

Approaches, enablers, barriers and outcomes of implementing facility-based stillbirth and neonatal death audit in LMICs: a systematic review

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ABSTRACT

Purpose To identify approaches, enablers, barriers and outcomes of facility stillbirth and neonatal death audit in low-income and middle-income countries (LMICs).

Data sources We searched MEDLINE, CINAHL Complete, Academic Search Index, Science Citation Index, Complementary index and Global health electronic databases.

Study selection Studies were considered eligible when reporting the approaches, enablers, barriers and outcomes of facility-based stillbirth and neonatal death audit in LMICs.

Data extraction Two authors independently performed the data extraction using predefined templates made before data extraction.

Results of data synthesis A total of 10 articles from 7 countries were included in the final analysis. Facility or external multidisciplinary teams performed death audits on a weekly or monthly basis. A total of 1018 stillbirths and neonatal deaths were audited. Of 18 audit enablers identified, nine were at the health provider level while 18 of 23 barriers to audit that were identified occurred at the facility level. The facility-level barriers cited by more than one study included: failure to implement change; inadequate training; limited time; increased workload; too many cases and poor documentation. Six studies reported that death audits resulted in structural improvements in physical structure, training, service organisation, supplies and equipment in the wards. Five studies reported that death audits improved the standard of care, with one study showing a significant improvement in measured standards. One study reported a significant reduction in newborn mortality rate of 29.4% (95% CI 0.6% to 2.4%; $p=0.0015$) and one study a reduction in perinatal mortality of 4.9% (52.8% in 2007 to 47.9% in 2008) before and after perinatal audit implementation.

Conclusion Stillbirth and neonatal death audit improves facility structures, processes of care and health outcomes in neonatal care. There is a need to enhance enablers and address barriers identified at both health provider and facility levels to improve the audit process.

INTRODUCTION

Improving access to healthcare alone is not enough to improve patient outcomes.¹ Recently, a focus on the quality of care (QoC)

was advocated to achieve the Sustainable Development Goal (SDG) 2030 of ensuring healthy lives and promoting well-being for all at all ages. Poor QoC is not only harmful but also wastes resources that could have been used in other sectors to improve the lives of citizens.¹

Despite increased facility-based births, women and babies are still dying or developing lifelong disabilities due to poor QoC.² WHO estimates 295 000 women and 2.5 million newborns die every year during childbirth from preventable causes. Furthermore, 2.6 million stillbirths occur each year. About 98% of these deaths occur in low-income and middle-income countries (LMICs).^{3–5}

Providing high QoC in LMICs remains a challenge and performance varies across providers.¹ Implementing quality improvement is possible in these countries through identifying problems in care and adopting best practice. Table 1 summarises definitions for stillbirth and neonatal deaths. WHO has recommended auditing stillbirths and neonatal deaths to identify and implement ways to improve the quality of maternal and newborn care.⁶ However, progress in LMICs has been limited compared with high-income countries.⁷

Stillbirth and neonatal death audit is the process of capturing information on the causes of deaths and analysing the QoC received, in a no-blame, interdisciplinary setting to improve the care provided to all mothers and babies.⁶ Through the process, the hospital staff have an opportunity to learn from the cases audited and improve care.

Many factors hinder or facilitate the successful implementation of auditing stillbirths and neonatal deaths.⁷ Critically, the effectiveness of audit depends on the ability to complete the audit process. Without effectively implementing the planned actions

**Table 1** Definitions of stillbirth and neonatal deaths

Stillbirth	A baby born dead at ≥ 28 weeks of gestation, or birth weight of ≥ 1000 g, or a body length of ≥ 35 cm
Antepartum stillbirth (macerated stillborn)	Death of a fetus before the onset of labour characterised by skin changes and peelings
Intrapartum stillbirth (fresh stillborn)	Death of a fetus during labour
Neonatal death	Death of a baby within the first 28 days of life
Early neonatal death	Death of a baby within the first 7 days of life
Late neonatal death	Death of a baby between 8 and 28 days of life
Perinatal deaths	Stillbirths and early neonatal deaths

to respond to the problems identified, the audit alone cannot improve QoC.⁸ Also, effective audit requires a system-wide effort to support the recommended initiatives. However, challenges related to system support, formulating appropriate recommendations based on preventable factors and implementing changes have been reported.^{7,9}

This systematic review will contribute to the existing evidence base by synthesising data on facility stillbirth and neonatal death audits and provide guidance on how to undertake a successful stillbirth and neonatal death audit initiative in LMICs. We address the following objectives:

1. To evaluate and synthesise the evidence on the approaches and outcomes of facility based stillbirth and neonatal death audit on QoC and perinatal and neonatal health outcomes in LMICs.
2. To identify enablers and barriers at health provider, facility and regional or national levels of care, to the implementation of successful stillbirth and neonatal death audits in LMICs.

Our work will serve as a guide to facility stillbirth and neonatal death audit implementation by evaluating the evidence on approaches used, outcome measures, opportunities and challenges to guide future healthcare workers undertaking similar initiatives to ensure that it is evidence based.

METHODS

We registered the review on the International Register of Systematic Prospective Reviews (registration number: CRD42019148515) and used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.¹⁰

Search strategy

In September 2019, we searched MEDLINE, CINAHL Complete, Academic Search Index, Science Citation Index, Complementary index and Global health for eligible studies from January 2009 to August 2019. Included search terms were “stillb*” OR “neonat*” OR “perinatal death” OR “neonatal death” AND audit OR review (online supplemental material box 1S).

