusters compared to control groups (RR: 0.85; 95% CI: 0.76, 0.96) 2. Early NMR reduced by 14% in intervention clusters compared to control groups (RR: 0.86; 95% CI: 0.75, 0.98) 3. Stillbirths reduced by 21% in intervention clusters compared to control clusters (RR: 0.79; 95% CI: 0.68, 0.92)
Reference: Bhandari et al.[36] **Objective:** To evaluate the Indian Integrated Management of Neonatal and Childhood	CHWs (*anganwadi* workers and accredited social health activists), auxiliary nurse midwives and physicians	**Training:** CHWs (*anganwadi* workers and accredited social health activists) and auxiliary nurse midwives received eight days of IMNCI training and physicians from government health system received 11 days of IMNCI training. Private	1. Improved skills to promote newborn care practices • CHWs were trained to conduct postnatal home visits and women's group meetings 2. Improved case management skills	1. NMR was lower in the intervention clusters than in control clusters (HR: 0.91; 95% CI: 0.80, 1.03) 2. NMR beyond the first 24 hours of birth was significantly lower in the

Reference, objective, setting and study design	Types of health worker	Workforce interventions	Postnatal interventions	Findings
Illness (IMNCI) programme, which integrates improved treatment of illness for children with home visits for newborn care, to inform its scale-up **Setting:** Haryana, India **Study design:** Cluster RCT		healthcare providers and TBA's received six hours and four hours of orientation training respectively. **Supervision:** Supervisors, trained in IMNCI and supervision skill, supervised CHWs and nurses. **Teamwork:** *Anganwadi* workers and accredited social health activists, auxiliary nurse midwives and physicians worked together.	• physicians, nurses and CHWs were trained to treat or refer sick newborns and children 3. Strengthened health system to implement IMNCI • supply of drugs and supervision were strengthened	intervention clusters than in control clusters(HR: 0.86; 95% CI: 0.79, 0.95) 3. The perinatal mortality rate was significantly lower in the intervention clusters (HR: 0.89; 95% CI: 0.78, 1.00); the effect of the intervention was seen only for home births 4. A significant interaction found between the place of birth and the effect of the intervention for all mortality outcomes except post-NMR
Reference: Carlo et al.[40] **Objective:** To evaluate the community-based interventions design to reduce the number of neonatal/perinatal deaths **Setting:** Rural communities in six countries (Argentina, Democratic Republic of Congo, Guatemala, India, Pakistan, and Zambia) **Study design:** Before-and-after design (WHO ENC Course) Cluster RCT (Neonatal	Birth attendants (traditional birth attendants, nurses, midwives, and physicians)	**Training:** **ENC course:** Used a train-the-trainer model, in which experienced trainers first trained master trainers who then trained community coordinators (physicians or nurses). Next, the community coordinators trained the birth attendants before the baseline period. After the baseline period, an experienced WHO trainer taught master trainers on ENC. The master trainers then taught the community coordinators who finally trained the birth attendants. Birth attendants received a three-day training on the differentiation between still birth and early neonatal death, clinical assessments like Apgar scores and adult education before the baseline period and a three-day training on ENC	• WHO ENC promotion (focuses on routine neonatal care, resuscitation, thermoregulation, breast-feeding, skin-to-skin care, care of the small baby, and common illnesses) • Modified version of the American Academy of Paediatrics Neonatal Resuscitation Programme (except in Argentina)	**1. ENC course:** • No significant reduction in 7-day NMR compared to the baseline period for all causes (RR: 0.99; 95% CI: 0.81, 1.22) or perinatal death • Significant reduction in the rate of stillbirth (RR: 0.69; 95% CI: 0.54, 0.88) **2. Neonatal Resuscitation Programme:** • Compared with control clusters, no reduction in 7-day NMR, perinatal death and stillbirth

Reference, objective, setting and study design	Types of health worker	Workforce interventions	Postnatal interventions	Findings
Resuscitation Programme)		after the baseline data collection. **Neonatal Resuscitation Programme:** An experienced trainer trained the birth attendants and they received three days of in-depth hand-on training on modified version of the American Academy of Paediatrics Neonatal Resuscitation Programme. Refresher course was conducted six months later. **Supervision:** Not discussed. **Teamwork:** Not discussed.		
Reference: Kumar et al.[14] **Objective:** To develop an intervention of behaviour change management, with a focus on prevention of hypothermia, aimed at modifying practices and reducing neonatal mortality **Setting:** Uttar Pradesh, India **Study design:** Cluster RCT	CHWs (*Saksham Sahayaks*), newborn stakeholders (traditional newborn care providers and birth attendants, unqualified medical practitioners, and health system workers) and community volunteers (*Saksham Karta*)	**Training:** CHWs, who had at least 12 years of schooling, received both classroom-based and apprenticeship-based field training over seven days on knowledge, attitudes, and practices related to ENC. Suitable CHWs were closely mentored by regional programme supervisors for an additional week before the final selection. **Supervision:** Regional programme supervisors, responsible for 6-7 CHWs, supervised their team through daily meetings. Moreover, CHWs performances were assessed and monitored by supervisors through spot checks during home visits.	**Intervention group-1:** Received preventive package of interventions for ENC, through two antenatal and two postnatal home visits, which included • birth preparedness • clean delivery • cord care and skin care • thermal care (STS) • breastfeeding promotion • danger sign recognition • careseeking from trained provider **Intervention group-2**: Received an ENC package similar to the group-1 but additionally used a liquid crystal hypothermia	Compared with controls, 1. NMR was reduced by 54% in the ENC intervention only (RR: 0.46; 95% CI: 0.35, 0.60) 2. NMR was reduced by 52% in the ENC plus ThermoSpot intervention group (RR: 0.48; 95% CI: 0.35, 0.66) 3. Perinatal deaths was reduced by 41% in the ENC intervention only (RR: 0.59; 95% CI: 0.47, 0.74) 4. Perinatal deaths was reduced by 38% in the ENC plus ThermoSpot intervention group (RR: 0.62; 95% CI: 0.47, 0.81)

