

Abstract

Sub-Saharan Africa, has the highest child mortality rate in the world (World Health Organisation [WHO], 2016). However, there is a paucity of current systematic reviews on the impact of essential newborn care interventions in Africa. Therefore, the aim of this systematic review is to summarise evidence about the impact of essential newborn care interventions in Africa. Numerous databases were searched to retrieve articles that reported interventions on newborn care in Africa. The search was limited to the English language and to articles published between 2007 to 2017.

Nine articles were selected for inclusion in this systematic review. Overall, these papers demonstrated an increase in performance of health workers (between 8 and 400%) following a test of knowledge, while health workers practical performance increased by 34 percent. Moreover, neonatal mortality reduced by 45%, while perinatal mortality reduced by 30%.

Training health care workers is one of the most effective ways of improving newborn care and neonatal survival in Africa. However, there is a need for additional evidence to support this, because none of the reviewed studies assessed the impact of training by examining variables such as trainees' satisfaction with training, the knowledge and skills developed, and the health outcomes achieved.

Introduction

Sub-Saharan Africa has the highest child mortality rate globally. In 2014, UNICEF reported that 1 in 11 children died before the age of five in sub-Saharan Africa, and that one in every three neonates died on the day they were born. A study undertaken by Liu *et al.* (2015) predicted that if present trends were to continue, 4.4 million children under five years of age would die by 2030. Liu *et al.* (2015) estimates that by 2030 sub-Saharan Africa would have

33% of the total births and 60% of the deaths of young children, compared to 25% of the births and 50% of the deaths that occurred in 2013 (Liu et al., 2015). Although neonatal mortality rates have declined from 33 to 20 deaths per 1,000 live births since the introduction of the Millennium Development Goals (MDGs), which aimed to reduce child mortality and improve maternal health (UNICEF, 2014), many developing countries have been unable to achieve the required progress to meet the MDGs.

High-income countries have recorded tremendous progress in reducing neonatal mortality, hence, remain the safest place for a baby to be born (UNICEF, 2018). A recent report by the United Nations Children Fund shows that the average newborn mortality rate for high-income and western countries is 3/1000 babies, while that of low-income countries is 27 (UNICEF, 2018). In 2016, Japan, Iceland, Singapore, Finland, Estonia, Slovenia, Cyprus, Belarus, Republic of Korea, Norway and Luxembourg had the lowest newborn mortality and is attributed to a “strong, well-resourced health systems, ample numbers of highly skilled health workers, a well-developed infrastructure, readily available clean water and high standards of sanitation and hygiene in health facilities” (UNICEF, 2018:pp12). It was further estimated that 16 million newborn lives could be saved by 2030 if every country brought down its newborn mortality to 31000 or less (UNICEF, 2018).

The large number of neonatal deaths in developing countries is significant, especially given that there are several simple evidenced-based care practices and interventions that, when initiated immediately after birth, are known to improve the survival rate of newborns (WHO, 2010).

In 2010, the WHO developed an Essential Newborn Care (ENC) course to enhance the capacity of midwives and other health workers involved with birth in hospitals and in the community to deal with preventable causes of neonatal death (WHO, 2010). The course was

designed to ensure that health workers could attain the skills and knowledge to provide appropriate care at the most vulnerable period in a newborn's life. The underpinning rationale for the development of this course was that neonatal mortality could be reduced if facility-based newborn care was to be carried out adequately (Neogi *et al.*, 2012). A periodic evaluation of the impact of ENC interventions across the African region will shape and strengthen policy that will ensure optimal care and the survival of neonates.

There is currently no systematic literature review of the impact of the ENC intervention in sub-Saharan Africa. It is therefore timely to conduct a systematic review of available evidence regarding the impact of the WHO newborn package on child survival in Africa to improve the understanding of how effective various interventions have been; such a review could also help to improve future interventions while tracking progress made in improving child survival in the region.

Operational definition of terms

Newborn care- Refers to that care given to the newborn infant from the time of delivery through about the first month of life.

Health outcome- This refers to neonatal and perinatal mortality

Satisfaction- This refers to the level the training or program is able to meet the expectation of participants.

Skills- This refers to the ability to perform newborn care in line with current evidence

Perinatal mortality- The number of stillbirths and neonatal deaths per 1000 births

Neonatal mortality- The number of deaths of babies between birth and 28 days of life per 1000 live births.

Methodology

This systematic review utilises the methodological approach known as Preferred Reporting Items for Systematic reviews and Meta-analyses (PRISMA) (Moher, Liberati, Altman, Tetzlaff, Mulrow, Gøtzsche, *et al.*, 2009). The PRISMA guidelines were used to write this report because it offers a more transparent method of reporting reviews. These guidelines were developed by an international group that included experienced authors and methodologists in response to the poor nature of reporting systematic review and meta-analysis that had been observed at the time (Moher *et al.*, 2009). The PRISMA guidelines consists of a 27-item checklist and a four-phase flow diagram. The checklist includes items deemed essential for the transparent reporting of a systematic review (Moher *et al.*, 2009).