Inclusion and exclusion criteria

We included studies if they met all of the following criteria: (1) studies describing approaches, enablers, barriers or reporting outcomes of stillbirth and neonatal death audits at the facility level; (2) original research article reporting either quantitative, qualitative data or both (3) study done in LMIC(s) defined and identified according to World Bank list;¹¹ (4) studies which implemented a full audit process; (5) published in English and (6) published between 1 January 2009 and 1 September 2019 (search date). We selected studies published since January 2009 as many LMICs become proactive in addressing quality problems from this date¹² and we aimed to focus the review on current practice. We excluded studies that only reported descriptive findings of audits as such reviews have been well covered elsewhere.^{13–15} We excluded systematic reviews as we were only interested in original research articles.

Quality appraisal

We used the checklist for reviewing disparate data developed by Hawker *et al*¹⁶ to appraise the studies (online supplemental material box 2S). The checklist comprises nine questions, each of which has four sub-categories, permitting summation of a methodological quality score. Each paper was rated on a scale from 9 (very poor) to 36 (good).

Data extraction and analysis

Two authors (MJG and JMM) independently screened titles and abstracts for eligibility (figure 1). A third author (MA) resolved any discrepancies. Articles approved for full-text screening were reviewed by the two authors (MJG and JMM) independently by applying the pre-established inclusion and exclusion criteria listed above; if there was disagreement, we reached consensus through discussion.

One author (MJG) performed data extraction and quality appraisal using pre-defined templates, made by the authors before the literature search. Another author (JMM) was consulted in case of uncertainty.

Since the included studies were heterogeneous regarding design and outcomes, we used the narrative approach to synthesise the evidence. We reported characteristics related to (1) publication, (2) study, (3)

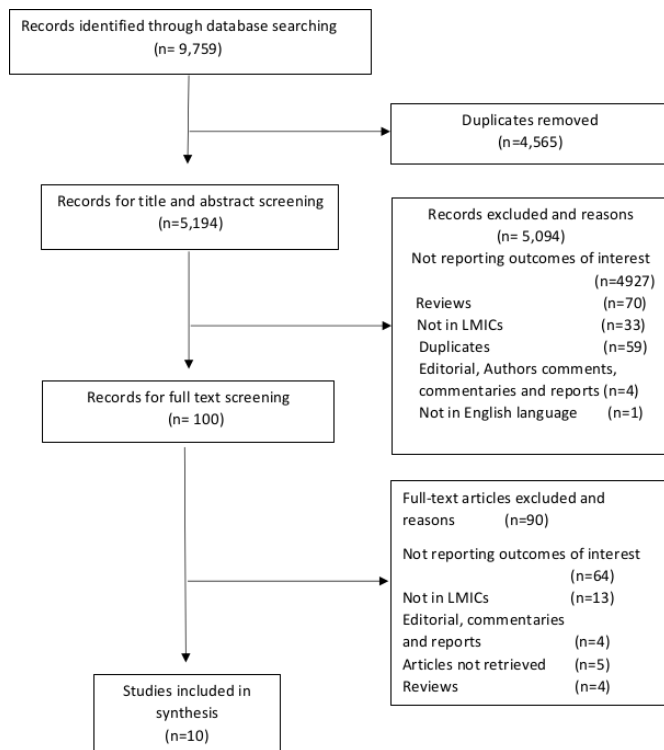


Figure 1 Study flow diagram. LMICs, low-income and middle-income countries.

audit type, (4) approaches, (5) structure outcomes, (6) process outcomes, (7) health outcomes and (8) enablers and barriers. We classified the approaches, enablers and barriers according to the Kruk and Gage schema ‘synthesising improvement approaches’.¹⁷ This guide classifies approaches at micro, meso and macrosystem levels, meaning health provider level; health facility, district or clinic level; and across health system or national level, respectively.

RESULTS

Study selection

The searches resulted in 9759 articles across all of the databases. After excluding 4565 duplicates, we screened 5194 titles and abstracts. Of these, we excluded 5094 articles for not meeting the inclusion criteria (figure 1). The remaining 100 articles underwent full-text review. Common reasons for exclusion at this stage were not reporting outcomes of interest (n=64) and not done in LMICs (n=13) according to World Bank Classification.¹¹ All studies were rated for quality as fair with a score ranging from 23 to 32 (online supplemental material table 1S). We finally identified ten studies as appropriate for inclusion in the synthesis.

Characteristics of studies

Ten studies from seven countries met the inclusion criteria: Tanzania (three studies), Uganda (two) and one study each from Bangladesh, Moldova, Solomon Islands, Ethiopia and Zambia. Online supplemental table 2S summarises the study designs. Six quantitative,^{9 18–22} two

qualitative^{23 24} and two mixed-method studies^{25 26} were identified. All studies were uncontrolled and described the outcome of stillbirth and neonatal death audit, with a before or after analysis, except two studies with a qualitative design.^{23 24} Audits were conducted either weekly^{9 21 22} or monthly.^{18 19} Study duration ranged from 1 month²⁴ to 48 months (online supplemental table 1S).¹⁹ The deaths audited in all studies were perinatal deaths (stillbirths and early neonatal deaths) except one study which audited deaths in neonates (0–28 days) and older children.⁹ The total number of cases audited ranged from a minimum of 5 to a maximum of 146 deaths per month (online supplemental table 1S). A total of 1018 stillbirths and neonatal deaths were audited.

