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A narrative review of course evaluation methods for continuing professional development: The case of paediatric and neonatal acute-care in-service courses in low and lower-middle income countries: BEME Guide No. 76

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ABSTRACT

Background: Training a skilled healthcare workforce is an essential part in reaching the United Nations Sustainable Development Goal to end preventable deaths in children and neonates. The greatest burden of mortality lies in low and lower-middle income countries (LLMIC). Short term, in-service courses have been implemented in many LLMIC to improve the quality of care delivered, but the evaluation methods of these courses are inconsistent.

Method: Studies describing evaluations of course and outcome measures were included if the course lasted seven days or less with postgraduate participants, included paediatric or neonatal acute or emergency training and was based in a LLMIC. This narrative review provides a detailed description of evaluation methods of course content, delivery and outcome measures based on 'Context, Input, Process and Product' (CIPP) and Kirkpatrick models.

Results: 5265 titles were screened with 93 articles included after full-text review and quality assessment. Evaluation methods are described: context, input, process, participant satisfaction, change in learning, behaviour, health system infrastructure and patient outcomes.

Conclusions: Outcomes, including mortality and morbidity, are rightly considered the fundamental aim of acute-care courses in LLMIC. Course evaluation can be difficult, especially with low resources, but this review outlines what can be done to guide future course organisers in providing well-conducted courses with consistent outcome measures for maximum sustainable impact.

KEYWORDS
Paediatric; neonatal; postgraduate; education; low-resource

Introduction

Health inequalities across the globe, highlighted by differences in child and neonatal mortality between different countries (Hagg et al. 2018), have motivated many to act. In low and lower-middle income countries (LLMIC), children often present later in their stage of illness, and a high proportion die early on in their admission to hospital (Berkley et al. 2003). Skilled healthcare workers are essential components of sustainable healthcare. In 2014, the percentage of births attended by a skilled attendant was 98.5% in the USA and 20.2% in Chad (Tiruneh et al. 2018). The situation is projected to worsen, with a shortfall of 18 million healthcare workers globally by 2030, predominantly in LLMIC (Liese and Maeder 2018).

The United Nations Sustainable Development Goals include ending preventable deaths of newborns and children under five years, highlighting training of the healthcare workforce to achieve this (United Nations 2015). Of 115 neonatal resuscitations by nurses/midwives in a Kenyan hospital, only 10% showed perfect and 27%

Practice points

- Course evaluation is an important component of continuing professional development delivery. Structuring outcome measures using the CIPP and Kirkpatrick models will provide evidence of course effectiveness.
- The diversity of outcome evaluations in this review displays what *can* be done in LLMIC and provides examples to what might work in which circumstances depending on the resources available.
- For sustainability and consistency of course delivery, there is a need for detailed description of the acute-care course. This should include justification of the context and content with site-specific data, incorporating the local language and the support of local or national organisations.
- Publication by and with LLMIC authors must be encouraged to fully understand the appropriateness and impact of these courses in their context.

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adequate initial resuscitation steps pre-course (Opiyo et al. 2008). In a study across 21 different LLMIC, 76% of paediatric patients had an adverse factor in their acute hospital care such as inappropriate triage or treatment (Nolan et al. 2001). These suggest in-service training is a requirement after pre-service education. Although there are multiple structural reasons why quality care might not be received, a first step would be to have a competent workforce.

Short term, in-service training courses have been implemented in many LLMIC to improve the quality of care. However, course evaluation is often either poorly understood or not prioritised by education providers. Without it, how is it possible to know if these programmes have any short or long term impact on the population they are designed to serve? Two main components of educational meeting evaluation are evaluations of both the course itself and of the course's outcomes or 'effectiveness' (Newble and Cannon 2001). This review uses a two-step analysis of each paediatric acute care course based in a LLMIC that has undertaken these aspects of evaluation to serve as a guide for future educators.

Shufflebeam's "Context, Input, Process and Product evaluation" (CIPP) model (Stufflebeam 2007) is an evidence-based method of evaluating all phases of an educational programme including design, implementation and assessment (Frye and Hemmer 2012). These phases should be justified, thereby not only describing *how* but also *why* a course was performed. Context is not a static background but a dynamic component of the course. It influences the success of its implementation and includes geographical setting, participant profession and prior knowledge and organisational infrastructure (Reed et al. 2018). The course content and delivery should be relevant to the diagnostic capability, equipment and treatments available in the target setting. Evaluating the process of the course can be shown by the authors' justification of any changes or adjustments made after the course had begun. In this way, the educators' *justification* can be used as an insight into the evaluation that occurred of the course itself.

The Kirkpatrick framework is a well-established educational theory that measures a course's effectiveness by way of outcome evaluation (Kirkpatrick and Kirkpatrick 2006). This can be adapted for use with postgraduate medical courses by determining the following four levels as outcomes of effectiveness: reaction (participants' satisfaction), learning (change in knowledge or skills), behaviour (change in clinical practice) and results (change in outcomes such as morbidity and mortality). It is apparent that as one progresses through these four levels, they can become more difficult and time-consuming to measure, although these levels cannot be thought of as hierarchical.

Aim

This review aims to investigate the evaluation methods already published to guide educators in course design and evaluation. The aim is to collate these heterogeneous study findings into a coherent textual narrative (Ryan 2013) to help educators ensure the considerable resources invested in in-service training are being put to best use. The protocol is available online at: https://bemecollaboration.org/Reviews±In±Progress/Paediatric±and±neonatal/.

Primary research question

What methods are used to evaluate teaching and outcomes of paediatric and neonatal acute-care continuing professional development short courses in low and lower-middle income countries?

Secondary research questions

What justification is given for the chosen evaluation methods?

Where have the authors evaluated the Context, Input, Process and Product of the course (CIPP framework)?

Which Kirkpatrick level(s) do the outcome measures correspond to?

Methods

The following databases were included, searched in November 2018 then updated in December 2020: OVID Medline, OVID Embase, ERIC, CINAHL, Web of Science, Scopus, Cochrane, African Index Medicus, Index Medicus for the Eastern Mediterranean Region (IMEMR), IndMED (India), Latin America and the Caribbean (LILAC), Western Pacific Region Index Medicus (WPRIM). An example search strategy is shown in Supplementary Appendix 1. The following clinical trial registries: clinicaltrials.gov, WHO International Clinical Trials Registry Platform (ICTRP). Reference lists of influential studies were checked for additional papers. The following keywords were included: paediatric, neonatal, children, emergency, acute, resuscitation, low income, low resource, resource-poor, developing country, outcome, evaluation.

