

## 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"> <li>• Avoidable factors in 70% of perinatal deaths</li> <li>• Health worker-related factors most common (84%)</li> <li>• Patient-related factors (11%)</li> <li>• Administrative-related factors (5%)</li> </ul>	31
Agaro et al, 2016 [25]	253 perinatal deaths	66 staff and 10 Key Informant interview	3 months	<ul style="list-style-type: none"> <li>• Low participation of health workers in MPDR</li> <li>• Facilitators for MPDR <ul style="list-style-type: none"> <li>-Existence of MPDR committees</li> <li>-Attendance of review meetings</li> <li>-Knowledge of MPDR objectives</li> <li>-Implementation of MPDR recommendations</li> <li>-Observed improvement in neonatal care</li> <li>-Provision of feedback</li> </ul> </li> <li>• Barriers for MPDR <ul style="list-style-type: none"> <li>-Health workers not aware of the MPDR process</li> <li>-Inadequate training of MPDR committee members</li> <li>-Inadequate support supervision</li> <li>-Lack of financial motivation to committee members.</li> <li>-Heavy workload to health workers</li> <li>-High number of perinatal deaths</li> <li>- Non-implementation of recommendations.</li> </ul> </li> </ul>	32

MPDR= Maternal Perinatal Death Review

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



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

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

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

Table 2S<sup>1</sup>: 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
<b>Demise et al., 2015[18]</b>	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
<b>Agaro et al., 2016[25]</b>	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	–
<b>Biswas et al., 2015[23]</b>	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

<sup>1</sup> Adapted from 1. Lazerini 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
<b>Stratulat et al., 2014[19]</b>	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
<b>Armstrong et al., 2014[24]</b>	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	-
<b>Nakibuuka et al., 2012[22]</b>	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
<b>Nyamtema et al., 2010[26]</b>	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
<b>Sandakabatu et al., 2018[9]</b>	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
<b>Kidanto et al., 2009[20]</b>	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
<b>Kasengele et al., 2017[21]</b>	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
<b>Demise et al, 2015[18]</b>	Review by hospital multidisciplinary audit team using a standardized data collection form	Prospective audit		Audit review meetings Implementing changes	
<b>Stratulat et al, 2014[19]</b>	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
<b>Nakibuuka et al, 2012 [22]</b>	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
<b>Sandakabatu et al., 2018[9]</b>	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
<b>Kidanto et al, 2009[20]</b>	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
<b>Kasengele et al, 2017[21]</b>	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