Four studies with a qualitative or mixed-methods design^{23–26} interviewed facility staff and key informants to understand the process of stillbirth and neonatal death audits in hospitals. The following data collection methods were used: document review,^{23 24} focus group discussion (FGD)²³ and in-depth interviews (IDIs).^{23–26} The staff and key informants interviewed for IDIs and FGD varied between studies. However, IDIs and FGD included facility staff involved in the process of auditing at the private hospital, health centre, district hospital and central hospital level. Staff included were doctors, nurses, administration staff, surgeons, family planning officers, health managers and other members of the audit committee. The number of participants in each study for IDIs ranged from 29 to 66 participants.^{25 26} Five doctors and six nurses participated in FGD conducted by one study.²³

Stillbirth and neonatal death audit approaches

Two approaches were reported by six studies in this analysis.^{9 10 20–23} The first three studies used multidisciplinary facility teams to audit deaths and develop and implement recommendations.^{9 18 22} In these studies, the lead member of the audit team was either a senior obstetrician or paediatrician or nurse. Although the composition of multidisciplinary teams differed between studies, in all three studies it consisted of obstetricians, paediatricians, medical officers, midwives, administrators, nurses, neonatologists, neonatal fellows and neonatal and delivery unit in charges. One study had only senior staff in the audit team.¹⁸ All studies used standard mortality audit forms adapted from WHO for gathering clinical information. One study also included verbal autopsy questions for guardians and staff.¹⁸

The second three studies used a confidential inquiry approach¹⁹ or external researchers²⁰ or external and internal auditors.²¹ These external multidisciplinary teams were not involved in the care of patients; they audited the cases and gave feedback to facility staff to implement recommendations.

Of six studies that reported audit approaches,^{9 10 20–23} five studies were prospective death audits, while one was retrospective and then prospective during reaudit.²³ One study used a criteria-based audit approach, where initial death audit of fresh stillbirths was undertaken and

developed standards as a benchmark to improve care.²¹ This was followed up by reaudit of stillbirths to assess adherence to standards. Most death audit approach activities were implemented at the facility level (eg, conducting audits, recommending solutions, implementing recommendations and training). Four studies reported engagement at the national level and two studies^{19 22} reported national stakeholder engagement through developing guidelines, coordinating audit and disseminating the findings. In contrast, two studies^{20 21} reported the use of external panel members or researchers at the national level. Online supplemental table 3S summarises the approaches.

Outcomes of stillbirth and neonatal death audit

Structure

Six studies^{9 10 20–23} reported structural improvements in one or more areas that improved the care of women in labour and neonates in the wards (table 2). Most changes were related to the physical structure of the ward; purchasing of essential supplies and equipment; training, staffing and organisation of services in the ward. Table templates for tables 2 and 3 were adapted from Lazerini *et al.*²⁷

Process

Five studies reported changes in the process of care. One study²¹ cited quantitative process outcomes against eight predefined standards, and all eight standards showed some significant improvement (table 3). Another study,¹⁹ reported improvements in standard care and case management of complications during labour and delivery. Other process outcomes reported by three studies^{19 20 25} were improved fetal heart rate monitoring, doppler device use, data documentation, partograph use, clinical decision making for complicated cases, referral system, the involvement of other professionals (social workers and psychologist) in the audit.

Outcomes (health)

Newborn outcomes were reported in only a few studies (table 3). Only two studies reported newborn/perinatal mortality.^{19 22} One study (21) reported a statistically significant reduction in mortality rates among fetuses/newborns (≥ 37 weeks and birth weight ≥ 2500 g) which decreased significantly from 5.1 per 1000 in 2006 to 3.6 per 1000 in 2013 (with 1.5 per 1000 or 29.4% reduction, 95% CI 0.6% to 2.4%; $p=0.0015$).¹⁹ The second study²² reported overall perinatal mortality reduction (52.8% in 2007 to 47.9% in 2008) before and after perinatal audit implementation but this difference was not statistically significant (table 3). Demonstrated changes were attributed to improved standards of care following implementation of stillbirth and neonatal death audits. No study reported newborn morbidity outcomes. One study²¹ reported a reduction in the incidence of maternal obstetric complications such as obstructed labour and antepartum haemorrhage, which contributes to stillbirths, following the

implementation of a fresh stillbirth audit using standards as a benchmark (table 3).

Enablers and barriers of implementing stillbirth and neonatal death audits

Four studies^{9 23–25} reported enablers (table 4) and five studies^{9 23–26} reported barriers (table 5). In total, 18 enablers were identified with nine at the health provider level, seven at the facility level, and two at the national or regional system levels (table 4). Only one enabler at the health provider level was cited by more than one study (table 4). Twenty-three barriers were identified with one at the health provider level, 18 at the facility level and four at the national system levels (table 5). Eight barriers at a facility level and one barrier at a national level were cited by more than one study (table 5).

Enablers

Most enablers ($n=9$) were identified at the health provider level. Audit meetings provided opportunities for teaching; learning was the only enabler mentioned by more than one study (table 4).^{9 24} The remaining enablers at both levels were mentioned by a single study (table 4). One study²⁵ assessed the statistical significance of changes in enablers at both the health provider and facility levels. The enablers associated with statistical significant changes at the health provider level included attendance records of review meetings ($p<0.001$), knowledge of objectives of maternal and perinatal death review (MPDR) ($p<0.001$) and an observed improvement in care ($p<0.001$).²⁵ Enablers identified at facility level included feedback ($p<0.001$), implementation of action ($p<0.001$) and the existence of an MPDR committee ($p<0.001$).²⁵

Barriers

Out of 23 barriers identified at three levels by five studies,^{9 23–26} 18 were identified at the facility level only (table 5). Barriers cited by more than one study at the facility level were inadequate formation and implementation of action plans^{9 24–26}; audit facility team members not trained^{9 24 25}; limited time led to the postponement of meetings^{9 23 24}; increased workload in the ward^{9 24 25}; health workers not aware of the death audit process^{25 26}; too many cases to review^{9 25}; poor documentation and inadequate information management systems^{23 26} and inadequate human resources (table 5).^{9 23} At the national level, a lack of broader engagement was the only barrier mentioned by more than one study (table 5).^{9 26}

DISCUSSION

This review has highlighted facility level barriers to audit that were common across studies including failure to implement action plans, inadequate training, limited time, increased workload, too many cases to review, poor documentation and inadequate information management systems. These findings will assist facility audit implementers and staff in identifying practical steps to

