

**Re-Visioning Emergency Obstetric
and Newborn Care (EmONC) Project**

DELPHI STUDY ON OBSTETRIC AND NEWBORN CARE SIGNAL FUNCTIONS

Summary report April 2023

Report written by:

Sarah Moxon, PhD London School of Hygiene & Tropical Medicine, UK and Alexandra Wharton-Smith, Independent Consultant

Contributions from:

Sudha Sharma, Former Secretary Ministry of Health and Population, currently working as Co-Director of CIWEC Hospital and Travel Medicine Center, Nepal

Jalemba Aluvaala, , KEMRI-Wellcome Trust Research Programme, University of Nairobi, Kenya

Allisyn Moran, World Health Organization, Geneva, Switzerland

Louise Tina Day, London School of Hygiene & Tropical Medicine, UK

Oona Campbell, London School of Hygiene & Tropical Medicine, UK

Samantha Lobis, AMDD Consultant

Patrica Bailey, DRPH, AMDD Consultant

Lynn Freedman, Averting Maternal Death and Disability, Columbia University, USA

Caitlin Warthin, Averting Maternal Death and Disability, Columbia University, USA

Isabel Gouse, MPH student, Columbia University, USA

We would like to acknowledge the contribution of all the participants in the Delphi study and thank them for their time and input to the study.

Funding

This work was supported, in whole or in part, by the Bill & Melinda Gates Foundation [INV-001363].

Ethical Approval

London School of Hygiene & Tropical Medicine Ethics Reference: 26292

Contents

Background	4
Aim.....	5
Methods.....	5
Round one: Exploring expert perceptions	7
Round two: Exploring initial consensus: Prioritising signal functions.....	8
Round three: Exploring consensus: rating of signal functions and levels of care in a prototype	10
Data storage and management.....	12
Analysis	12
Results.....	13
Demographic characteristics of final sample	13
Summary of results from round one (qualitative and exploratory)	15
Summary of results from round two (prioritizing signal functions)	18
Summary of results from round three (rating of signal functions and levels of care in a prototype)	20
Overall synthesis of Delphi rounds	24
Recommendations (April 2023)	25
Areas of prototype with lack of consensus	25
Strengths and Limitations	27
References	29
Appendices.....	31
Appendix 1. Participant Information Sheet and Consent Form.....	31
Appendix 2. Recruitment survey invitation email.....	34
Appendix 3. Recruitment survey.....	36
Appendix 4. Round one survey	43
Appendix 5. Round two survey.....	56
Appendix 6: EmONC Signal Functions for Delphi R2.....	67
Appendix 7: Detailed results on EmONC Signal Functions for Delphi R2.....	73
Appendix 8. Round three survey	84
Appendix 9: EmONC Signal Functions for Delphi R3.....	117
Appendix 10: Feedback on EmONC Signal Functions from Delphi R3	124
Appendix 11 and 12. Cascade charts for obstetric and newborn care synthesising results of Delphi study across rounds.....	134

Abbreviations

AMDD.....	Averting Maternal Death and Disability
AVB.....	Assisted vaginal birth
ENAP.....	Every Newborn Action Plan
EmOC.....	Emergency Obstetric Care
EmONC.....	Emergency Obstetric and Newborn Care
EPMM.....	Ending Preventable Maternal Mortality
GDPR.....	General Data Protection Regulation
HCD.....	Human Centred Design
KMC.....	Kangaroo Mother Care
LMIC.....	Low- and Middle-Income Country
LSHTM.....	London School of Hygiene and Tropical Medicine
MNH.....	Maternal and Newborn Health
ROP.....	Retinopathy of Prematurity
UN.....	United Nations
UNICEF.....	United Nations Children’s Emergency Fund
UNFPA.....	United Nations Population Fund
WHO.....	World Health Organization

