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.
<table>
<thead>
<tr>
<th>Quality Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Very Poor</strong></td>
<td>No mention of issues.</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Authors and year</th>
<th>Number of cases audited</th>
<th>Interviews</th>
<th>Duration</th>
<th>Summary of findings</th>
<th>Quality score</th>
</tr>
</thead>
</table>
| Demise et al, 2015 [18] | 61 (30 stillbirths and 31 early neonatal deaths) | No | 6 months | • 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 | • Low participation of health workers in MPDR  
• Facilitators for MPDR  
- 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  
- 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
- 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

Stratulat et al, 2014 [19]
- 257 perinatal deaths
No
48 months
- 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:
  - Trainings in audit
  - Setting up of audit committees
  - Implementation of the review of cases
  - Dissemination of information

- 37 informants interviews (IDIs) involved in MPDR
1 month
- 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

Nakibuuka et al, 2012 [22]
- 120 perinatal deaths (41 MSB, 38 FSB, 41 END)
No
9 months
- Avoidable factors included:
  - Poor neonatal resuscitation skills
  - Incorrect use of the partographs
  - Delay in performing caesarean sections
- Activities implemented included:
  - 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

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
<table>
<thead>
<tr>
<th>Study</th>
<th>Sample Size</th>
<th>Duration</th>
<th>Findings</th>
</tr>
</thead>
</table>
| Nyamtema et al, 2010[26] | 29 IDIs and 30 semi-structured questionnaires with staff involved the audit | 1 month | - 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 |
- Included social risk factors and community problems in the modifiable factors  
- Followed-up implementation of action plans  
- Areas for improvement:  
  - Communication  
  - Clinical assessment and treatment  
  - Availability of laboratory tests  
  - Antenatal clinic attendance  
  - Equipment for high dependency neonatal/paediatric care. |
| Kidanto et al, 2009[20] | 133 perinatal deaths (MSB-18, FSB-78 and END-37) | No 5 months | - 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 |

MSB = Macerated stillbirth, FSB = Fresh stillbirth, END = Early Neonatal death, IDIs = In-depth Interviews
<table>
<thead>
<tr>
<th>Study</th>
<th>Sample Size</th>
<th>Duration</th>
<th>Key Findings</th>
</tr>
</thead>
</table>
| Kasengele et al, 2017[21] | 146 (115, initial and 31 re-audit FSB) | 3 months | - 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 |

FSB = Fresh stillbirth
Table 2S1: Summary of studies included in the review

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

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

---

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

Dash (-)= Not reported, FSB= Fresh stillbirth, MSB= Macerated stillbirth
<table>
<thead>
<tr>
<th>Author/Year</th>
<th>Country</th>
<th>Hospital type/number</th>
<th>Methodology</th>
<th>Who performed audit</th>
<th>Audit meeting frequency</th>
<th>Who developed recommendations</th>
<th>Who implemented recommendations</th>
<th>Type of death audited</th>
<th>Selection criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandakabatu et al., 2018[9]</td>
<td>Solomon Islands</td>
<td>1 national referral hospital (tertiary)</td>
<td>Reviewing Child death auditing process through systematic observations-prospective audit</td>
<td>Paediatric team and monthly combined with the obstetric team</td>
<td>Weekly</td>
<td>Paediatric team and monthly combined with the obstetric team</td>
<td>Facility staff (doctors and nurses)</td>
<td>Child deaths (neonatal deaths and deaths on older children)</td>
<td>All neonatal and child deaths occurred during the study period</td>
</tr>
<tr>
<td>Kidanto et al., 2009[20]</td>
<td>Tanzania</td>
<td>1 National Referral Hospital</td>
<td>Prospective death audit</td>
<td>3 auditors obstetrician (2 external and 1 internal auditors)</td>
<td>-</td>
<td>3 auditors obstetrician (2 external and 1 internal auditors)</td>
<td>Nurse and doctors from the labour ward and neonatal unit</td>
<td>Stillbirths, FSB/MSB and Early neonatal deaths</td>
<td>All perinatal deaths ≥1500g occurred during the study period</td>
</tr>
<tr>
<td>Kasengele et al., 2017[21]</td>
<td>Zambia</td>
<td>1 District Hospital</td>
<td>Retrospective death audit</td>
<td>Clinical audit team members from the hospital</td>
<td>Weekly</td>
<td>Clinical audit team members from the hospital</td>
<td>Facility staff</td>
<td>FSB</td>
<td>FSB with foetal heart present, Apgar score of 0</td>
</tr>
</tbody>
</table>

Dash (-)= Not reported, FSB= Fresh stillbirth, MSB= Macerated stillbirth
### Table 3S: Summary of approaches

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

Dash (-)=Not reported
<table>
<thead>
<tr>
<th>Author/year</th>
<th>Approach</th>
<th>Audit type</th>
<th>National Level</th>
<th>Implementation level</th>
<th>Health provider Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kidanto et al, 2009[20]</td>
<td>Using external and internal auditors obstetrician (2 external and 1 internal auditors)</td>
<td>Prospective audit</td>
<td>Audits by international external auditors</td>
<td>Internal auditor from hospital, hospital nurses and doctors participated in protocol preparation and implementing changes. Training on audit</td>
<td>Participating in training</td>
</tr>
<tr>
<td>Kasengele et al, 2017[21]</td>
<td>Obstetric team audit and external researchers</td>
<td>Retrospective (initial and re-audit)</td>
<td>External researchers</td>
<td>Clinical audit team members participated in the research: Hospital staff implementing changes</td>
<td>–</td>
</tr>
</tbody>
</table>

Dash (-)=Not reported