Table 2 Structural outcomes*

Author/year	Ward physical structure	Staffing	Equipment and supplies	Training	Service organisation
Demise, 2015 ¹⁸	Increased use of radiant warmers in NICU	–	–	Refresher training on neonatal resuscitation for midwives and physicians	Improved administration of antepartum steroids Implementation of KMC Using transport incubators and cellophane wraps
Stratulat, 2014 ¹⁹	–	–	–	–	Routine audit sessions established Adaptation of audit guidelines and tool used at national level National level involvement in coordinating audit meetings developed 15 clinical practice protocols for neonatal care
Nakibuuka, 2012 ²²	Created Space for resuscitation in labour wards and NICU	Recruited more anaesthetists. Doctors involved in preoperative care	Ambu-bags and masks provided in the labour ward and newborn unit	Trained midwives and doctors on labour and partograph use Trained Intern doctors and midwives on neonatal resuscitation, respiratory distress and CPAP	New standards developed for the caesarean section decisions and disseminated Neonatal resuscitation protocols displayed in wards
Sandakabatu, 2018 ⁹	–	–	–	Teaching opportunities during child death review meetings	Quality improvement team established
Kidanto, 2009 ²⁰	–	–	Purchased New sets) of vacuum and Doppler machines	120 midwives and doctors trained in the use of partograph, abnormal labour and newborn resuscitation Nurses/midwives routine CPD sessions weekly	Established an audit committee Introduced daily and monthly assessments of all perinatal deaths management protocols for eclampsia and other obstetrics emergencies developed and pasted in the wards established a record tracing the patient from the labour ward to the theatre to reduce delays obstetrician on call stationed in the labour ward
Kasengele, 2017 ²¹	–	–	–	–	Doctors on call slept in the hospital weekly perinatal reviews and feedback

*Table template was adapted from reference.²⁷

CPAP, continuous positive airway pressure; CPD, Continuous Professional Development; KMC, Kangaroo mother care; NICU, neonatal intensive care unit.

Table 3 Mortality, morbidity and process of care outcomes*

Author/year	Mortality perinatal, neonatal and stillbirths	Morbidity (neonatal, perinatal and maternal)	Standard of care	Other process outcomes
Stratulat, 2014 ¹⁹	Proportional mortality rates among fetuses/newborns with a gestational age of ≥ 37 weeks and with a birth weight of ≥ 2500 g for the years 2005–2013. The proportional mortality rate decreased from 5.1 per 1000 in 2006 to 3.6 per 1000 in 2013 (with 1.5 per 1000 or 29.4% reduction, 95% CI 0.6 to 2.4; z-value 3.2; p=0.0015).		Improvements in the standards of care through multidisciplinary audit sessions and a no-blame approach Improved management of cases (breach presentation, cord pathology and Intrauterine growth retardation monitoring)	Improved birth records partograph updated and modernised Improved documentation tools for perinatal deaths partograph used correctly and appropriate Improved clinical decision making for complicated cases from 44% in 2007 to 82% in 2010 Recognised the role of other professionals (social workers and psychologist) in preventing perinatal deaths strengthened collaboration across borders
Nakibuuka, 2012 ²²	The overall perinatal mortality rate in 2008 was 47.9 compared with 52.8 per 1000 total births in 2007		–	–
Kidanto, 2009 ²⁰	–	–	–	Improved referral system to reduce delays Improved documentation
Kasengele, 2017 ²¹	–	Obstructed labour accounted for 55.7% (n=64) in the initial audit and 38.7% (n=12) in the reaudit Antepartum haemorrhage accounted for 23.5% (n=27) at baseline and 16.1% (n=5) at re-audit. Unknown causes increased from 14.8% (n=17) in the initial audit to 38% (n=12) in the reaudit.	Increases occurred in: Partograph usage (from 36 (31.3%) to 20 (65%)) All Severe pre-eclampsia/eclampsia cases received correct treatment of magnesium sulphate at both initial and reaudit referral of women with obstructed labour (31 (48%) to 11 (92%)); women catheterised (22 (38%) to 7 (58%)); women reviewed within 15 min (2 (3%) to 4 (33%)); C/S operating staff notified (31 (37%) to 16 (100%)); C/S done within 10 min (31 (37%) to 12 (78%))	

*Table template was adapted from reference.²⁷
C/S, Caesarean Section; Dash (-), not reported.

Table 4 Enablers of implementing stillbirth and neonatal death audit

Level	Enabler	Total	Citation
Health provider	Audit meetings provided opportunities for teaching and learning	2 Studies	(9 24)
	Confidentiality nature of discussion	1 Study	(9)
	Positive atmosphere of voluntary participation and no blame	1 Study	(9)
	Attendance of review meetings (p<0.001)	1 Study	(25)
	Knowledge of objectives of MPDR (p<0.001)	1 Study	(25)
	Observed improvement in maternal and newborn care (p<0.001)	1 Study	(25)
	Strengthened responsibilities of the healthcare providers	1 Study	(23)
	Documentation process of patient records enriched	1 Study	(23)
	Facility providers committed to the process of reviewing	1 Study	(24)
	Facility	Existence of MPDR committees (p<0.001)	1 Study
Implementation of MPDR recommendations (p<0.001)		1 Study	(25)
Provision of feedback (p<0.001)		1 Study	(25)
Created a discussion platform of deaths		1 Study	(23)
Discovered gaps and challenges related to deaths		1 Study	(23)
Corrective measures were taken after audit		1 Study	(23)
Improved supervision and monitoring systems		1 Study	(23)
National	MPDR part of medical school curriculum	1 Study	(24)
	National and decentralised administrative levels were both engaged in the MPDR process	1 Study	(24)

MPDR, maternal and perinatal death review.

improve the impact that audit has on reducing stillbirths and neonatal deaths.