Study selection

The following inclusion criteria were used:

Population: Participant is any postgraduate/high-level healthcare provider.
Intervention: Face-to-face paediatric or neonatal acute/emergency care course; duration seven days or less.
Context: Low- or lower-middle income country.
Outcome: Evaluation of course teaching methods; Evaluation of course outcomes.

No language restrictions.
The only exclusion criteria was review articles.
Definitions:

- Low income and lower-middle income country as defined by the World Bank (World Bank 2021)
- Continuing professional development: 'the process by which health professionals keep updated to meet the needs of patients, the health service, and their own professional development. It includes the continuous acquisition of new knowledge, skills, and attitudes to enable competent practice.' (Peck et al. 2000)
- Acute/emergency care: The care of a neonate or child (up to 16th birthday) within the first 24 hours of healthcare attendance.

Two reviewers independently screened titles and abstracts against the inclusion/exclusion criteria. If both agreed the paper should be included, it was moved to full-text review. If both agreed the paper should not be included, it was excluded. If the reviewers disagreed, the full paper was sought and the paper included in the full-text review. Cohen's kappa was used to measure inter-rater reliability.

Two reviewers independently read the full-text and verified the inclusion/exclusion criteria were met. Disagreements were reviewed by a third reviewer and a consensus reached. A data extraction and quality assessment form (Supplementary Appendix 2) for all included papers was completed independently by two reviewers and disagreements reviewed with a third reviewer for a consensus. If data was incomplete the authors were contacted for additional information.

Quality assessment

No article was excluded based on study design except review articles. The following assessments (Supplementary Files) were used for quality assessment of:

1. The postgraduate educational intervention described adapted from Kern's framework (Kern 2015). This risk of bias assessment reflects the quality of reporting and areas assessed included problem identification, needs of learners, goals and objectives, educational strategies, implementation, content and conclusion.
2. The study quality by Medical Education Research Study Quality Instrument (MERSQI) tool (Reed et al. 2007). This reflects quality in study design or methodology and areas assessed included study design, sampling, type of data, validity evidence for evaluation scores, data analysis and outcomes.

Results

In the original search, 6905 papers were retrieved with 4154 remaining after duplicate removal. In the updated search, 2172 additional papers were retrieved with 1113 after duplicate removal. The titles and abstracts of all 5267 papers were screened and 266 articles moved to full-text review. Cohen's kappa was 0.47. 93 articles were included in the final review. The PRISMA flowchart is seen in Table 1.

Course evaluation methods of teaching and outcomes for continuing professional development within low and lower-Middle income countries

Quality assessment

There were eight randomised-controlled trials (RCTs) and three non-randomised controlled studies. The majority of the remaining studies used pre- and post-intervention designs. 14 of the 93 studies were conference abstracts. 72 papers had an overall high or unclear risk of bias according to the Kern framework, reflecting the poor descriptions of interventions leading to low to average reporting quality. Conference abstracts had the highest risk of bias. The MERSQI sub-scores are presented in Table 2, with common areas of poor scoring including the pre- and post-intervention design used by the majority of studies, a lack of validity evidence reporting and Kirkpatrick Level two being the most common level of evaluation studied. The number of outcome evaluations per Kirkpatrick level are shown in Figure 1.

Many studies provided limited information on methods used to evaluate the 'context', 'input' and 'process' of the course, with most emphasis being on the 'product'. However, a justification of the choice of location, participants, input and a description of facilitators and barriers are evidence that an evaluation of course design and implementation was performed by some and are described below.

Context

A description of the target participants and the setting is widely recognised as crucial for understanding the impact of an intervention and for replicability (Hoffmann et al. 2014; Van Hecke et al. 2020). Neonatal or child mortality rates in a country or region are a common introduction to the topic and used to justify the geographical location, for example, a Neonatal Resuscitation Program (NRP) in Sudan study begins by explaining 96% of neonatal deaths occur in 'developing' countries with 19% due to birth asphyxia (Trevisanuto et al. 2007).

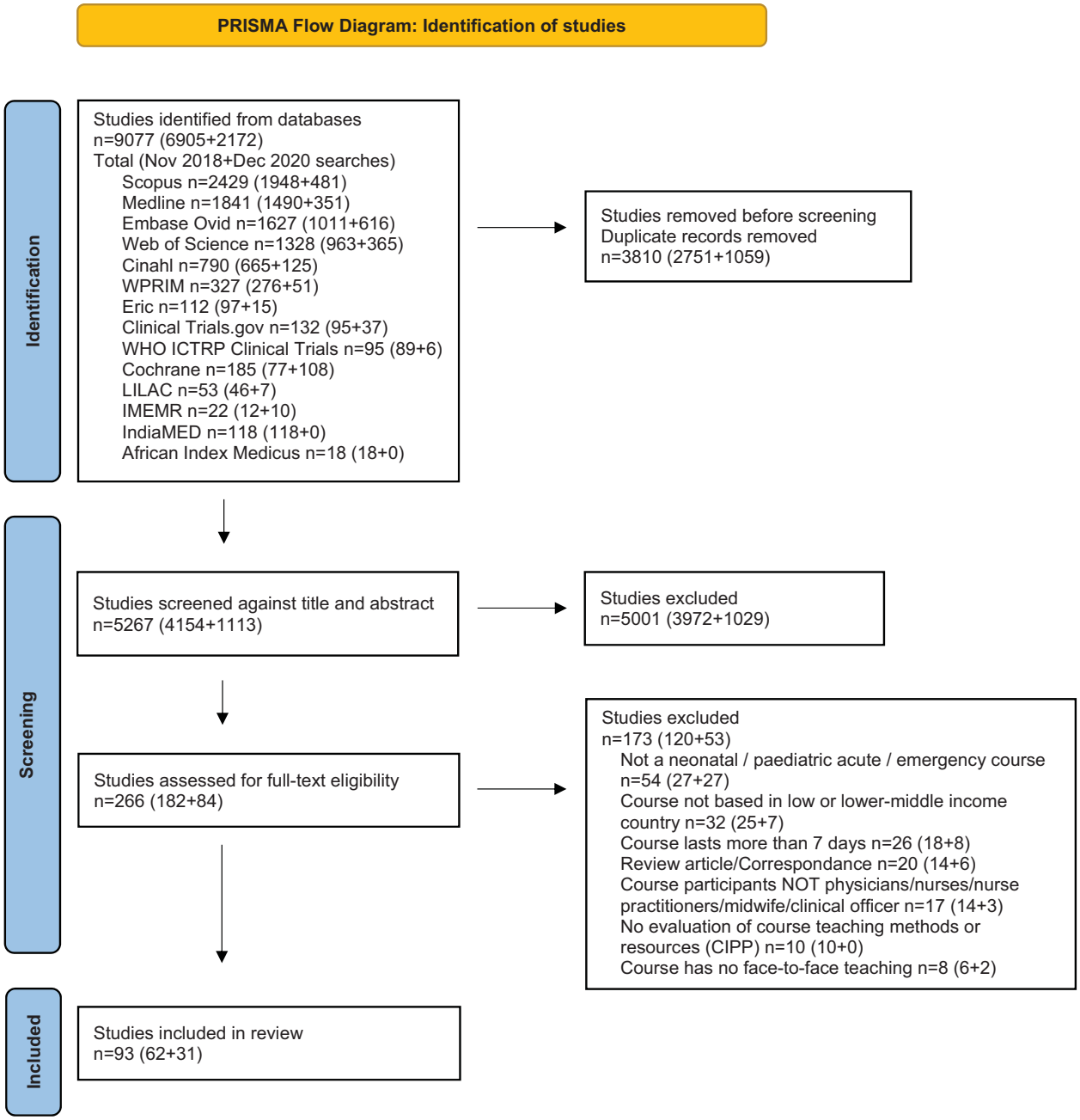
Greater insight into learner needs was provided when the context was assessed more specifically on the site of the course, for example, through hospital-based data such as incidence of severe asphyxia prior to NRP in Mongolia (Hosokawa 2011). The choice of eight rural hospitals in Kenya for the Emergency Triage Assessment and Treatment (ETAT) course was to represent the variety of rural hospital settings, comparable as all had >1000 children and >1200 deliveries per year (Ayieko et al. 2011). Helping Babies Breathe (HBB) in India and Kenya used sites that had a Global Network population registry to allow follow up to 42 days (Bang et al. 2016; Bellad et al. 2016).