Background

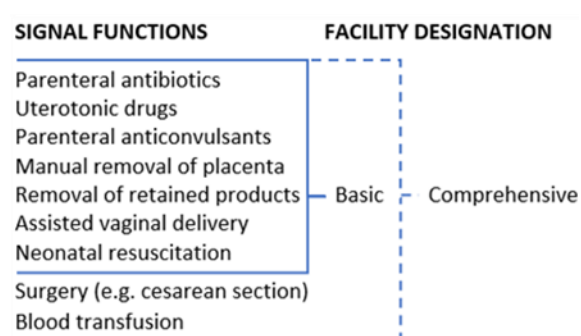
The 1997 *Guidelines for monitoring the availability and use of obstetric services* (WHO, UNICEF, and UNFPA, 1997) describe a set of connected indicators to measure and monitor the availability, utilization, and quality of emergency obstetric care (EmOC) in low- and middle-income countries (LMICs). The EmOC framework has been enormously influential over the last 30 years. It is now found in virtually all LMIC health plans for maternal and newborn health (MNH), and often forms the basis for planning for infrastructure, human resources, equipment, supplies, transport, and referral related to care during childbirth. But much has changed in the health systems and MNH landscape in the last 30 years.

Signal functions

Central to the 1997 *Guidelines* was a set of signal functions – a shortlist of key emergency obstetric interventions capable of averting deaths from the main direct causes of maternal mortality (defined by WHO as haemorrhage, infection, complications from delivery and unsafe abortion) (WHO, UNICEF, and UNFPA, 1997). The framework arranged signal functions in two levels: basic and comprehensive (see current framework presented in Figure 1). The performance of signal functions within a set time period (typically 3 months) defined a facility as a functioning EmOC facility, enabling the calculation of EmOC availability as the first indicator in a 6-indicator set that generated information on access, utilization and quality.

Since the first publication of these guidelines in 1997, there was an update in 2009 that was led by the Averting Maternal Death and Disability (AMDD) program and UN agencies. Together, they published *Monitoring emergency obstetric care: A Handbook* (WHO *et al.*, 2009). This updated handbook included the addition of a newborn signal function (neonatal resuscitation) as shown in Figure 1. Since then, the term "EmONC" (emergency obstetric and newborn care) has been adopted and the MNH landscape has continued to progress; this has included an increase in health facility delivery.

Figure 1. Current EmOC Signal Functions



This Delphi study was part of the Re-Visioning EmONC Project; an initiative to review, rethink, and revise the EmONC framework. The Project is led by a Steering Committee coordinated by the Averting Maternal Death and Disability (AMDD) program at Columbia University Mailman School of Public Health, and includes the London School of Hygiene and Tropical Medicine (LSHTM), UNICEF, UNFPA, and WHO. The substantive work of review and revision is being conducted through four workstreams (WS) as follows: (1) WS1 signal functions, 2) WS2 Levels of care 3) WS3 Quality and experience of care 4) WS4 Indicators and targets. The entire project is framed and implemented using principles of human-centered design (HCD) to ensure that the revised EmONC framework meets the needs and real-world conditions at the national and sub-national policy level and at the

frontlines of health systems in LMICs at different stages of the obstetric transition. This Delphi study has been a joint output for the project from WS1 and WS2 on signal functions and levels of care.

Aim

The overall aim of this Delphi study was to build expert consensus on obstetric and newborn care signal functions and levels of care for a revised emergency obstetric and newborn care (EmONC) framework as part of the Re-Visioning EmONC project.

Methods

Study Design

The Delphi research method derives its name from the Delphi Oracle, which the ancient Greeks used to consult for authoritative predictions. More recently, the method has been adapted as a technique to elicit and refine group judgements based on a rationale that group consensus is preferable to relying on singular expert opinion – especially when there is an area of contestation or lack of empirical evidence (Powell, C, 2002). The Delphi method has become widely used to achieve consensus in healthcare and is a well-established method for indicator development (Boulkedid *et al.*, 2011). Delphi studies provide an equal platform for anonymous responses (avoiding conformity bias), facilitating iteration, controlled feedback and statistical group response; the latter of which coalesces individual opinions into an appropriate aggregate after the final round (Dalkey, 1969). An online Delphi method, (a ‘modified’ Delphi), was chosen as the most suitable design for gathering input from global experts in monitoring and measurement of obstetric and newborn care and generating consensus. Previous studies have shown that online Delphi studies can lead to increased sample size and diversity, reduced managerial burden through digital data collection and high levels of data security (Donohoe and Needham, 2009)(Cole, Donohoe and Stellefson, 2013). The protocol for this study was developed during the beginning of the COVID-19 pandemic and it was viewed as essential to choose research methods that could be carried out without the need for travel or field data collection. Moreover, online Delphi methods have been found to have good retention and participant satisfaction rates (Hall *et al.*, 2018a).