Overall, the 10 studies included in this review support the key role that death audit plays in improving care and outcomes in perinatal and newborn care. Despite the identified barriers in this review, stillbirth and neonatal death audits resulted in improvements in facility structures, processes of care and neonatal health outcomes. We identified the following variables use of senior staff (obstetrician, paediatrician or senior nurse) to champion the audits at the facility, regular audit meetings with no blame approach, involvement of key decision-makers (doctors, nurses, health managers and administrators), implementing audit recommendations such as changes in physical structure of the ward, purchasing of essential supplies and equipment, training, staffing, and changing ward protocols and policies, suggesting that improvements need to be made in audit and service organisation to improve outcomes. More enablers have been identified at the health provider level while more barriers have been identified at the facility level. As the majority of barriers are related to the availability of staff to perform a death audit, our review has also shown that even auditing one death per week can be essential in identifying gaps in care.

This review adds to the latest evidence on how audits are performed, their outcomes on QoC and perinatal and neonatal health in LMICs. In addition, the present review has identified enablers and barriers and categorised them according to system levels to guide future implementers.

All included studies audited stillbirth and early neonatal deaths (0–7 days) except one study that included neonates from 0 to 28 days. Despite included studies resulted in significant improvement in care, it is essential to note that all studies were uncontrolled before and after studies. A review by Schouten *et al*²⁸ found that uncontrolled before and after studies tend to exaggerate positive impacts as opposed to studies using a controlled design. With regard to the impact of audits on neonatal outcomes, only two studies reported newborn and perinatal mortality and no newborn morbidity outcomes were reported, suggesting this area could be explored further.

Stillbirth and neonatal death audit approaches

This review has shown the usefulness of both facility and external multidisciplinary teams in performing stillbirth and neonatal death audits. Further, criteria-based audits facilitate implementation of action plans and enable healthcare workers to evaluate standards at subsequent audits. Studies on maternal death audits reported that involving facility staff in the audit process promoted successful implementation, ownership and sustainability of the process.^{29 30} Most audits were conducted prospectively. The number of audited cases varied among the studies in this review, from a minimum of five cases to a maximum of 146 cases per month. Even though large numbers of cases reviewed may result in an in-depth analysis of gaps in care, such audit might pose a challenge in developing and implementing recommendations due to inadequate human and material resources in the

**Table 5** Barriers of implementing stillbirth and neonatal death audit

Level	Barrier	Total	Citation
Health provider	Care providers not aware of actions implemented following audit recommendations	1 Study	(26)
Facility	Health workers not aware of death audit process	two studies	(25 26)
	Audit facility team members not trained	3 Studies	(9 24 25)
	Inadequate supportive supervision	1 Study	(25)
	Lack of financial motivation	1 Study	(25)
	Increased workload in the ward	3 Studies	(9 24 25)
	Too many cases to review	2 Studies	(9 25)
	Inadequate formation and implementation of action plans	4 Studies	(9 24–26)
	Poor documentation and poor information management systems	2 Studies	(23 26)
	Cause of deaths not followed International Classification of Disease 10th version	1 Study	(23)
	Inadequate human resource	2 Studies	(9 23)
	Limited time led to the postponement of meetings	3 Studies	(9 23 24)
	Lack of clarity in its intended purpose	1 Study	(24)
	Weak analysis and discussion of the cases	1 Study	(24)
	Lacks specific measurable action plan	1 Study	(24)
	Lack of key hospital decision-makers in the audit committees	1 Study	(26)
	Failure to disseminate audit reports to the national authorities	1 Study	(26)
National	Inadequate material resources (equipment for resuscitation)	1 Study	(9)
	Reporting forms not systematically analysed at the national level	1 Study	(24)
	Technical committee meetings not held	1 Study	(24)
	Funding guidelines not adequately disseminated	1 Study	(24)
	Lack of broader engagement at the national level	2 Studies	(9 26)

LMIC context. In such contexts, it might be unrealistic to audit all stillbirths and neonatal deaths per month as these are often numerous. Depending on level of staffing and workload at the facility, it may be more practical for the mortality audit team to either review a selection of stillbirths and neonatal deaths or increase the frequency of meetings.⁶ Performing stillbirth and neonatal death audits at the departmental level is also essential in identifying gaps in care and interventions.

The majority of the approach activities were implemented at the facility level. Nambiar *et al*³¹ reported three system levels that are approached when implementing quality improvement initiatives. These are the microlevel (health providers), mesolevel (health facility team) and macrolevel (regional or national level). Despite all system levels being of value, facility level activities are central to the successful implementation of stillbirth and neonatal death audits. As described by Kaplan *et al*³² in their model of understanding success in quality, the facility level is responsible for quality improvement leadership, initiative support, senior leadership commitment, guidance and direction that shapes behaviour of staff pursuing quality improvement projects. Proper training of staff involved in death audits ensures quality implementation of audits and its recommendations. However, structural adjustments are required to facilitate the death audits. These

adjustments include audit team characteristics, workforce focus, resource availability and data infrastructure that exist across all system levels to trigger and influence the success of death audit processes.³²

While at the health provider level, the participation of individual staff is essential in the audit process, a single motivated care provider who has the capability and desire to improve performance will be of great value to the system.³² National or regional level activities like regulation, tool development, governance and dissemination need continuous coordination, as they act as external motivators that stimulate the organisation to improve the performance in death audit or any quality improvement projects.³²

Outcomes of stillbirth and neonatal death audits

A previous systematic review on effects of perinatal mortality audits in LMICs reported a reduction in perinatal mortality of 30% (95% CI 21% to 38%) after the introduction of facility-based perinatal audits.⁸ However, this previous review focused on perinatal mortality audits (stillbirths and early neonatal deaths, 0–7 days old), which may miss late neonatal death audits or early neonatal deaths occurring in neonatal wards after discharge from the labour ward, which might give a false impression about overall neonatal mortality audits (age 0–28 days). The

current review retrieved the latest evidence on outcomes of stillbirth and neonatal death audits. Overall findings varied both within and between studies. Most of the articles reported a mixture of outcomes that fell into the category of structure, process and health outcomes. Only one study reported a significant decrease in newborn mortality.