Study selection

Articles were screened for selection and checked against the eligibility criteria to determine if they were to be included in the review. The inclusion criteria were: 1) The study was conducted in sub-Saharan Africa, 2) The study involved evaluation/testing of the WHO's ENC training program (or intervention), targeted at health workers in health facilities, and 3) Outcomes included the impact of the intervention on the knowledge and/or skills of health care workers, as well as any aspect of newborn care or neonatal mortality.

Information sources and search strategy

The search was conducted in February 2017 and updated in December 2017. PubMed, Web of Science, Scopus, CINALH and Trip were all searched for articles. Pregnancy and child birth, child health, public health and neonatal care titles were searched in the Cochrane library. The Cochrane register of clinical trials was also searched. The WHO's reproductive

health library and the Nigerian Ministry of Health’s website were also searched. References of each of the articles found were hand checked for related articles.

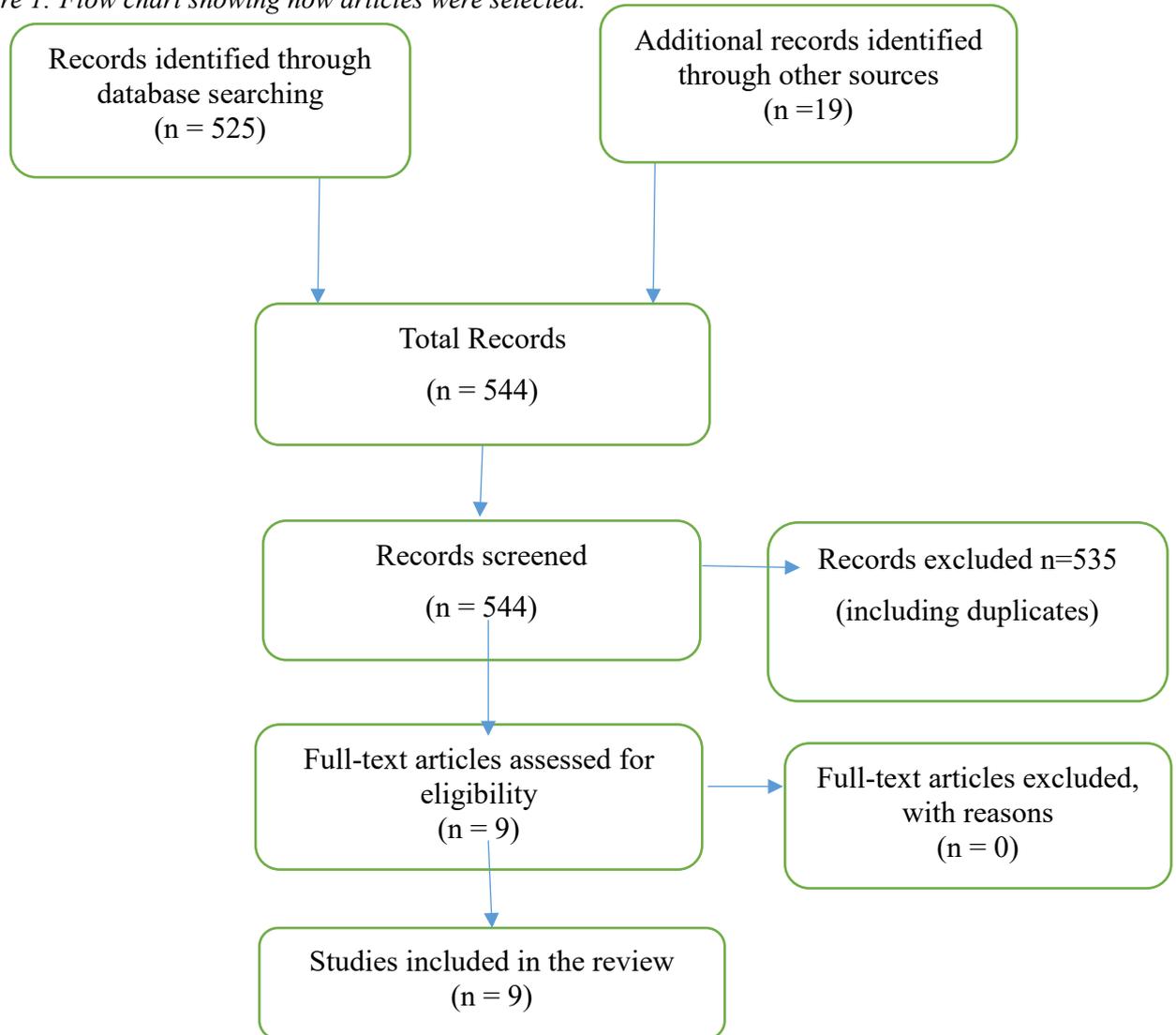
The literature search was performed using the following keywords: “intervention OR training AND newborn care OR neonatal care OR infant care AND neonatal survival OR newborn survival OR neonatal mortality OR child mortality”. Limiters were applied, including only articles published in the English language, and with a publication date not more than ten years old. A summary of the number of articles retrieved is presented in Table 1.