The Delphi study was completed in three rounds (see Figure 2), which was agreed to be sufficient to address the study aims and fit within the overall project timeline while avoiding fatigue among the participating experts. The surveys were designed in a stepwise fashion with each round of survey building on findings from previous rounds and adding in technical input and evidence from across the other project workstreams. The study was approved by LSHTM Observational / Interventions Research Ethics Committee (Reference number: 26292). Informed written digital consent was obtained from all study participants (see Appendix 1).

Project team

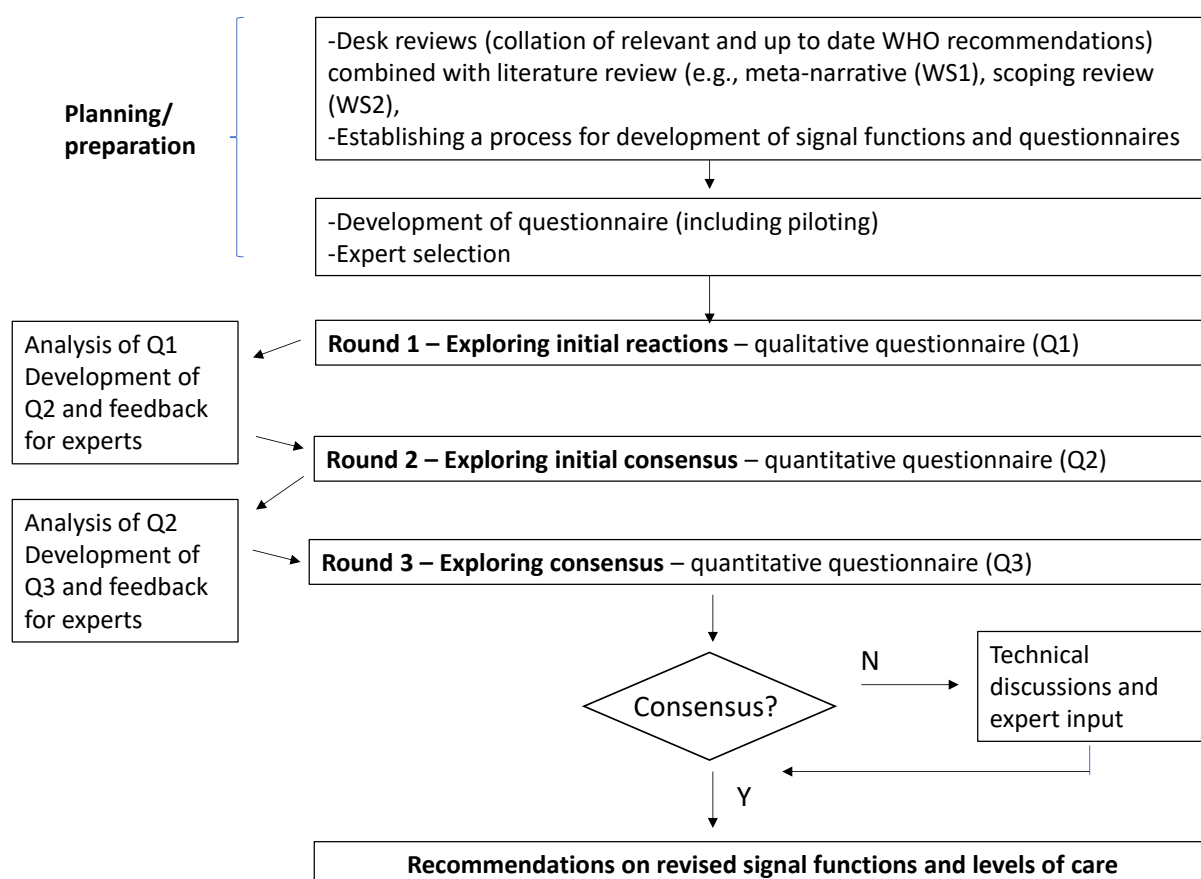
The study was conducted by the core study team, coordinated by Sarah Moxon at LSHTM with support from Alexandra Wharton-Smith.