Enablers and barriers to implement stillbirth and neonatal death audits

Identification of enablers and barriers are essential for hospital management and programme planners to implement successful stillbirth and neonatal death audits that improve the QoC. In this review, 18 enablers and 23 barriers were identified at three levels, with more enablers (9) cited at the health provider level and more barriers (18) cited at facility level. Similar barriers have been reported in the previous review on maternal and perinatal death audits.⁷ Hospital management should prioritise both enhancing enablers identified at the health provider level to maintain staff morale and resolving barriers at facility level as they demotivate staff involved in audits to effect change. In their review, Nyamtema *et al*²⁶ found that other facilities had discontinued audit meetings due to the failure of hospital management to implement audit recommendations.

Limitations

The current systematic review has some limitations, mainly relating to scope. Although the present review assembled evidence from seven different countries, located in four different regions (sub-Saharan Africa, South Asia, Europe/Central Asia and East Asia and Pacific), the published research included in this review was limited since only 10 studies were identified, thus, potentially limiting generalisability. Our search was limited to literature describing approaches, enablers, barriers or reporting outcomes of stillbirth and neonatal death audits at the facility level and to English language papers only. This limited search might have missed information regarding other elements of death audits and also studies reported in other languages. Five articles could not be retrieved, which may have included important additional information to the review. Our search only included original research articles; more information may be available in the grey literature, organisation reports, reviews, dissertations and theses, and conference proceedings. Although two authors conducted screening and eligibility assessment, data extraction and quality appraisal were primarily conducted by one author, which might have led to selection bias. However, where there was uncertainty, the second author was approached.

CONCLUSION

Implementation of stillbirth and neonatal death audits improves structure, process and health outcomes in maternal and neonatal care. Using a multidisciplinary facility team to conduct audits contributes to the success

of the process. Despite all system levels being of value, facility-level activities are central to the successful implementation of stillbirth and neonatal death audits. Even auditing a single death is useful in the process of improving care at the facility level. Completing the audit cycle by implementing recommendations is crucial to improving perinatal outcomes. The indemnification of both audit enablers and barriers can help hospital management to improve audit processes. Researchers should aim at generating more evidence on how to implement stillbirth and neonatal death audits effectively, including sustaining the practice in order to further improve its impact on newborn outcomes in LMICs.

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Supplemental Materials

Box 1S: Search Terms and Boolean Operators Used in Final Searches of MEDLINE, CINAHL Complete, Academic Search Index, Science Citation Index, Complementary index, and Global health

1. “stillb*”
2. “neonat*”
3. “perinatal death”
4. “neonatal death”
5. audit OR review
6. These search terms were then combined to give a final search of 1 OR 2 OR 3 OR 4 AND 5, which was used to search abstracts in these databases.

Box 2S: Questions used to assess quality of studies included by Hawker and colleague [16]**Scoring Criteria**

Good=4

Fair=3

Poor=2

Very poor=1

Lower scores =poor quality

Notes for appraising the quality of each paper**1. Abstract and title:**

Did they provide a clear description of the study?

Good: Structured abstract with full information and clear title.

Fair: Abstract with most of the information.

Poor: Inadequate abstract.

Very Poor: No abstract.

2. Introduction and aims:

Was there a good background and clear statement of the aims of the research?

Good: Full but concise background to discussion/study containing up-to-date literature review and highlighting gaps in knowledge. A clear statement of aim AND objectives, including research questions.

Fair: Some background and literature review. Research questions outlined.

Poor: Some background but no aim/objectives/questions, OR Aims/objectives but inadequate background.

Very Poor: No mention of aims/objectives. No background or literature review.

3. Method and data:

Is the method appropriate and clearly explained?

Good: Method is appropriate and described clearly (e.g., questionnaires included).

Clear details of the data collection and recording.

Fair: Method appropriate, description could be better. Data described.

Poor: Questionable whether method is appropriate. Method described inadequately. Little description of data.

Very Poor: No mention of method, AND/OR Method inappropriate, AND/OR No details of data.

4. Sampling:

Was the sampling strategy appropriate to address the aims?

Good: Details (age/gender/race/context) of who was studied and how they were recruited. Why this group was targeted. The sample size was justified for the study. Response rates shown and explained.

Fair: Sample size justified. Most information given, but some missing.

Poor: Sampling mentioned but few descriptive details.

Very Poor: No details of sample.

5. Data analysis:

Was the description of the data analysis sufficiently rigorous?

Good: Clear description of how analysis was done. Qualitative studies:

Description of how themes derived/ respondent validation or triangulation.

Quantitative studies: Reasons for tests selected hypothesis driven/ numbers add up/statistical significance discussed.

Fair: Qualitative: Descriptive discussion of analysis. Quantitative.

Poor: Minimal details about analysis.

Very Poor: No discussion of analysis.

6. Ethics and bias:

Have ethical issues been addressed, and what has necessary ethical approval gained? Has the relationship between researchers and participants been adequately considered?

Good: Ethics: Where necessary issues of confidentiality, sensitivity, and consent were addressed. Bias: Researcher was reflexive and/or aware of own bias.

Fair: Lip service was paid to above (i.e., these issues were acknowledged).

Poor: Brief mention of issues.

Very Poor: No mention of issues.

7. Results:

Is there a clear statement of the findings?

Good: Findings explicit, easy to understand, and in logical progression. Tables, if present, are explained in text. Results relate directly to aims. Sufficient data are presented to support findings.

Fair: Findings mentioned but more explanation could be given. Data presented relate directly to results.

Poor: Findings presented haphazardly, not explained, and do not progress logically from results.

Very Poor: Findings not mentioned or do not relate to aims.

8. Transferability or generalizability:

Are the findings of this study transferable (generalizable) to a wider population?