Table 1: Articles retrieved after searching various databases

Databases	Number of articles retrieved
PubMed	216
Web of Science	28
Scopus	69
CINALH	180
Trip	32
Cochrane	0
Others	19
Total	544

A total of 525 articles were retrieved from the databases. A further nineteen articles (19) were considered after hand-searching the reference lists resulting in a total of 544 articles. The initial screening was undertaken by reading the abstracts of the selected articles and the intervention tested. At this level, only primary sources were included that reported original research regarding the impact of ENC training on the health care workers’ knowledge or practice or neonatal health outcomes. After screening for all inclusion criteria, a total of nine articles were selected for inclusion in this systematic review. A summary of the screening process is presented in Figure 1. The selected articles were then read and summarised.

Figure 1: Flow chart showing how articles were selected.



Methodological quality assessment

The nine articles were assessed using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) system for rating the quality of evidence and the strength of recommendations (Guyatt *et al.*, 2008). The GRADE system classifies the quality of evidence by taking into consideration the study design, the quality of the study, its consistency and directness (GRADE Working Group, 2004). According to the GRADE system, study designs are classified into observational studies and randomised trials (GRADE

Working Group, 2004). Randomised control trials, for instance, may begin as high-quality evidence, but confidence in the evidence may decrease depending on the study limitations, the inconsistency of the results, the indirectness of the evidence, imprecision and reporting bias (Guyatt *et al.*, 2008). Conversely, observational studies may start with a low-quality grading, but may be upgraded if the magnitude of the treatment is large or significant (Guyatt *et al.*, 2008). Evidence is considered high quality if further research is unlikely to alter confidence in the estimate of effect. Moderate-quality evidence relates to the findings if further research is likely to have an important impact on confidence in the estimate of effect and that new research may change the estimate. Evidence is considered low quality if further research is likely to change the findings. Very low-quality evidence indicates that any estimate of effect is very uncertain.

Method of data synthesis

Main findings of the review was analyzed using descriptive synthesis. Findings were described and summarised based on four major headings including satisfaction with training, knowledge gained, skills and behaviour changes and health outcome.

Results

All nine articles were assessed to be methodologically sound, i.e. they met the inclusion criteria and were of at least moderate quality. One study was assessed to have produced high-quality evidence (Matendo *et al.*, 2011), while the remaining eight articles were determined to be of moderate quality (Brantuo *et al.*, 2014; Carlo *et al.*, 2010; Chomba *et al.*, 2008; Dynes *et al.*, 2013; Grady *et al.*, 2011; Makene *et al.*, 2014; Manasyan *et al.*, 2011; McClure *et al.*, 2007). Therefore, all nine articles were included in the review (Table 2).

Characteristics of studies

Study characteristics was considered in terms of setting and target population, and nature of

training program

Setting and target population

All studies selected were conducted in sub-Saharan Africa. One study was conducted in Ethiopia (Dynes *et al.*, 2013), four in Zambia (Carlo *et al.*, 2010; Chomba *et al.*, 2008; Manasyan *et al.*, 2011; McClure *et al.*, 2007), one in the Democratic Republic of Congo (Matendo *et al.*, 2011), one in Ghana (Brantuo *et al.*, 2014) and one in Tanzania (Makene *et al.*, 2014). Grady *et al.* (2011) conducted their study across seven sub-Saharan African countries (Somalia, Kenya, Malawi, Swaziland, Zimbabwe, Tanzania and Sierra Leone).

A total of 2764 health professionals involved with newborn care participated in the nine studies. These included nurses (Brantuo *et al.*, 2014; Chomba *et al.*, 2008; Grady *et al.*, 2011; Matendo *et al.*, 2011) nurse-midwives (Grady *et al.*, 2011; McClure *et al.*, 2007), midwives (Brantuo *et al.*, 2014; Carlo *et al.*, 2010; Manasyan *et al.*, 2011), traditional birth attendants (Matendo *et al.*, 2011), community extension workers (Dynes *et al.*, 2013), medical assistants (Brantuo *et al.*, 2014) and physicians (Brantuo *et al.*, 2014, Grady *et al.*, 2011). One study was undertaken with volunteer community health promoters (Dynes *et al.*, 2013).

Training programs

The WHO training programs differed in terms of content, duration, and method of implementation as well as data collection and outcomes measured

a. Content and development of training program

All studies were generally focused on improving newborn care and neonatal health outcomes.

All the included studies tested the impact of the WHO's ENC training in various ways. The

WHO's ENC course comprises five modules divided over 14 sessions. These 14 sessions

cover: introduction to pregnancy, childbirth, postpartum and newborn care (PCPNC), standard precautions, care of the newborn at the time of birth, thermoregulation, breastfeeding, overcoming difficulties with breastfeeding, communication skills, examination of the newborn, newborn resuscitation, routine care of the newborn, feeding alternatives, care of small babies, injections and kangaroo care (WHO, 2010).