Most participants were birth attendants or healthcare workers looking after children. Some studies more specifically chose participants; for example, HBB justified their choice as those who were to be 'Master trainers' in collaboration with the Ethiopian Ministry of Health (Hoban et al. 2013). A Critical Care short course in multiple LLMIC invited non-clinical participants such as field epidemiologists in addition to physicians and nurses to improve communication to overcome challenges such as specimen transportation (Diaz et al. 2018).

Input

HBB has many published course evaluations in which the aim, curriculum and teaching methods are well described (Msemo et al. 2013; Mduma et al. 2018) or have a link to the course website. They justify this methodology as promoting adult learning by hands-on skills practice using low-cost mannequins, paired-learning and immediate feedback (Seto et al. 2015). A cluster RCT in Uganda used HBB with an additional module teaching the use of a laryngeal mask airway (LMA) during neonatal resuscitation (Pejovic et al. 2020). This modified *input* allowed mortality to be compared between LMA and face-mask use post-course to

Table 1. PRISMA flow chart of included studies.



WPRIM: Western Pacific Region Index Medicus; WHO ICTRP: World Health Organization International Clinical Trials Registry Platform; LILIAC: Latin America and the Caribbean; IMEMR: Index Medicus for the Eastern Mediterranean Region.

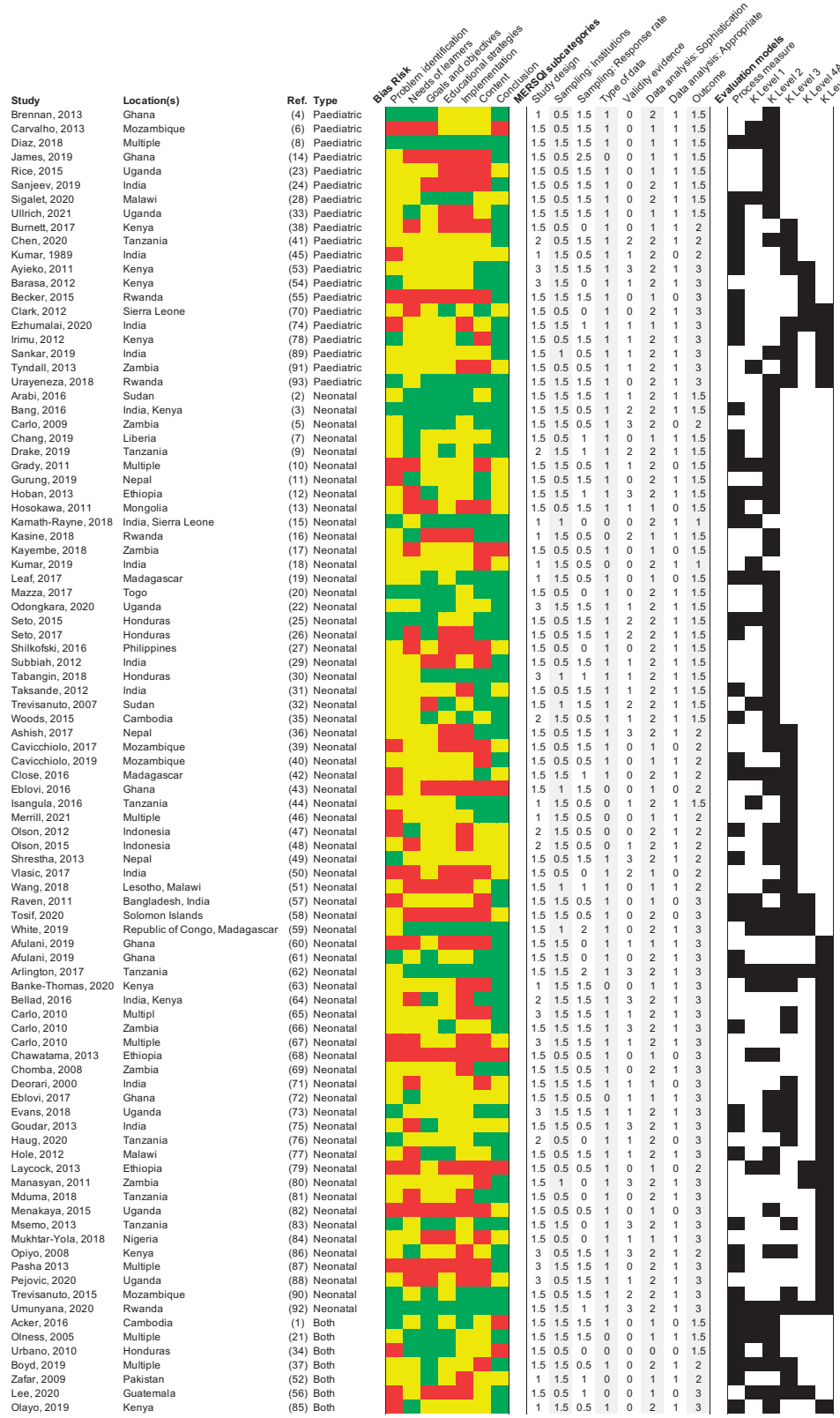
support learning of advanced airway skills by non-physicians. A second edition of HBB was created after an Utstein-style meeting identified challenges in resuscitation science, educational efficacy and local implementation (Kamath-Rayne et al. 2018).