Good: Context and setting of the study is described sufficiently to allow comparison with other contexts and settings, plus high score in Question 4 (sampling).

Fair: Some context and setting described, but more needed to replicate or compare the study with others, PLUS fair score or higher in Question 4.

Poor: Minimal description of context/setting.

Very Poor: No description of context/setting.

9. Implications and usefulness:

How important are these findings to policy and practice?

Good: Contributes something new and/or different in terms of understanding/insight or perspective. Suggests ideas for further research.

Suggests implications for policy and/or practice.

Fair: Two of the above (state what is missing in comments).

Poor: Only one of the above.

Very Poor: None of the above.

Table 1S: Findings of the included studies

Authors and year	Number of cases audited	Interviews	Duration	Summary of findings	Quality score
Demise et al, 2015 [18]	61 (30 stillbirths and 31 early neonatal deaths)	No	6 months	<ul style="list-style-type: none"> • Avoidable factors in 70% of perinatal deaths • Health worker-related factors most common (84%) • Patient-related factors (11%) • Administrative-related factors (5%) 	31
Agaro et al, 2016 [25]	253 perinatal deaths	66 staff and 10 Key Informant interview	3 months	<ul style="list-style-type: none"> • Low participation of health workers in MPDR • Facilitators for MPDR <ul style="list-style-type: none"> -Existence of MPDR committees -Attendance of review meetings -Knowledge of MPDR objectives -Implementation of MPDR recommendations -Observed improvement in neonatal care -Provision of feedback • Barriers for MPDR <ul style="list-style-type: none"> -Health workers not aware of the MPDR process -Inadequate training of MPDR committee members -Inadequate support supervision -Lack of financial motivation to committee members. -Heavy workload to health workers -High number of perinatal deaths - Non-implementation of recommendations. 	32

MPDR= Maternal Perinatal Death Review

Biswas et al,2015[23]	–	35 IDIs with facility staff and 1 FGD (5 doctors and 6 nurses)	11 months	<ul style="list-style-type: none"> • Senior staff nurses championed the facility death reviews • Doctors supported senior nurses. • Improved quality of care at facilities as a result of facility death audits 	30
Stratulat et al, 2014[19]	257 perinatal deaths	No	48 months	<ul style="list-style-type: none"> • Perinatal death audit improved maternity and newborn care • Reduced perinatal deaths at term by 1.5 per 1000; from 5.1 per 1000 in 2006 to 3.6 per 1000 in 2013 • Key activities included; <ul style="list-style-type: none"> -Trainings in audit -Setting up of audit committees -Implementation of the review of cases -Dissemination of information 	23
Armstrong et al,2014[24]	–	37 informants interviews (IDIs) involved in MPDR	1 month	<ul style="list-style-type: none"> • Hospital reviews fail to identify appropriate challenges and solutions at the facility level. • Staff committed to the process of maternal death review, but action and response are insufficient 	27
Nakibuuka et al, 2012[22]	120 perinatal deaths (41 MSB, 38 FSB, 41 END)	No	9 months	<ul style="list-style-type: none"> • Avoidable factors included: <ul style="list-style-type: none"> -Poor neonatal resuscitation skills -Incorrect use of the partographs -Delay in performing caesarean sections • Activities implemented included: <ul style="list-style-type: none"> -Training on neonatal resuscitation -Introduction of CPAP for babies with respiratory distress -Staff updated on use of partographs • Perinatal mortality rate reduced by 0.9 per 1000 after introduction of the audits 	28

MSB=Macerated stillbirth, FSB=Fresh stillbirth, END=Early Neonatal death, CPAP=Continuous Positive Airway Pressure, IDIs In-depth Interviews,

MPDR=Maternal Perinatal Death Review, FGD=Focus Group Discussion

Nyamtema et al, 2010[26]	-	29 IDIs and 30 semi-structured questionnaires with staff involved the audit	1month	<ul style="list-style-type: none"> • Maternal and perinatal audit systems poorly established in structure and process • Less effective to improve the quality of care • Key decision-makers did not take part in audit committees • Most care providers (60%) not aware of any action implemented as result of audit 	29
Sandakabatu et al,2018[9]	66 (48 neonatal deaths and 18 deaths older children)	No	6 months	<ul style="list-style-type: none"> • Proper use of systematic classification of causes of death • Included social risk factors and community problems in the modifiable factors • Followed-up implementation of action plans • Areas for improvement; <ul style="list-style-type: none"> -Communication -Clinical assessment and treatment -Availability of laboratory tests -Antenatal clinic attendance -Equipment for high dependency neonatal /paediatric care. 	29
Kidanto et al, 2009[20]	133 perinatal deaths(MSB-18, FSB-78 and END-37)	No	5 months	<ul style="list-style-type: none"> • Suboptimal factors were identified in 80% of audited cases • Half of suboptimal factors caused adverse perinatal outcome and were preventable • Poor foetal heart monitoring during labour was indirectly associated with over 40% of perinatal death. • There was a poor to fair agreement between external and internal auditors 	28

MSB=Macerated stillbirth, FSB=Fresh stillbirth, END=Early Neonatal death, IDIs= In-depth Interviews

Kasengele et al, 2017[21]	146 (115, initial and 31 re-audit FSB)	No	3months	<ul style="list-style-type: none"> • Only 36 (33.3%) labouring women in the initial audit and 20 (65%) in the re-audit managed using a partograph • Obstructed labour was the main cause of intrapartum stillbirths • Antepartum haemorrhage caused 27 (23.5%) stillbirths in the baseline audit and 5 (16.1%) in the re-audit • Suboptimal care was observed in the initial audit but none in subsequent audit 	28
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FSB=Fresh stillbirth