Six studies tested the impact of the WHO's ENC training course (Carlo *et al.*, 2010; Chomba *et al.*, 2008; Makene *et al.*, 2014; Manasyan *et al.*, 2011; Matendo *et al.*, 2011; McClure *et al.*, 2007), as it was originally designed. Grady *et al.* (2011) and Dynes *et al.* (2013) also included maternal care modules in their packages. For example, Grady *et al.* (2011) adopted the "Liverpool School of Tropical Medicine-Royal College of Obstetrics and Gynaecology Life Saving Skills – Essential Obstetric Care and Newborn Care' (LSTM-RCOG LSSEOC and NC) training package designed specifically for the developing country setting" (Grady *et al.*, 2011: pp 19). This included content to address causes of maternal death (haemorrhage, sepsis, eclampsia, obstructed labour and complications from spontaneous abortion), in addition to the WHO's essential newborn modules. Similarly, Dynes *et al.* (2013) added aspects of maternal care (care at delivery, postpartum health assessment, counselling) to the WHO's ENC modules.

Brantuo *et al.* (2014) in Ghana specifically focused their intervention on improving health workers' capacity to deal with leading causes of neonatal mortality: infection, asphyxia and prematurity. This package is also an adaption of the WHO's ENC training course.

None of these studies sought actively to involve the end users (healthcare workers) in the development and/or adaption of the training course. However, it is important to involve healthcare workers in determining training needs, as this may result in a more positive

attitude towards the intervention and moreover catalyse behaviour change (Kirkpatrick and Kirkpatrick 2007), which will ensure quality newborn care.

b. Duration of training program

The duration of the delivered and tested training programs differed greatly. The WHO's ENC course is designed to be delivered over an average of one day. In the current review, training programs lasted between two days and two years perhaps due to variation in the content of interventions. Brantuo *et al.* (2014) implemented their intervention over two days, Grady *et al.* (2011) over three days, Chomba *et al.* (2008) over seven days, Carlo *et al.* (2010) over 10 days and Makene *et al.* (2014) over 13 days. Manasyan *et al.* (2011), Matendo *et al.* (2011) and McClure *et al.* (2007) all implemented their training over five days each. The training intervention by Dyne *et al.* (2013) is ongoing and lasted for 2 years.

c. Method of implementation

Six of the studies evaluated training programs that were delivered using a train-the-trainer model (Carlo *et al.*, 2010; Chomba *et al.*, 2008; Dynes *et al.*, 2013; Manasyan *et al.*, 2011; Matendo *et al.*, 2011; McClure *et al.*, 2007). In a train-the-trainer model, an experienced person who has previously completed the course, teaches a less-experienced instructor how to deliver the courses, workshops and/or seminars. This instructor subsequently trains other health workers, as taught by the course designer or subject expert.

The remaining papers all reported on studies that evaluated 'direct' training programs, whereby the subject designer or researcher implemented training directly to the target audience. As highlighted earlier, no study sought to assess and identify the specific training needs of the participants prior to delivering the program.

d. Data collection and outcomes measured

The nine studies used a range of methodologies and data collection techniques. All included studies were quantitative: one used a cluster randomised control trial (RCT) (Matendo *et al.*, 2011), one was a descriptive study (Dynes *et al.*, 2013) and seven were pre- and post-test design studies (Brantuo *et al.*, 2014; Carlo *et al.*, 2010; Chomba *et al.*, 2008; Grady *et al.*, 2011; Makene *et al.*, 2014; Manasyan *et al.*, 2011; McClure *et al.*, 2007). The cluster RCT was undertaken in the Democratic Republic of Congo (Manasyan *et al.*, 2011). Matendo *et al.* (2011) evaluated the impact of the WHO's ENC course training on perinatal mortality. The primary outcome for the RCT was perinatal mortality (Matendo *et al.*, 2011). Outcomes reported by the included articles are presented in Table 2.

Table 2: Outcomes reported in included articles

Outcome measured	Article(s)
Knowledge	McClure <i>et al.</i> , 2007
Satisfaction with training, knowledge and skills	Grady <i>et al.</i> , 2011
Neonatal health outcome	Carlo <i>et al.</i> , 2010; Chomba <i>et al.</i> , 2008; Manasyan <i>et al.</i> , 2011; Matendo <i>et al.</i> , 2011
Knowledge and skills	Dynes <i>et al.</i> , 2013; Makene <i>et al.</i> , 2014
Knowledge and neonatal health outcome	Brantuo <i>et al.</i> , 2014

In Grady *et al.*'s (2011) research, satisfaction with training was determined by means of a standard questionnaire and verbal response from participants. Participants were invited to state their level of satisfaction with various aspects of the training on a scale ranging from 'not useful' to 'extremely useful'. In addition, verbal feedback was collected using small group discussion.