Reference, objective, setting and study design	Types of health worker	Workforce interventions	Postnatal interventions	Findings
		Besides these, all regional teams met on monthly programme meetings to share their experiences. **Teamwork:** Newborn-care stakeholders and community volunteers enhanced and supported the activities of the CHWs. Newborn-care stakeholders within the community had access to newborn babies during the first 4-9 days after delivery for working with families to ensure adherence with the intervention. Community volunteers played a role in programme advocacy and to support families with knowledge, skills, and resources. CHWs met with newborn-care stakeholders and community volunteers to discuss experiences and strategies on separate monthly meetings.	indicator (ThermoSpot)	
		Formal health workers		
Reference: Carlo et al.[37] **Objective:** To examine the effectiveness of two training programmes on the incremental reduction of 7-day NMRs for low-risk institutional deliveries **Setting:** Community health clinics in Zambia (Lusaka and Ndola)	Midwives who performed deliveries in low-risk, first-level, urban, community health clinics	**Training:** **ENC course:** Used a train-the-trainer model, in which experienced researchers first trained midwives to become research nurses who then trained practicing midwives (with 3 years college degree in midwifery) before the baseline period. A WHO officer and two experienced trainers taught research nurses on ENC course after the baseline data collection. These research nurses then trained all practicing midwives.	• WHO ENC course (universal precautions and cleanliness, routine neonatal care, resuscitation, thermoregulation, breastfeeding, kangaroo care, care of small infants, and common illnesses) • American Academy of Paediatrics Neonatal Resuscitation Programme (in-depth basic resuscitation)	1. All-cause, 7-day NMR decreased by 41% after ENC training (RR: 0.59; 95% CI: 0.48, 0.77); decreases in rates of deaths attributable to birth asphyxia and infection 2. The 7-day NMR was decreased further after NRP training, after correction for loss to follow-up monitoring.

Reference, objective, setting and study design	Types of health worker	Workforce interventions	Postnatal interventions	Findings
Study design: The active baseline design (an improvement over the before/after controlled study design)		Research nurses received five days training on research concepts, differentiation between still birth and early neonatal death, clinical assessments and Apgar scores before baseline period and five days training on ENC course after baseline data collection. Research nurses then trained practicing midwives (three years college degree in midwifery). **Neonatal Resuscitation Programme (NRP):** After post ENC training data collection, an experienced instructor trained the research nurses on NRP and subsequently they trained all midwives. Research nurses received five days in-depth hand-on training on NRP and then they trained practicing midwives. **Supervision:** Not discussed.		

Table 4: Key findings of studies from this review

Reference	Types of health workers	Workforce intervention			Postnatal intervention					NMR reduction
		Training	Supervision	Team work	A*	B*	C*	D*	E*	%
Gill et al.[38]	TBAs	✓				✓				45
Kirkwood et al.[39]	CBSVs	✓	✓		✓					8
Bang et al.[11]	VHWs & TBAs	✓	✓	✓	✓					70
Bang et al.[32]	VHWs & TBAs	✓	✓	✓	✓					50**
Baqui et al.[12]	CHWs, community mobilisers & volunteers	✓	✓	✓	✓					34
Baqui et al.[33]	CHWs & community mobilisers	✓	✓	✓	✓					4***
Darmstadt et al.[35]	CHWs & TBAs	✓	✓		✓					13
Baqui et al.[34]	Auxiliary nurse-midwives, *anganwadi* workers & volunteers	✓		✓	✓					34****
Bhutta et al.[13]	LHWs, TBAs /Dais & CHCs	✓	✓	✓	✓					15
Bhandari et al.[36]	CHWs, auxiliary nurse midwives & physicians	✓	✓	✓				✓		9
Carlo et al.[40]	Birth attendants	✓					✓			1
Kumar et al.[14]	CHWs, newborn stakeholders & community volunteers	✓	✓	✓					✓	Group1: 54 Group 2: 52
Carlo et al.[37]	Midwives	✓					✓			41

Note: * A: Promoted a variety of ENC practices and referred newborn babies to health centres, if assessed danger sign; B: Promoted a modified version of neonatal resuscitation protocol and provided antibiotics with referral to health centres, if needed; C: Promoted WHO ENC practices and a modified version of the American Academy of Paediatrics Neonatal Resuscitation Protocol; D: Promoted newborn care practices, improved case management skills and strengthened health system; E: Intervention group 1: Promoted ENC practices, Intervention group 2: Promoted ENC plus ThermoSpot intervention

** Morbidity reduction

*** Case fatality rate - treated by CHWs

****Within the group of women who received a postnatal visit within 28 days of delivery

Figure 1: Literature review process