Table 2S¹: Summary of studies included in the review

Author/ Year	Country	Hospital type/number	Methodology	Who performed audit	Audit meeting frequency	Who developed recommend- ations	Who implemented recommend- ations	Type of death audited	Selection criteria
Demise et al., 2015[18]	Ethiopia	1 National referral hospital	A prospective audit	Facility staff	monthly	Facility staff	NICU staff and Labour ward staff	Stillbirths and early neonatal deaths	All stillbirths and early neonatal deaths during the study period
Agaro et al., 2016[25]	Uganda	1 district hospital, 1 Health Centre level IV, 5 Health Centre Level III	A cross- sectional mixed method study- a retrospective review of audited information	–	–	–	–	Stillbirths and early neonatal deaths	–
Biswas et al., 2015[23]	Bangladesh	2 District hospitals, 12 Sub-district facilities, 2 maternal and child welfare centres	Qualitative study-In-depth interviews, Focus group interviews and document review	–	–	–	–	Maternal, Neonatal deaths and stillbirths audits	–

Dash (-)= Not reported, NICU=Neonatal Intensive Care Unit, IV=Intravenous line

¹ Adapted from 1. Lazzarini M, Richardson S, Ciardelli V, et al. Effectiveness of the facility-based maternal near-miss case reviews in improving maternal and newborn quality of care in low-income and middle-income countries: a systematic review. *BMJ Open* 2018;8(4):e019787. doi: 10.1136/bmjopen-2017-019787 [published Online First: 2018/04/21]

Author/ Year	Country	Hospital type/number	Methodology	Who performed audit	Audit meeting frequency	Who developed recommend- ations	Who implemented recommend- ations	Type of death audited	Selection criteria
Stratulat et al., 2014[19]	Moldova	Moldova country	Confidential Inquiry into perinatal deaths prospectively-project implementation	External panel	Monthly	External panel	Facility staff	Perinatal deaths (stillbirths and early neonatal deaths)	Reported stillbirths and neonatal deaths to national level
Armstrong et al., 2014[24]	Tanzania	1 regional hospital, 1 district hospitals and 1 faith-based hospital	Reviewed the national MPDR guidelines and conducted a qualitative study with key informants using semi structured interviews	-	-	-	-	Maternal and perinatal deaths audits	-
Nakibuuka et al., 2012[22]	Uganda	1 Private not for profit hospital	Retrospective descriptive study - prospective audit	Hospital staff	Weekly	Hospital staff	Hospital staff	Perinatal deaths (stillbirths (FSB/MSB) and ENND)	All stillbirths and early neonatal deaths during the study period
Nyamtema et al., 2010[26]	Tanzania	4 public hospitals (1 national hospital, 3 municipal hospitals) and 4 private hospitals	A cross-sectional mixed-method study	-	-	-	-	Maternal and perinatal deaths audits	-

Dash (-)= Not reported, FSB= Fresh stillbirth, MSB= Macerated stillbirth

Author/ Year	Country	Hospital type/number	Methodology	Who performed audit	Audit meeting frequency	Who developed recommend- ations	Who implemented recommend- ations	Type of death audited	Selection criteria
Sandakabatu et al., 2018[9]	Solomon Islands	1 national referral hospital (tertiary)	Reviewing Child death auditing process through systematic observations-prospective audit	Paediatric team monthly combined with the obstetric team	Weekly	Paediatric team and monthly combined with the obstetric team	Facility staff (doctors and nurses)	Child deaths (neonatal deaths and deaths on older children)	All neonatal and child deaths occurred during the study period
Kidanto et al., 2009[20]	Tanzania	1 National Referral Hospital	Prospective death audit	3 auditors obstetrician (2 external and 1 internal auditors)	-	3 auditors obstetrician (2 external and 1 internal auditors)	Nurse and doctors from the labour ward and neonatal unit	Stillbirths, FSB/MSB and Early neonatal deaths	All perinatal deaths $\geq 1500g$ occurred during the study period
Kasengele et al., 2017[21]	Zambia	1 District Hospital	Retrospective death audit	Clinical audit team members from the hospital	Weekly	Clinical audit team members from the hospital	Facility staff	FSB	FSB with foetal heart present, Apgar score of 0

Dash (-)= Not reported, FSB= Fresh stillbirth, MSB= Macerated stillbirth

Table 3S: Summary of approaches

Author/year	Approach	Audit type	Implementation level		
			National Level	Facility Level	Health provider Level
Demise et al, 2015[18]	Review by hospital multidisciplinary audit team using a standardized data collection form	Prospective audit		Audit review meetings Implementing changes	
Stratulat et al, 2014[19]	Confidential inquiry panel -External multidisciplinary panel	Prospective audit	National stakeholders developing methodology, standards, training tools, approval, endorsement of implementation and facilitate dissemination	Implementing changes; Implementing audit reviews at an institutional level using national confidential inquiry guidelines	Participated in audit sessions
Nakibuuka et al, 2012 [22]	Multidisciplinary team audit	Prospective audit	Ministry of Health developed perinatal death audit tools and guidelines	Adopted guidelines from MoH; Weekly audit meetings lead by senior obstetrician or paediatrician, trained medical officers, nurses and midwives on perinatal death audits	Participated in perinatal death audit; attending training on perinatal death audits
Sandakabatu et al., 2018[9]	Multidisciplinary team audit	Prospective audit	–	Weekly audit meetings lead by senior paediatrician and monthly combined obstetric and paediatric team audit	–

Dash (-)=Not reported

Author/year	Approach	Audit type	Implementation level		
			National Level	Facility Level	Health provider Level
Kidanto et al, 2009[20]	Using external and internal auditors obstetrician (2 external and 1 internal auditors)	Prospective audit	Audits by international external auditors	Internal auditor from hospital, hospital nurses and doctors participated in protocol preparation and implementing changes. Training on audit	Participating in training
Kasengele et al, 2017[21]	Obstetric team audit and external researchers	Retrospective (initial and re-audit)	External researchers	Clinical audit team members participated in the research: Hospital staff implementing changes	-

Dash (-)=Not reported