Knowledge testing was routinely undertaken using multiple choice questions administered before and after training (Brantuo *et al.*, 2014; Dynes *et al.*, 2013; Grady *et al.*, 2011; Makene *et al.*, 2014; McClure *et al.*, 2007). The net improvement in performance from the pre-training score indicated the impact of the training on knowledge.

Skill development was determined with a practical checklist and direct observation (Makene *et al.*, 2014; McClure *et al.*, 2007), and with scenarios whereby the participant was asked to demonstrate and explain what they would do in response to a particular problem or prevention strategy using role play (Dynes *et al.*, 2013; Grady *et al.*, 2011).

Neonatal health outcomes were commonly determined through clinical audits (Chomba *et al.*, 2008). Matendo *et al.* (2011) collected information about neonatal health outcomes through observations and reports from health workers who had been trained to do so. Similarly, Carlo *et al.* (2010) and Manasyan *et al.* (2011) collected information about early neonatal mortality by maintaining birth registers during the period of study, where all births and all cases of mortality were recorded.

Summary of results

There were several major outcomes reported in the nine studies, including satisfaction with training, knowledge and skill development and neonatal health outcomes. This section will consider the impact of interventions from two perspectives: 1) the impact on health professionals, and 2) the impact on neonatal health outcomes. The results is summarized in table 3.

a. Impact on health professionals

The success of the training programs was largely measured in terms of the impact on the health professionals and their satisfaction with the training, the knowledge gained and the skills developed.

b. Satisfaction and knowledge acquisition

Knowledge acquisition was evaluated in the same manner in all studies. However, the duration of the intervention varied. Baseline knowledge was established using questionnaires before training, then reassessed by using the same questionnaires after intervention. One study (Grady *et al.*, 2011) reported on health professionals' satisfaction with the training received and the knowledge gained. In this large cross-country study, 600 participants were highly satisfied with the three-day training program they attended. Knowledge and skills around newborn care were also significantly increased ($p < 0.001$), reporting a 16% improvement in knowledge following the intervention.

Knowledge acquisition was reported in five of the nine studies as part of the outcomes measured (please see Table 3). Participants were generally tested before training, using questions developed from the content of the training curriculum, and subsequently re-examined using the same set of questions after the training. A study conducted in Ethiopia by Dynes *et al.* (2013) with various cadres of health workers reported an increase in performance scores with regard to newborn care by over 250% among health extension workers, and 300% among the general team. A similar study in Zambia by McClure *et al.* (2007) to determine the impact of a five-day training intervention using the WHO ENC course reported a 12% increase in performance score (mean of 65% pre-training and 77% post-training) on written evaluation.

A significant improvement in the knowledge of 278 health workers (73% vs 89% $p < 0.001$) was observed in a study conducted to determine the impact of a two-day training intervention on birth asphyxia, sepsis and kangaroo care in Ghana (Brantuo *et al.*, 2014). Similarly, Makene *et al.* (2014) examined the impact of a 13-day competency-based in-service training program of health workers in Tanzania, utilizing a pre- and post-study design. They reported an improvement in knowledge about newborn care from 39% to 73%.

Generally, health care workers demonstrated significant improvement in knowledge because of training received, and such improvement appeared to be positively associated with longer duration of training.

c. Improvement in skills/practice because of training

It is anticipated that knowledge gain due to training is incorporated into practice. The behaviour change that comes with training should be reflected in terms of better quality care for newborns. Three studies reported on the impact of training on skills regarding newborn care (Grady *et al.*, 2011; Makene *et al.*, 2014; McClure *et al.*, 2007). These studies generally demonstrated an improvement in the care of newborns immediately after birth. Impact of the training on behaviour was measured by participants performing an observed task, such as an objective clinical examination or a structured observation on a live patient. Duration of training interventions was between three days and thirteen days. Performance or score before and after training was compared. A study in Zambia (McClure *et al.*, 2007) reported a 19% improvement in performance after using an 18-item performance evaluation to determine the impact of a five-day WHO newborn care course. Grady *et al.* (2011) examined skills developed after a three-day training course by asking participants to demonstrate and explain what they would do in response to a problem presented in a scenario. They observed over

100% improvement in skills compared with pre-training performance. A 13-day training program in Tanzania by Makene *et al.* (2014) resulted in 34% improvement in newborn care.