- Core team: Sarah Moxon, Alexandra Wharton-Smith, Sudha Sharma, Jalemba Aluvaala, Allisyn Moran, Louise Tina Day, Oona Campbell, Lynn Freedman, Patsy Bailey, Samantha Lobis and Caitlin Warthin: The core team members had diverse experience in caring for obstetric and newborn patients, working with the EmONC measurement framework, and/or Delphi methodologies.
- Re-Visioning EmONC WS1 on signal functions and WS2 on levels of care: global teams of individuals with diverse experience working with signal functions and global health systems.

Workstream meetings were held on an ad hoc basis. Where appropriate, WS1 and WS2 reviewed elements of study tools, piloted surveys and/or provided feedback on findings from individual rounds.

- Re-Visioning EmONC Project Steering Committee: The Re-Visioning EMONC project Steering Committee made up of representative individuals from UNICEF, UNFPA, WHO and LSHTM and provided input and feedback to the study protocol, provided feedback on results between individual rounds, and aided technical decisions between rounds.

Figure 2. Study flow for Delphi study on obstetric and newborn care signal functions and levels of care



Delphi participants

As part of the planning and preparation phase for the Delphi study from April-August 2021, a list of experts in MNH from clinical, research, programme and policymaker backgrounds was created through recommendations from the Re-Visioning EmONC Project Steering Committee. The study protocol was shared with the Steering Committee and individuals provided recommendations through a shared document by email. Individuals with a combination of clinical and programmatic expertise were considered ideal, although researchers, non-clinical programs individuals with experience working with the EmONC signal functions were also invited. A balanced combination of those with obstetric and newborn expertise were approached. The purpose was to create a diverse sample of participants with a range of professional expertise and experience in different geographies. Including both academic and professional experts was considered valuable to ensure different perspectives (Briedenhann and Butts, 2008). Given the focus of the EmONC project in LMIC, we wanted participants to have substantial experience working in LMICs. As identified through the HCD component of the project, wherever possible, efforts were made to increase the participation

of data end users (those assumed to use the framework for decision-making purposes), such as policy makers, programme managers and planners.

A recruitment email (see Appendix 2) containing information on the Delphi study and a link to complete a recruitment survey and sign up for the Delphi study was sent out to the complete list of potential participants asking them to complete the recruitment survey (Appendix 3) and to share with their networks in order to create a comprehensive respondent list. The invitation email and recruitment survey were translated/back-translated into French and Spanish, to enable participants to respond in their preferred language and to promote a representative cohort of experts.

The recruitment email was also sent to targeted project email lists, such as the Every Newborn Action Plan (ENAP) and Ending Preventable Maternal Mortality (EPMM) management team encouraging additional snowball sampling through project mailing lists. Targeted emails were drafted to regional and in-country actors (e.g. through UNFPA country teams) to encourage participation of in-country contacts and data end users and shared by professional contacts in the steering committee in the appropriate language (e.g. French, English or Spanish).

In total 279 participants were invited to participate in Round 1 of the Delphi (111 from the recruitment surveys, 100 from convenience sampling, 68 from the ENAP and EPMM mailing lists). All participants were informed that participation in all rounds of the Delphi would lead to an invitation for inclusion in the group list of authors in the subsequent publication of the Delphi study results. The participants remained anonymous to allow them to express potentially divergent opinions freely (many participants were acquainted through professional networks, but participation in the study remained anonymous). Only members of the core study team viewed participants' names. Only those who meet group authorship requirements and consent to their name being included in the authorship group will be identifiable by name in the final publication.

Round one: Exploring expert perceptions

Given the early stage of the overall Re-Visioning EmONC Project that the Delphi study was launched, the study team decided to keep the first round open and exploratory with free text options to elicit information on what the expert participants would like to see in a revised EmONC framework and how this could be reflected in the revised signal functions and levels of care.

The draft survey was reviewed by members of the core team, edited based on suggestions and then entered into Smart Survey¹, which is an internet-based, encrypted and secure GDPR compliant software platform. The survey was piloted by the core team and other members of the steering committee before being refined and shared with translators. During the process of translation, further minor amendments and refinements to wording and sentence structure were made to improve the overall clarity and translatability into French and Spanish. The French and Spanish versions were piloted by members of the steering committee or workstreams who were native speakers of these languages. To ensure language consistency with existing documents the WHO versions of the monitoring framework were used as a guideline for any technical terminology that required translation resulting in the round one survey (see Appendix 4).