Disaster management training for children in multiple countries in South America, Africa and Asia (Olness et al. 2005) used short didactic lectures then multi-phase case discussions justified by Barrow's problem-based learning approach. The input of many courses had been specifically created or adapted for LLMIC, for example, a one-day newborn resuscitation training designed for Kenya based on UK Resuscitation Council Training (Opiyo et al. 2008). The input of Neonatal Life Support (NLS) in Zambia was justified because it included chest compressions whereas HBB and WHO Early Newborn Care (ENC) courses did not, whereas the choice of the ENC course was justified by another provider in Zambia as it was the "minimal acceptable standard" for midwife training (Chomba et al. 2008). Detailed knowledge of the *context* of the course will feed into the *input* required for that specific setting.

Process

Describing facilitators and barriers encountered during the course is helpful for the future organisation of that course and of others. Recognising the barrier of maintaining clinical care during course attendance, a newborn resuscitation course for 600 doctors and midwives from 33 hospitals in Cambodia held each module twice (Woods et al. 2015). In contrast, a Nepalese course on early newborn care could only recruit 30 nurses due to manpower and time constraints (Shrestha et al. 2013).

Table 2. BEME studies' summary table.s



Study	Location(s)	Ref.	Type	MERSQI							
Brennan, 2013	Ghana	(4)	Paediatric	1	0.5	1.5	1	0	2	1	1.5
Carvalho, 2013	Mozambique	(6)	Paediatric	1.5	0.5	1.5	1	0	1	1	1.5
Diaz, 2018	Multiple	(8)	Paediatric	1.5	1.5	1.5	1	0	1	1	1.5
James, 2019	Ghana	(14)	Paediatric	1.5	0.5	2.5	0	0	1	1	1.5
Rice, 2015	Uganda	(23)	Paediatric	1.5	0.5	1.5	1	0	1	1	1.5
Sanjeev, 2019	India	(24)	Paediatric	1.5	0.5	1.5	1	0	2	1	1.5
Sigalet, 2020	Malawi	(28)	Paediatric	1.5	0.5	1.5	1	0	2	1	1.5
Ullrich, 2021	Uganda	(33)	Paediatric	1.5	1.5	1.5	1	0	1	1	1.5
Burnett, 2017	Kenya	(38)	Paediatric	1.5	0.5	0	1	0	1	1	2
Chen, 2020	Tanzania	(41)	Paediatric	2	0.5	1.5	1	2	2	1	2
Kumar, 1989	India	(45)	Paediatric	1	1.5	0.5	1	1	2	0	2
Ayieko, 2011	Kenya	(53)	Paediatric	3	1.5	1.5	1	3	2	1	3
Barasa, 2012	Kenya	(54)	Paediatric	3	1.5	0	1	1	2	1	3
Becker, 2015	Rwanda	(55)	Paediatric	1.5	1.5	1.5	1	0	1	0	3
Clark, 2012	Sierra Leone	(70)	Paediatric	1.5	0.5	0	1	0	2	1	3
Ezhumalai, 2020	India	(74)	Paediatric	1.5	1.5	1	1	1	1	1	3
Irimu, 2012	Kenya	(78)	Paediatric	1.5	0.5	1.5	1	1	2	1	3
Sankar, 2019	India	(89)	Paediatric	1.5	1	0.5	1	1	2	1	3
Tyndall, 2013	Zambia	(91)	Paediatric	1.5	0.5	0.5	1	1	2	1	3
Urayeneza, 2018	Rwanda	(93)	Paediatric	1.5	1.5	1.5	1	0	2	1	3
Arabi, 2016	Sudan	(2)	Neonatal	1.5	1.5	1.5	1	1	2	1	1.5
Bang, 2016	India, Kenya	(3)	Neonatal	1.5	1.5	0.5	1	2	2	1	1.5
Carlo, 2009	Zambia	(5)	Neonatal	1.5	1.5	0.5	1	3	2	0	2
Chang, 2019	Liberia	(7)	Neonatal	1.5	0.5	1	1	0	1	1	1.5
Drake, 2019	Tanzania	(9)	Neonatal	2	1.5	1	1	2	2	1	1.5
Grady, 2011	Multiple	(10)	Neonatal	1.5	1.5	0.5	1	1	2	0	1.5
Gurung, 2019	Nepal	(11)	Neonatal	1.5	0.5	1.5	1	0	2	1	1.5
Hoban, 2013	Ethiopia	(12)	Neonatal	1.5	1.5	1	1	3	2	1	1.5
Hosokawa, 2011	Mongolia	(13)	Neonatal	1.5	0.5	1.5	1	1	1	0	1.5
Kamath-Rayne, 2018	India, Sierra Leone	(15)	Neonatal	1	1	0	0	0	2	1	1
Kasine, 2018	Rwanda	(16)	Neonatal	1	1.5	0.5	0	2	1	1	1.5
Kayembe, 2018	Zambia	(17)	Neonatal	1.5	0.5	0.5	1	0	1	0	1.5
Kumar, 2019	India	(18)	Neonatal	1	1.5	0.5	0	0	2	1	1
Leaf, 2017	Madagascar	(19)	Neonatal	1	1.5	0.5	1	0	1	0	1.5
Mazza, 2017	Togo	(20)	Neonatal	1.5	0.5	0	1	0	2	1	1.5
Odongkara, 2020	Uganda	(22)	Neonatal	3	1.5	1.5	1	1	2	1	1.5
Seto, 2015	Honduras	(25)	Neonatal	1.5	0.5	1.5	1	2	2	1	1.5
Seto, 2017	Honduras	(26)	Neonatal	1.5	0.5	1.5	1	2	2	1	1.5