There was variation in the way skills were evaluated. Grady *et al.* (2011) and McClure *et al.* (2007) used standard checklists to observe care rendered to mannequins, while Makene *et al.* (2014) made observations in the labour room. A higher improvement in skills was observed in studies in which intervention was delivered directly (not using train-the-trainer model).

d. Impact on neonatal health outcomes

Changes in neonatal mortality and perinatal mortality were the major outcome measures associated with improvements in neonatal health in four of the studies included (Brantuo *et al.*, 2014; Carlo *et al.*, 2010; Chomba *et al.*, 2008; Manasyan *et al.*, 2011). Across these studies neonatal mortality (infants dead by 28 days of life) was reduced as a result of training. Interventions in studies that evaluated neonatal health outcomes were implemented between two days and 10 days. Carlo *et al.* (2010) revealed a reduction in neonatal mortality from 11.5 to 6.8 deaths per 1000 live births after a 10-day ENC training course in Zambia. A week's training using the WHO's ENC course in Zambia for 123 nurses indicated a 45% decline (from 11.3 to 6.2 per 1000 live births) in neonatal mortality (Chomba *et al.*, 2008). Another study in Zambia by Manasyan *et al.* (2011) evaluated the impact of a five-day course using the WHO's ENC training on seven-day neonatal mortality. The researchers reported a decrease in neonatal mortality from 11.5 to 6.8 per 1000 live births. Similarly, a cluster randomised control trial in Democratic Republic of Congo by Matendo *et al.* (2011) reported a 24% reduction in perinatal mortality (seven-day neonatal mortality and stillbirths) as a result of a five-day WHO ENC training course (RR 0.73;95 CI 0.56-0.96).

Neonatal mortality reduced by 17.6% and 11.1% in two intervention sites following two-day training in Ghana (Brantuo *et al.*, 2014). Carlo *et al.* (2010) also reported a 30% reduction in perinatal mortality following a 10-day training program.

Table 3: Summary of the articles assessed for inclusion in the review

Author (year)/Country	Study design	Intervention	Sample and sample size	Data collection/outcome	Key findings	Quality of evidence
<p>Dynes, M., Buffington, ST., Carpenter, M., Handley, A., Kelley, M., Tadesse, L., Bayene, HT., and Sibley, L. (2013) Strengthening maternal and newborn health in rural Ethiopia: Early results from frontline health workers community maternal and newborn health training. <i>Midwifery</i>, 29 (3): 251–259.</p> <p>Ethiopia</p>	Descriptive design	<p>Maternal care (care at delivery, postpartum health assessment, counselling) and newborn care (postnatal health assessment and counselling about exclusive breastfeeding, thermal care, kangaroo care, hand washing, cord care and illness recognition).</p> <p>2-year program</p>	91 Health Extension Workers, and 626 guide team members including Traditional Birth Attendants and volunteer community health promoters from six rural districts of two regions in Ethiopia.	Performance testing was done to assess transfer of knowledge and skills from training	<p>Post training performance scores were significantly higher than immediate pre-training scores for the two regions ($p > 0.001$).</p> <p>The performance score increased by over 250% among Health Extension Workers and by 300% among general team members for the maternal care topic.</p> <p>There was an increase of more than 300% and 400% in performance score for the newborn topic respectively among Health Extension Workers and General team members.</p>	Moderate-quality evidence

Author (year)/Country	Study design	Intervention	Sample and sample size	Data collection/outcome	Key findings	Quality of evidence
<p>McClure, EM., Carlo, WA., Wright, LL., Chomba, E., Uxa, F., Lincetto, O., and Bann, C. (2007) Evaluation of the educational impact of the WHO Essential Newborn Care course in Zambia. <i>Acta paediatrica</i>, 96 (8): 1135–1138.</p> <p>Zambia</p>	Pre-Post Design	WHO newborn care course delivered over five days	114 nurse midwives	Written and performance evaluation before and after training	Performance increase from a mean of 65% correct pre-training to 84% correct post training and from 65% to 77% correct on the written evaluation.	Moderate-quality evidence
<p>Chomba, E., McClure, EM., Wright, LL., Carlo, WA., Chakraborty, H., and Harris, H. (2008) Effect of WHO Newborn Care on Neonatal Mortality by Education. <i>Ambulatory Pediatrics</i>, 8(5):300–305.</p> <p>Zambia</p>	Before and after design	One-week ENC training	123 Nurses	Seven-day neonatal mortality after parental consent	<p>Neonatal mortality decreased from 11.3 per 1000 live births pre-ENC to 6.2 per 1000 live births following ENC implementation.</p> <p>Neonatal mortality was inversely related to years of education of mothers.</p>	Moderate-quality evidence
<p>Matendo, R., Engmann, C., Ditekemena, J., Gado, J., Tshefu, A., Kinoshita, R. <i>et al.</i> (2011) Reduced perinatal mortality following enhanced training of birth attendants in the Democratic Republic of Congo: A time-dependent effect. <i>BMC Medicine</i> 9:93. Available at: http://www.biomedcentral.com/1741-7015/9/93.</p> <p>Democratic Republic of Congo</p>	Cluster randomised trial	ENC training, including routine neonatal care, initiation of breathing and resuscitation, thermoregulation, early and exclusive breastfeeding, kangaroo care, care of small baby,	152 TBAs and 18 Nurses	Secondary analysis to determine perinatal mortality before and after study.	There was no decline in perinatal mortality when the outcome of all deliveries prior to ENC training was compared to those after ENC training but before the	High-quality evidence. There was randomisation and comparison of groups.