The round one survey was organised into six sections (see Appendix 4):

- Background
- Consent
- Contact information

¹ <https://www.smartsurvey.co.uk>

- Section A: Signal functions and what aspects of care signal functions should capture (type of care (routine/emergency), type of interventions, timing of care and priority complications)
- Section B: Levels of care and which criteria should influence how levels of maternal and newborn care should be organized (health system criteria, linkage between maternal and newborn levels of care, current and optimal configurations of levels of care)
- Respondent demographic information

For Section A and B, some questions required a quantifiable answer or to make a judgement between different options. All questions in Section A and Section B had free-text boxes for comments and suggestions.

On 17th November 2021, the invitation email to join round one of the Delphi study was sent to 279 identified experts. The invitation email and study were made available in English, French and Spanish. Informed digital written consent was included as part of the round one survey and participants could not proceed to complete the first round of the survey without giving consent. Detailed participant information was included as an attachment to the round one invitation email (See Appendix 1).

Participants were given 23 days to complete the survey (extended from an initial two-week period to maximise participation). Reminders were emailed to the invitees who had not completed or who had only partially completed the survey during the last week of November and the first week of December 2021.

Analysis of round one

Raw data files were exported from SmartSurvey into Excel (Microsoft Corporation, Washington, USA). Separate data files were exported and merged in English, French and Spanish. All quantitative responses were summarised as percentages. We chose an inductive-deductive approach to analyse the qualitative data (Azungah, 2018). A thematic framework was constructed based on emergent themes from the data and the question topics and data were coded line-by-line and categorised by theme in excel. Two members of the study team (SM and AWS) analysed the qualitative data for inter-coder reliability and validity (O'Connor and Joffe, 2020) and reached agreement on the sorting of data into distinct themes and sub-themes. The first round helped to identify themes and concepts that would guide the further construction of the signal functions and levels of care over the subsequent rounds guided by the respondent perceptions of the signal functions and levels of care approach.

Round two: Exploring initial consensus: Prioritising signal functions

Round two of the Delphi study focused on prioritising signal functions for the revised EmONC framework. The decision for the signal functions to focus on emergency obstetric and newborn care was based on findings from round one and broader discussions from the Re-Visioning EmONC Project Steering Committee and relevant workstreams.

Following desk reviews of existing WHO recommendations and guidelines for MNH, WS1 created a series of matrices of priority complications and mapped these to evidence-based interventions. These were combined with results from the round one Delphi to generate a long list of potential signal functions for the revised framework (32 newborn interventions and 30 obstetric interventions).

The project team convened an in-person technical workshop in May 2022 with the aim of agreeing on 1) a set of signal functions criteria 2) a short list of signal functions for ranking in round two of the Delphi study.

The round two survey (Appendix 5) was created following the technical workshop and had four sections:

- Introduction/background
- Contact information
- Obstetric signal functions
- Newborn signal functions

Participants could choose to complete the obstetric section, the newborn section or both.

For the section on signal functions, Delphi participants were provided clear definition of signal functions characteristics (Box 1) as defined in the technical workshop. They were then given a scenario (see Appendix 5) and asked to prioritise nine signal functions for obstetric and nine priority signal functions for newborn care, respectively.

Box 1 Signal Functions Definitions

Ideal characteristics/criteria for signal functions

CRITICAL: The signal function should represent a clinical intervention or service performed by health workers to manage one or more complication(s) that would otherwise result in major cause/s of maternal or newborn death and disability, or stillbirth.

a TRACER: Performance of the intervention or service ideally indicates that multiple other components of treatment or aspects of care are also present (e.g., performance of surgery generally indicates the availability of anaesthesia).

FREQUENT: The intervention or service should be performed often enough to reflect ongoing performance or functionality of the facility.

SIMPLE: Not necessarily simple to perform, but the intervention or service should be clearly and operationally defined and feasible to measure reliably across contexts.

See appendix 6 for the list of signal functions (including definitions) circulated for round two.