Shilkofski, 2016	Philippines	(27)	Neonatal	1.5	0.5	0	1	0	2	1	1.5
Subbiah, 2012	India	(29)	Neonatal	1.5	0.5	1.5	1	1	2	1	1.5
Tabangin, 2018	Honduras	(30)	Neonatal	3	1	1	1	1	2	1	1.5
Taksande, 2012	India	(31)	Neonatal	1.5	0.5	1.5	1	1	2	1	1.5
Trevisanuto, 2007	Sudan	(32)	Neonatal	1.5	1	1.5	1	2	2	1	1.5
Woods, 2015	Cambodia	(35)	Neonatal	2	1.5	0.5	1	1	2	1	1.5
Ashish, 2017	Nepal	(36)	Neonatal	1.5	0.5	1.5	1	3	2	1	2
Cavicchiolo, 2017	Mozambique	(39)	Neonatal	1.5	0.5	1.5	1	0	1	0	2
Cavicchiolo, 2019	Mozambique	(40)	Neonatal	1.5	0.5	0.5	1	0	1	1	2
Close, 2016	Madagascar	(42)	Neonatal	1.5	1.5	1	1	0	2	1	2
Eblovi, 2016	Ghana	(43)	Neonatal	1.5	1	1.5	0	0	1	0	2
Isangula, 2016	Tanzania	(44)	Neonatal	1	1.5	0.5	0	1	2	1	1.5
Merrill, 2021	Multiple	(46)	Neonatal	1	1.5	0.5	0	0	1	1	2
Olson, 2012	Indonesia	(47)	Neonatal	2	1.5	0.5	0	0	2	1	2
Olson, 2015	Indonesia	(48)	Neonatal	2	1.5	0.5	0	1	2	1	2
Shrestha, 2013	Nepal	(49)	Neonatal	1.5	0.5	1.5	1	3	2	1	2
Vlasic, 2017	India	(50)	Neonatal	1.5	0.5	0	1	2	1	0	2
Wang, 2018	Lesotho, Malawi	(51)	Neonatal	1.5	1	1	1	0	1	1	2
Raven, 2011	Bangladesh, India	(57)	Neonatal	1.5	1.5	0.5	1	0	1	0	3
Tosif, 2020	Solomon Islands	(58)	Neonatal	1.5	1.5	0.5	1	0	2	0	3
White, 2019	Republic of Congo, Madagascar	(59)	Neonatal	1.5	1	2	1	0	2	1	3
Afulani, 2019	Ghana	(60)	Neonatal	1.5	1.5	0	1	1	1	1	3
Afulani, 2019	Ghana	(61)	Neonatal	1.5	1.5	0	1	0	2	1	3
Arlington, 2017	Tanzania	(62)	Neonatal	1.5	1.5	2	1	3	2	1	3
Banke-Thomas, 2020	Kenya	(63)	Neonatal	1	1.5	1.5	0	0	1	1	3
Bellad, 2016	India, Kenya	(64)	Neonatal	2	1.5	1.5	1	3	2	1	3
Carlo, 2010	Multipl	(65)	Neonatal	3	1.5	1.5	1	1	2	1	3
Carlo, 2010	Zambia	(66)	Neonatal	1.5	1.5	1.5	1	3	2	1	3
Carlo, 2010	Multiple	(67)	Neonatal	3	1.5	1.5	1	1	2	1	3
Chawatama, 2013	Ethiopia	(68)	Neonatal	1.5	0.5	0.5	1	0	1	0	3
Chomba, 2008	Zambia	(69)	Neonatal	1.5	1.5	0.5	1	0	2	1	3
Deorari, 2000	India	(71)	Neonatal	1.5	1.5	1.5	1	1	1	0	3
Eblovi, 2017	Ghana	(72)	Neonatal	1.5	1.5	0.5	0	1	1	1	3
Evans, 2018	Uganda	(73)	Neonatal	3	1.5	1.5	1	1	2	1	3
Goudar, 2013	India	(75)	Neonatal	1.5	1.5	0.5	1	3	2	1	3
Haug, 2020	Tanzania	(76)	Neonatal	2	0.5	0	1	1	2	0	3
Hole, 2012	Malawi	(77)	Neonatal	1.5	0.5	1.5	1	1	2	1	3
Laycock, 2013	Ethiopia	(79)	Neonatal	1.5	0.5	0.5	1	0	1	0	2
Manasyan, 2011	Zambia	(80)	Neonatal	1.5	1	0	1	3	2	1	3
Mduma, 2018	Tanzania	(81)	Neonatal	1.5	0.5	0	1	0	2	1	3
Menakaya, 2015	Uganda	(82)	Neonatal	1.5	0.5	0.5	1	0	1	0	3
Msemo, 2013	Tanzania	(83)	Neonatal	1.5	1.5	0	1	3	2	1	3
Mukhtar-Yola, 2018	Nigeria	(84)	Neonatal	1.5	0.5	0	1	1	1	1	3
Opiyo, 2008	Kenya	(86)	Neonatal	3	0.5	1.5	1	3	2	1	2
Pasha 2013	Multiple	(87)	Neonatal	3	1.5	1.5	1	0	2	1	3
Pejovic, 2020	Uganda	(88)	Neonatal	3	0.5	1.5	1	1	2	1	3
Trevisanuto, 2015	Mozambique	(90)	Neonatal	1.5	0.5	1.5	1	2	2	1	3
Umunyana, 2020	Rwanda	(92)	Neonatal	1.5	1.5	1	1	3	2	1	3
Acker, 2016	Cambodia	(1)	Both	1.5	1.5	1.5	1	0	1	0	1.5
Olness, 2005	Multiple	(21)	Both	1.5	1.5	1.5	0	0	1	1	1.5
Urbano, 2010	Honduras	(34)	Both	1.5	0.5	0	0	0	0	0	1.5
Boyd, 2019	Multiple	(37)	Both	1.5	1.5	0.5	1	0	2	1	2
Zafar, 2009	Pakistan	(52)	Both	1	1.5	1	0	0	1	1	2
Lee, 2020	Guatemala	(56)	Both	1.5	0.5	1	0	0	1	0	3
Olayo, 2019	Kenya	(85)	Both	1	1.5	0.5	1	0	2	1	3

Table 2: studies grouped into paediatric or neonatal courses or courses which include both paediatric and neonatal teaching.
Bias risk = quality assessment of postgraduate educational intervention adapted from Kern's framework. Green = low risk; yellow = uncertain risk, red = high risk.
MERSQI = quality assessment of outcome evaluation by Medical Education Research Study Quality Instrument (MERSQI) tool.
Evaluation models = Process measure from 'Context, Input, Process and Product' (CIPP) model, K Level = Kirkpatrick Level. Black = reported, White = Not reported.