Author (year)/Country	Study design	Intervention	Sample and sample size	Data collection/outcome	Key findings	Quality of evidence
		<p>recognition of danger signs, and recognition and management of complications.</p> <p>Five-day intervention</p>			<p>Neonatal Resuscitation Program training.</p> <p>However, a gradual reduction in perinatal mortality was observed during the year following ENC training (RR0.73;95% CI: 0.56-0.96), which was independently associated with time following training.</p>	
<p>Manasyan, A., Chomba, E., McClure, EM., Wright, LL., Krzywanski,S., Carlo, WA. et al (2011) Cost-effectiveness of Essential Newborn Care Training in Urban First-Level Facilities. <i>Paediatrics</i>, 127: e1176-e1181.</p> <p>Zambia</p>	<p>Before and after study</p>	<p>ENC training, including routine neonatal care, initiation of breathing and resuscitation, thermoregulation, early and exclusive breastfeeding, skin to skin care, care of small baby, recognition of danger signs, and common illnesses.</p> <p>Five-day training</p>	<p>123 midwives</p>	<p>Seven-day neonatal mortality before and after training period.</p>	<p>All-caused seven-day (early) neonatal mortality decreased from 11.5 per 1000 to 6.8 per 1000 live births after the ENC training of clinic midwives.</p> <p>The intervention costs were \$208 per life saved and \$5.24 per disability-adjusted life-year averted.</p>	<p>Moderate-quality evidence</p>

Author (year)/Country	Study design	Intervention	Sample and sample size	Data collection/outcome	Key findings	Quality of evidence
<p>Brantuo, MNA., Cristofalo, E., Mira M., Mehe, MM., Ameh, J., Brako, NO. et al. (2014) Evidence-based training and mentorship combined with enhanced outcomes surveillance to address the leading causes of neonatal mortality at the district hospital level in Ghana. <i>Tropical Medicine and International Health</i>, 19(4): 417–426.</p> <p>Ghana</p>	Before and after	<p>Birth asphyxia, sepsis, kangaroo mother care</p> <p>Two-day training</p>	278 medical officers, nurses, midwives, medical assistants and auxiliary health workers.	Improvement in knowledge and neonatal mortality	<p>There was significant improvement in provider knowledge (73% vs. 89% correct, $P < 0.001$), with even greater improvement among trainees receiving recurrent refresher training (86% vs. 94% correct, $P < 0.001$).</p> <p>Neonatal mortality reduced from 17 to 14 per 1000 live births and 27 to 24 per 1000 live births in the two intervention sites.</p>	Moderate-quality evidence
<p>Grady, K., Ameh, C., Adegoke, A., Kongnyuy, E., Dornan, J., Falconer, T., Islam, M., & Van den Broek, N. (2011) Improving essential obstetric and newborn care in resource-poor countries, <i>Journal of Obstetrics and Gynaecology</i>, 31(1): 18–23. DOI: 10.3109/01443615.2010.533218</p> <p>Seven African countries (Somalia, Kenya, Malawi, Swaziland, Zimbabwe, Tanzania and Sierra Leone)</p>	Before and after design	<p>Causes of maternal death, haemorrhage, sepsis, eclampsia, obstructed labour and complications with abortion, newborn resuscitation and newborn care.</p> <p>Three-day package</p>	600 health professionals nurse-midwives, doctors, clinical officers and specialist	Satisfaction, improvement in knowledge and skills	<p>Knowledge about the diagnosis and management of complications of pregnancy and childbirth as well as newborn care significantly increased ($p < 0.001$).</p> <p>There was a measurable improvement in</p>	Moderate-quality evidence

Author (year)/Country	Study design	Intervention	Sample and sample size	Data collection/outcome	Key findings	Quality of evidence
					skills ($p < .001$), and participants expressed a high level of satisfaction with the training.	
<p>Carlo, WA., McClure, FM., Chomba, E., Chakraborty, H., Hartwell, Y., Harris, MS <i>et al.</i> (2010) Newborn Care Training of Midwives and Neonatal and Perinatal Mortality Rates in a Developing Country. <i>Pediatrics</i>, 126(5):DOI:10.1542/peds.2009-3464</p> <p>Zambia</p>	Pre-and-post	<p>Universal precautions and cleanliness, routine neonatal care, initiation of breastfeeding, resuscitation, and prevention of hyperthermia, kangaroo care, counselling on infant care, danger signs recognition and management of complications.</p> <p>10-day training</p>	123 midwives and 71 689 neonates	Perinatal mortality	Findings revealed that perinatal mortality was reduced by about 30% (18.3 to 12.9 per 1000 births) and all seven-day causes of neonatal mortality were reduced from 11.5 to 6.8 deaths per 1000 births.	Moderate-quality evidence
<p>Makene, CL., Plotkin, M., Currie, S., Bishanga, D., Ugwi, P., Henry H. <i>et al.</i> (2014) Improvements in newborn care and newborn resuscitation following a quality improvement program at scale: Results from a before and after study in Tanzania. <i>BMC Pregnancy and Childbirth</i>, 14:381-392. Available at; http://www.biomedcentral.com/1471-2393/14/381.</p> <p>Tanzania</p>	Before and after study	<p>Competency-based in-service training on ENC.</p> <p>13-day training</p>	At least 516 health workers	Health workers knowledge and practice	<p>Health worker knowledge improved significantly, from 23% in 2010 to 41% in 2012 ($p < 0.0001$).</p> <p>Overall achievement on the index score for newborn care went from 39% to 73%, representing an</p>	Moderate-quality evidence

Author (year)/Country	Study design	Intervention	Sample and sample size	Data collection/outcome	Key findings	Quality of evidence
					increase of 34 percentage points (<0.0001).	