Similar to round one, the round two survey was piloted with the steering committee and relevant workstream members and refined before translation. Following translation to French and Spanish further minor refinements were made. For the signal function lists, to ensure consistency, existing WHO translated documents were used to guide terminology in the different languages.

On 17th August 2022, the invitation for round two was sent to all 212 participants who completed round one. The round two survey was available in English, French and Spanish and was open from 17 August to 9 September 2022. Reminders were emailed to all the round two invitees who had not completed, or only partially completed the survey during the first week of September 2022.

Analysis of round two

Raw data files were exported from the survey software as spreadsheets in Microsoft Excel (Microsoft Corporation, Washington, USA). Separate data files were exported and merged for participants in English, French and Spanish. Email addresses provided by round two participants were checked for consistency with those provided by the same participants in round one and changed for consistency if required. Participants in round two who did not respond to round one were excluded. Rounds one and two datasets were then merged on email address using Stata 16 (StataCorp, Texas, USA).

Descriptive statistics for round two were produced using Stata for the following variables: work setting, gender identification, language, survey sections filled in, professional group, experience in

WHO regions and the country where participants have the most experience working in maternal and newborn health. For each signal function, ranks given by participants were assigned an equivalent rank score and mean scores calculated for each signal function in order to calculate the top nine rated.

Thematic analyses (Azungah, 2018) were conducted on the freetext comments for round two. The aim was to: 1) identify appropriate, relevant changes to the wording of signal functions and 2) identify themes relevant to the overall aims of the Delphi study and broader Re-Visioning EmONC project.

Round three: Exploring consensus: rating of signal functions and levels of care in a prototype

Round three of the study was focused on rating signal functions and levels of care combined in a prototype. In September 2022, a technical workshop was held. The workshop was comprised of all steering committee members and some members of individual workstreams (including members from WS1 and WS2), and others with relevant involvement in the project. In preparation for this workshop, a prototype of the configuration of signal functions and levels of care was created based on the findings and expert recommendations from previous rounds of the Delphi and from evidence collated from WS1 and WS2 (this included evidence synthesis from literature review carried out by WS1 and WS2). The prototype was presented at the technical workshop alongside the results and findings from the previous Delphi rounds. Feedback from the workshop participants was collated and discussed before further refinements to the prototype and signal functions were made, including refinements to the definitions and those signal functions included in the prototype. For example, the proposed signal function on referral did not emerge as one of the top nine signal functions rated in round two, but there was strong feedback from qualitative findings from previous Delphi rounds and from discussions at the technical workshop that a refined referral signal function should be maintained for the final round. Collated feedback on the individual signal functions from round two can be found in Appendix 7.

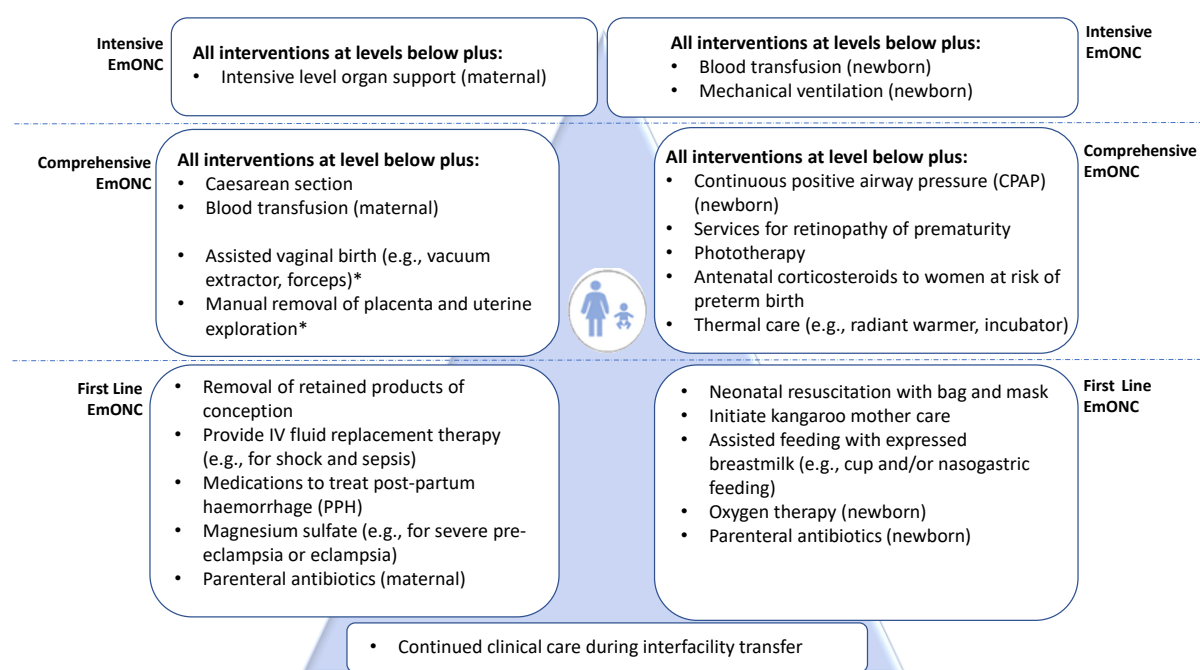
The round three survey was created based on the results from rounds one and two and agreed recommendations which emerged from the technical workshop and included four sections:

- Introduction/background including prototype (see Figure 3)
- Contact information
- Section A levels of care
- Section B Signal functions

In Section A on levels of care participants were asked about their agreement with the suitability of the three levels of care presented in the prototype and their agreement on the proposed naming of the three levels. In Section B on signal functions individuals were asked about their agreement with individual signal functions (whether they agreed or disagreed with their inclusion) and their agreement with the placement of signal functions at different levels of care in the prototype. For all questions, participants who disagreed were given the option to comment on their reasons and to offer alternative suggestions. Participants were also asked a question on whether there should be any additional signal functions beyond those proposed in the prototype. Participants could complete questions on obstetric care signal functions, newborn care signal functions, or both. See Appendix 8 and 9 for the complete round three survey and the list of signal functions, including definitions.

Similar to previous rounds, the round three survey was piloted with the steering committee and relevant workstream members and refined before translation. Following translation to French and Spanish further minor refinements were made.

Figure 3. Prototype of EmONC signal functions and levels of care for round three



*These signal functions are required at comprehensive and intensive EmONC levels, but they can (and often will) be part of service delivery at first line EmONC facilities.

On 6th December 2022, the invitation for round three was sent to all 131 participants who completed both round one and round two. The round three survey was open from 6th December 2022 to 11th January 2023. Two sets of reminders were emailed to all the round three invitees who had not completed, or only partially completed the survey in December and then in early January.

Analysis of round three

Raw data files were exported from the survey software as spreadsheets in Microsoft Excel, separately for the three languages, and were merged in Microsoft Excel. Email addresses, which served as a unique identifier for each participant so that their responses could be tracked across all three rounds, were checked for consistency with those listed for the same participants in the merged round one and two dataset and were changed for consistency if required. Participants to round three who were not found in the round one and two dataset were excluded. The datasets were then merged on email address using Stata to produce a full dataset of all three rounds.

Descriptive statistics for round three were produced for: work setting, gender identification, language, survey sections filled in, professional group, experience in WHO regions and the country where participants have the most experience working in maternal and newborn health.

Descriptive statistics were also produced for: agreement on the naming of the three levels of care, agreement on the inclusion of 11 named obstetric and 13 named newborn signal functions in the revised framework at any level, and agreement on the level at which each of the obstetric and newborn care signal functions should be included in the revised framework.

Thematic analyses were conducted on the freetext comments for rounds three (Azungah, 2018). Firstly, free text comments were summarised by theme for each of the questions in round three to understand the range of different reasons that participants disagreed or strongly disagreed with round three questions. This was compiled in a summary presentation for the steering committee. Following this, the free text comments were further analysed with the aims of: 1) identifying appropriate, relevant themes on the wording and configuration of the signal functions and levels of care 2) identifying additional proposed signal functions which meet the signal function criteria or be appropriate for other areas of the measurement framework, and 3) identifying themes relevant to the overall aims of the Delphi study and broader Re-Visioning EmONC project.