Partnership with the Tanzanian Ministry for Health and Social Welfare was a major facilitator in the extensive roll-out of HBB across the country and was described as supporting training and ensuring availability of equipment (Msemo et al. 2013). Partnering with a marine conservation organisation was justified by a Madagascan HBB as it

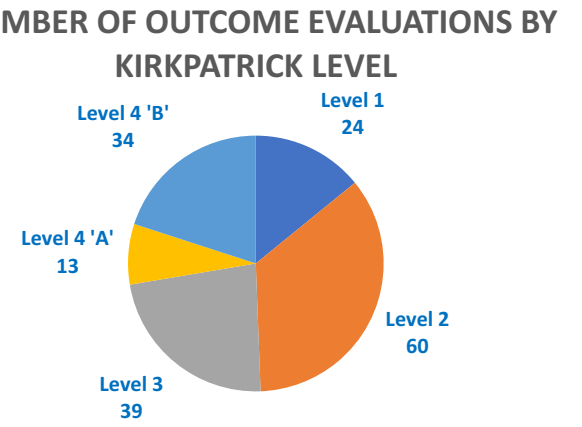


Figure 1. Number of outcome evaluations by Kirkpatrick Level (multiple levels per paper possible).

enabled meeting 'key players' in the community (Leaf et al. 2017). Augmenting this argument is the difficulties a Paediatric and Neonatal Life Support course in Honduras encountered due to a lack of institutional support (Urbano et al. 2010).

Many courses described the benefit of performing a course in the local language, such as the first HBB in Spanish in Honduras (Seto et al. 2015) and NRP being translated into Mongolian (Hosokawa 2011). An Essential Obstetric and Newborn Care (EOC&NC) course in Bangladesh and India was performed in English; the authors stated this led to an underestimation of the participants' knowledge (Raven et al. 2011).

An ETAT course in Malawi used an adult learning strategy called "Think, Pair, Share" with problem-solving done in pairs, justified as it reduced learner stress (Sigalet et al. 2021). Other courses described resistance to teaching methods, such as problem-based learning in Disaster Management training (Olness et al. 2005). Strongly-held beliefs of doctors resistant to oral rehydration solution for acute gastroenteritis (Kumar et al. 1989) or older midwives to HBB techniques (Close et al. 2016) were overcome during or after the course when participants witnessed positive outcomes from taught techniques.

Kirkpatrick level one

The most common method of participant reaction is by feedback form regarding course satisfaction immediately post-course, usually by Likert scale then white-space questions, such as is done routinely at the end of the HBB (Hoban et al. 2013; Seto et al. 2015; Close et al. 2016), Safer Anaesthesia from Education (SAFE) (Boyd et al. 2019; White et al. 2019) and NRP (Trevisanuto et al. 2007) which are used for faculty feedback. After an Advanced Paediatric Life Support (APLS) course in Zambia, semi-structured interviews were used to assess perceived relevance and impact of the course (Tyndall et al. 2013). Similarly, key informant interviews and focus group discussions have been used after EOC&NC assessing satisfaction and attitude towards training from participants and others including patients and Ministry of Health staff (Banke-Thomas et al. 2020). 222 focus groups were held after 13,169 healthcare providers attended HBB in Tanzania to identify program strengths, weaknesses, barriers and whether they would recommend it to others (Arlington et al. 2017). The focus groups and interviews gained more in-depth answers about barriers to learning than the feedback forms.

Kirkpatrick level two

Level two can be split into three categories: knowledge, skills and self-efficacy or confidence. Evidence of knowledge gain is most often sought by a pre- and post-course quiz, such as the 80 questions for NRP in Sudan covering its seven steps of resuscitation and graded against the NRP manual (Trevisanuto et al. 2007) and many others. HBB in Ethiopia compared results of the pre- and post-knowledge quiz between professions and trainee-to-trainer ratios (Hoban et al. 2013).

HBB has a standard and validated knowledge and skills evaluation after their courses including a pre- and post-knowledge quiz, skills stations and objective structured clinical exams (OSCEs). Using these methods, HBB identified the decline in skills was greater than knowledge decline over time with evaluations up to 4-years post-course (Wang et al. 2018). Refresher training (Bang et al. 2016), daily skills training (Gurung et al. 2019) or structured 'On the Job Training' by an HBB champion (Drake et al. 2019) all increased retention. For example, the group with monthly OSCEs for 6 months had greater odds of passing than less frequent practices (Tabangin et al. 2018). HBB has published an evaluation of their OSCE including item difficulty, discrimination and item agreement (Seto et al. 2017). In contrast, administration of the pre- and post-knowledge test and OSCEs after the Prehospital Care Provider training in Cambodia was inconsistent, therefore, no comparisons were possible between the 58 courses (Acker et al. 2016).

A combined HBB and Helping Mothers Survive course in the Philippines video-taped the pre- and post-course OSCE and could determine whether the participant had quickened time-critical skills such as initiation of ventilation in a simulated apnoeic neonate (Shilkofski et al. 2016). A cluster RCT of HBB used these evaluations to determine whether video-debriefing prevented knowledge and skill deterioration over time (Odongkara et al. 2020). During ETAT in Uganda, key critical actions were timed, such as intraosseous placement, in a pre- and post-simulation test (Rice et al. 2015). In Cambodia, a simulated neonatal resuscitation test was done 7-11 months after a Maternal and Child Health course (Woods et al. 2015). The participants' skills were compared to participants' colleagues and healthcare workers in different hospitals. This was designed to show skill retention for participants and spill-over to colleagues.

Self-efficacy with paediatric resuscitation and bag-valve-mask ventilation (BVM) was measured after ETAT in Ghana (Brennan et al. 2013). 12 months after NRP in Indonesia, a knowledge quiz and self-efficacy questionnaire was sent as a non-randomised trial to 242 trained midwives and 106 control midwives (Olson et al. 2012). The NRP in Zambia performed a 14-item self-efficacy evaluation pre, post and then six months after the course investigating a correlation between self-efficacy and skills decline (Carlo et al. 2009).

Kirkpatrick level three

Evidence of behaviour change can occur through self-reporting, objective observation or documentation of clinical practice. Self-reporting can be achieved through

surveys, focus group discussions or logbooks of clinical practice. NRP in Indonesia asked participants to report their resuscitation attempts in the 12 months post-course and compared them with a control group (Olson et al. 2012). They performed a Path analysis to understand the extent knowledge and self-efficacy contribute to resuscitation attempts (Olson et al. 2015). The 222 semi-structured focus group discussions after HBB courses across Tanzania asked how HBB affected their work (Isangula et al. 2018). SAFE in the Republic of Congo and Madagascar used semi-structured interviews at four then 12-18 months to assess translation of knowledge and skills into personal practice (White et al. 2019).