Discussion

The aim of this systematic review was to summarise evidence regarding the impact of the WHO's ENC training course on newborn care and neonatal survival in sub-Saharan Africa. The findings from this systematic review suggest that an improvement in newborn care and neonatal survival can indeed be achieved by training health workers using the WHO's ENC package. The broad composition of health care professionals involved in the studies spoke to the generalizability of the findings among health workers involved with newborn care. However, generalising findings for sub-Saharan Africa may not be appropriate at this point due to the uneven geographical distribution of the studies included in this review.

There is a need for additional evidence regarding interventions relating to newborns, especially in North and West Africa and particularly in Nigeria (sub-Saharan Africa), as no studies were identified from this country. In addition, given the extent of the problem, it is essential to continue gathering high-quality evidence (UNICEF, 2014; UNICEF, 2015; WHO, 2016). An assessment of the quality of the evidence from the studies selected for the literature review revealed that most studies were of moderate quality because of the designs adopted and the overall limitation of the study (Guyatt *et al.*, 2008).

One of the most effective ways of reducing child mortality is by building the capacity of health workers in identifying and solving complications during pregnancy and childbirth (Ameh & Van de Broek, 2015). Such capacity building is usually delivered as in-service training. The content of the training curriculum evaluated in this review was largely the same. Although minimal information was provided regarding the planning of the training programs, none appeared to seek participant assessment of training needs or content development related to their specific needs and/or cultural contexts. Expert educationalists, such as Kirkpatrick (1998, 2007), argue that context-specific issues need to be considered to improve

effectiveness of programs. Training packages may therefore need to undergo some level of modification, whilst being mindful that the evidence on which they are based is appropriate and correctly delivered. Involving the end users of an education package would seem an appropriate and valuable strategy to increase engagement and ensure effectiveness by providing targeted need-specific content.

The WHO's ENC training course was designed to be delivered within about 15 hours (WHO, 2010). The studies considered in this review had various durations, ranging from days to weeks. The duration of the training is influenced by course content, availability of resources and availability of participants, among other factors. The current review suggested that better knowledge scores were obtained with longer training sessions. However, this was not seen in the case of skills and neonatal health outcomes. Health workers in general are busy individuals, especially those in settings with inadequate personnel. It is therefore imperative that health researchers consider the context of the setting in which the training program is to be delivered. Training time needs to be sufficient to ensure that content is not compromised, but also that it does not risk affecting or interfering with patient care.

There was a higher improvement in skills for training implemented through train-the-trainer model than direct implementation. However, due to the lack of available literature, more studies are required to make best-practice conclusions about the best mode of delivering an ENC with a view to achieving skill development. In addition, two studies did not clinically observe performance (Grady *et al.*, 2011; McClure *et al.*, 2007), but rather used scenarios. Observation of performance using scenarios in unreal situations may not translate into real life practice. Thus, studies that observe behaviour change during clinical practice are likely to provide a greater understanding of the effectiveness of training programs, such as the WHO's ENC package.

A reduction in neonatal mortality as a result of training health workers in the essentials of newborn care underscores the relevance of such training in child survival. The four studies that evaluated the impact of the WHO package on neonatal mortality demonstrated a reduction of between 11.1% and 45.1% (Carlo *et al.*, 2010; Chomba *et al.*, 2008; Manasyan *et al.*, 2011; Matendo *et al.*, 2011). Similarly, a reduction of between 24% and 30% was seen with regard to perinatal mortality (Carlo *et al.*, 2010; Matendo *et al.*, 2011). All the studies demonstrated that training of health workers in the essentials of newborn care had a positive impact on child survival. Properly planned, implemented and appropriately resourced interventions are likely to yield even better results.

Conclusion

This systematic review has demonstrated that interventions focused on improving neonatal health outcome in sub-Saharan Africa are promising and thus lay the foundation for high-quality research to identify cost-effective interventions in the future. The review also adds to the body of evidence that highlights the positive impact of the WHO's ENC training course in respect of health care workers' clinical practice around newborn care and thus neonatal survival. To achieve a reasonable reduction in neonatal mortality by 2030, it is imperative to identify and scale up interventions that have the most impact on neonatal survival. It is difficult to implement and sustain the WHO's ENC training in sub-Saharan Africa without external support. Hence, there is a need to consider how the WHO's ENC package could be delivered, sustained and evaluated locally.

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