Participant logbooks were used after an Essential Surgical Skills - Emergency Maternal and Child Health (ESS-EMCH) course in Pakistan to record patients they managed after the course. 63 logbooks documented 1123 resuscitations (Zafar et al. 2009). HBB in Ghana asked participants to keep a logbook of deliveries attended and interventions required for 12 months post-course (Eblovi et al. 2017). SAFE asked participants to keep a logbook of paediatric clinical cases they had managed differently due to the course (Boyd et al. 2019).

APLS in Zambia was evaluated by a sampling of case-notes for documentation of vital signs and initial management (Tyndall et al. 2013) and acute gastroenteritis training in Kenya by pre- and post-course documentation of key signs and correct treatment (Burnett and Thuranira 2017). Rural ETAT courses in Kenya, randomising hospitals to intensive or control training, performed a retrospective casenote review over 18 months regarding documentation of clinical signs and treatment as process indicators of change (Ayieko et al. 2011). A two-day training in India on prescribing during paediatric cardiopulmonary resuscitation performed a pre- and post-course casenote review of medication 'fallacies' during CPR (Sankar et al. 2019). Another course in India teaching about paediatric emergency referrals examined the quality of referral letters pre- and post-course (Ezhumalai et al. 2020).

The large HBB study in Tanzania placed a computer in or close to every labour ward for data entry of observed resuscitation skills into a national form pre- and post-course (Msemo et al. 2013). NRP in India similarly filled out a proforma for three months pre-course then monthly data for 12 months measuring BVM, chest compressions and medication use (Deorari et al. 2000). A cluster RCT of ENC and NRP in multiple countries documented resuscitation techniques on standard data collection forms completed by midwives which were then reviewed by Community Coordinators (Carlo W et al. 2010). A Paediatric Emergency course in Tanzania developed by the African Federation of Emergency Medicine observed 402 cases of respiratory distress, 394 cases of trauma and 396 cases of sepsis in the seven weeks post-course and compared clinical behaviour between nurses who had attended the course and those who had not (Chen et al. 2019).

Direct observation of clinical practice after a course is a more objective measure of behaviour change than self-reporting. After ENC in Nepal a skills-learning checklist was completed during observation of clinical practice, including immediate neonatal care and infection management (Shrestha et al. 2016). A newborn resuscitation course in Kenya observed resuscitations by trained observers using a checklist of resuscitation steps and compared trained to untrained nurses (Opiyo et al. 2008). Acute diarrhoea training in India was evaluated 12 months post- course by observation of participants managing five patients using a structured data collection form (Kumar et al. 1989). A cluster RCT of HBB in Uganda used direct clinical observation of resuscitations pre-course, six months then 12 months post-course in 42 facilities to identify what 'dose' of peer-assisted learning was required post-course for skills retention (Evans et al. 2018).

Video-recording of clinical practice was performed for 50 resuscitations before and 50 after NRP in Mozambique using a fixed camera above the radiant warmer so the participants' faces were not recorded (Trevisanuto et al. 2015). A score was given for correct procedures and their duration then compared to the midwives' subjective scores of their clinical performance revealing a mismatch (Cavicchiolo et al. 2017). HBB in Tanzania used video-recordings of resuscitations plus trained observers to time events such as time to ventilation to identify gaps between observed clinical practice and HBB intention (Haug et al. 2020).

Kirkpatrick level four 'A'

Measuring a change in the health system infrastructure post-course is arguably a marker of effectiveness, especially if those changes were made by the participants themselves, motivated by their learning. ETAT + training in Rwandan district hospitals lead to hospital directors' desire to improve services and an increase in the number of hospitals with a paediatric triage system, paediatric and neonatal resuscitation equipment and paediatric protocols (Becker et al. 2015). All districts providing Essential Obstetric Care (EOC) were visited at baseline then three, six and 12 months after EOC&NC courses in Bangladesh and India to determine if they were providing the signal functions of EOC (one of which is newborn resuscitation) (Raven et al. 2011). This was done by discussion with staff, direct observation and data extraction from registers.

Equipment such as bag-valve-mask availability can be audited pre- and post-course, including after an Early Essential Newborn course in Solomon Islands (Tosif et al. 2020) and a Service Availability and Readiness Assessment pre- and post-HBB in Rwanda (Umunyana et al. 2020). A large study involving 13,169 participants at HBB courses in Tanzania performed 335 facility and equipment checklists to determine whether, for example, a bag-valve-mask and suction devices were present in every delivery area (Arlington et al. 2017). 'Structural indicators' were evaluated after the RCT study of ETAT courses in Kenya looking for equipment availability, basic supplies and service organisation with a checklist of 113 items required for guideline-directed care (Ayieko et al. 2011). These were compared between hospitals receiving 1.5-day didactic training or those receiving an 5.5-day extended ETAT programme.

These HBB and ETAT studies both subsequently performed a cost analysis of the courses. For the HBB courses (Arlington et al. 2017) this was a cost analysis of HBB implementation in each facility and therefore the projected cost of national roll-out. The ETAT courses in Kenya performed a cost-effectiveness analysis by calculating the price of course development, implementation and treatment

costs by four six-monthly case note reviews of 400 randomly selected admissions (Barasa et al. 2012). Their aim was to determine whether the ETAT + strategy was a good use of limited resources. ENC courses run in 96 rural communities in multiple countries underwent cost-effectiveness analysis of cost per life saved and disability-adjusted life-year (Manasyan A. et al. 2011).

Kirkpatrick level 4 'B'

Improving the health or wellbeing of children is rightly considered the fundamental aim of acute-care courses in LLMIC. The landmark study on the roll-out of HBB across Tanzania (Msemo et al. 2013) showed a 47% reduction in early neonatal mortality using data collection forms from every delivery area two months pre- and post-course. One hospital involved showed no improvement in clinical management seven months post-course, so a secondary analysis was performed including a variable life-adjusted display of cumulative lives saved and a cumulative sum chart to detect small but persistent changes over time (Mduma et al. 2018).

A later HBB study in Tanzania (Arlington et al. 2017) examined neonatal mortality rate, stillbirth rate and deaths from asphyxia, but used historical health information systems which were too limited in pre-course data to be comparable. A NRP study in Malawi, with only 14 participants, had the primary outcome of total neonatal deaths measured for 15 months post-intervention compared to retrospective hospital data from 15 months before (Hole et al. 2012). No change in mortality was seen. A well-conducted study on HBB courses in India and Kenya had two 12-month study periods pre- and post-course with a total of 70,704 births followed, and again no significant difference in mortality was seen (Bellad et al. 2016). This does not equate to these courses being ineffective, but perhaps the evidence for this would come from other levels of the Kirkpatrick framework.

Combined ENC/NRP courses in Zambia evaluated the seven-day neonatal mortality, perinatal deaths, asphyxia and infection-related deaths, stillbirths and one minute Apgar scores at three time points: pre- and post-ENC and post-NRP (Carlo et al. 2010). Of note, this study included an "active baseline design" where research nurses were taught research concepts, data collection including differentiation between stillbirth and early neonatal deaths and Apgar scores before the baseline data was collected so pre- and post-course data was comparable. A "difference-in-difference" analysis was performed to determine if any changes were due to the courses rather than trends over time.

A large cluster RCT in five LLMIC included the Emergency Obstetric and Newborn Care (EmONC) course in its package of interventions alongside community birth attendant training and hospital transport (Pasha et al. 2013). A pre-existing health registry was used to enroll and follow pregnant women to delivery (over 100,000 births included) and six weeks beyond to determine differences in perinatal mortality in the 18-24 months of the intervention. Outcomes 12 months post-course were also reported. HBB in Uganda also used routine statistics from a government register to detect changes in mortality pre- and post-course (Evans et al. 2018).

Hospital mortality rate, sepsis within 72-hours of hospital admission and intervention side-effects were evaluated pre- and post-training on prevention and recognition of infection in Rwanda (Urayeneza et al. 2018). Severity of illness on arrival to the referral hospital was assessed pre- and post-training on paediatric emergency referrals in India (Ezhumalai et al. 2020). A post-course observational study of CPAP use and patient outcome was performed after a two-day course on paediatric and neonatal CPAP in Kenya (Olayo et al. 2019). Inpatient mortality was evaluated by sampling 500 case notes pre- and post-ETAT (Clark et al. 2012) in Sierra Leonne. As this was part of a multifaceted intervention, including hospital layout, staff allocation, equipment and medical record keeping, the effect on mortality cannot be ascribed to the training course alone.

Other patient outcomes aside from mortality include Apgar scores collected by data collection forms (Msemo et al. 2013; Mukhtar-Yola et al. 2018), hospital data (Hole et al. 2012; Trevisanuto et al. 2015) or by research nurses (Carlo et al. 2010). The cluster RCT of combined ENC/NRP courses evaluated neurological outcome at 7 days for surviving neonates who had received BVM as assessed by community coordinators (Carlo W et al. 2010).

Discussion

The ultimate aim of paediatric and neonatal emergency courses is to have a positive impact on the health of the local population. Achieving this goal requires a well-designed short course, relevant to the LLMIC context, and validated outcome measurements.

This narrative review draws together evidence that serves as a guide to future course organisers. A useful Cochrane Review was published last year on the effects of continuing education meetings on professional practice and healthcare outcomes (Forsetlund et al. 2021). However, most of the studies were from North America and Europe and included only randomised studies focusing on Kirkpatrick Level 4. Our review focuses on the acute-care of children and neonates in LLMIC, collating all components of course evaluation methods from LLMIC to provide a more pragmatic review targeted for the healthcare workers caring for this vulnerable population.

Strengths of our review include the large selection of databases, including many region-specific, and inclusion of papers from any language. Key learning points include a need for detailed description of the acute-care course, including justifying context and content with site-specific data, incorporating the local language and the support of local or national organisations for sustainability. Outcome measurements should be validated and in a pre-post-comparison study an "active baseline design" is a good practice point, where data collectors are trained in research concepts and definitions before the baseline data is collected so pre- and post-course data is comparable and results reflect the intervention alone.

Many studies had a poor description of their course and scored poorly on the Kern bias score. Consequently, this could make it difficult to replicate their evaluation methods for other courses and this is a limitation of this review. However, as with most educational developments, the lessons learnt can provide transferable concepts which this

review has collated and described pragmatically. The heterogeneity of the evaluation methods shows the sheer diversity of available methods. This may be advantageous in LLMIC where there is a range of available resources for this work. Even though few (11 out of 93) papers have a control group and only 8 were RCTs, this review describes what *can* be done with limited resources. Another limiting factor was the 'moderate' Cohen's kappa score for inter-rater reliability (0.47), although any disagreements between reviewers led to the paper being included in the next stage of the review or a third reviewer being sought.

Course evaluation is often underfunded and consequently not a formalised process leading to easy synthesis. The importance of describing and evaluating training interventions is, however, being increasingly recognised with formal criteria being published such as the Criteria for Reporting on Development and Evaluation of Professional Training interventions in Healthcare (CRe-DEPTH) (Hoffmann et al. 2014; Van Hecke et al. 2020). It is vital that course evaluation is performed and reported at a high standard to synthesise and build on research findings and avoid wasting resources. Structuring outcome measures into Kirkpatrick levels, using the examples above, will provide evidence of course effectiveness.

A notable exception are the studies on Helping Babies Breathe, which have well-described and justified learning outcomes, curriculum and resources as well as consistent and validated outcome evaluations. Arguably this enabled the conduct of good-quality RCTs and provided the landmark paper in this field (Msemo et al. 2013). Course organisers that aim to guide development of healthcare infrastructure changes can change the perception that only expensive and highly technical care can change mortality (Manasyan et al. 2013).

An emergent finding of this review was the proportion of first and last authors based in a LLMIC institution: 40% (37/93) and 20% (19/93) respectively. 12% (13/93) of papers did not have any authors from a LLMIC institution. Publication of training evaluation by LLMIC authors must be facilitated to fully understand the appropriateness and impact of these courses in their context.

Conclusion

Course evaluation can be difficult, especially in a LLMIC with stretched resources, and this is reflected in the inconsistent reporting of these interventions and outcome measures and low-quality study design. By explaining evaluation methods of course content, delivery and outcome measures based on a CIPP and Kirkpatrick models, this review provides a detailed description of the current landscape of evaluation methods of in-service training in LLMIC. This should serve as a guide for future course organisers to provide well-conducted courses with consistent outcome measures. This, in turn, will enable educators to create short courses with the maximum lasting impact for these children and neonates who need it most.

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Author contributions

AG and MK conceived the review. AJ assisted AG in the database search strategies. AG, MK, RP, KP, HG, EH, JH, RI, AJ, JH, LB, RH, SW and JT were involved in the article screening and data extraction. AG led drafting of the manuscript with all authors providing critical revisions and approval of the final version. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

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