Data storage and management

All data storage and management procedures were United Kingdom General Data Protection Regulation (UK GDPR) compliant, and the data were collected in the GDPR-compliant software, SmartSurvey. Identifying information (name and email address) was collected only to allow the study team to contact the participants through the rounds of the study and will only be retained where participants have explicitly given permission to do so as part of the consent process. Identifiable data were only visible to the study team. All data have been stored on encrypted password protected computers and only accessible by the named researchers in the study. Personal information has been kept in a different file to other study information and will be destroyed within 10 years of completion of the study. Exported data files (prior to anonymisation) and the email list of participants with identifiers were all password protected in individual files. As the study related to expert opinion and professional knowledge as applied to signal functions, no sensitive information was collected as part of the study.

Study participants were given information prior to consenting to participate about the management of their data and given the option to contact the study team for further information about data management, or if they should decide that they want their data to be deleted. At the end of the study anonymised data files that are deemed suitable for sharing by LSHTM data management team will be archived in the LSHTM data repository, data compass

<https://datacompass.lshtm.ac.uk/information.html>.

Analysis

There is a lack of general agreement in the literature to guide the consensus process in a Delphi study and whether to pre-determine levels of consensus for the final round has been debated (Holey *et al.*, 2007). One argument is that applying numerical values to subjective responses is reductive and unconvincing (Holey *et al.*, 2007). An alternative point of view encourages pre-defined consensus thresholds to reduce research bias, such as arbitrary or post-hoc rationales (Williams and Webb, 1994). In view of Delphi consensus ambiguity, this study adopted an iterative approach to building consensus based on the emerging results of the rounds and building on cumulative knowledge and evidence from wider project outputs (including literature reviews and other research outputs from WS1 and WS2). Regular feedback and technical discussion with project expert groups was built in as a fundamental part of the approach to allow for expert input, sharing results of quantitative and qualitative/free text responses to aid decision-making on areas of uncertainty. There were two key technical workshops involving the core Delphi team, steering committee and workstream members between rounds, which were critical for decision-making in order to build subsequent questionnaires. Each round of the Delphi study took a different approach with a clearly defined objective/aim working towards building a prototype for the final round. Final decisions

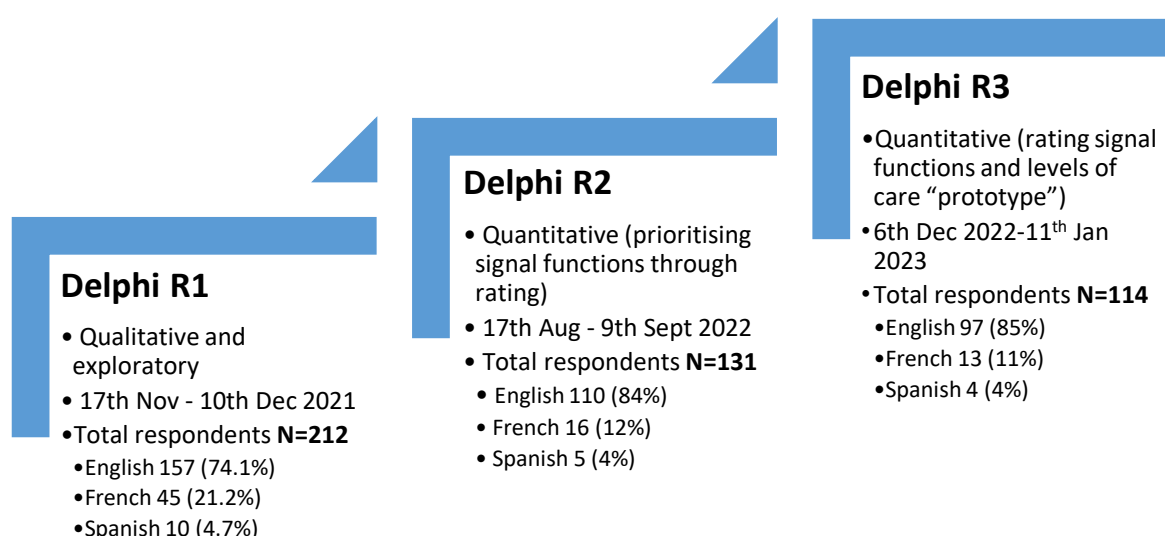
about consensus thresholds were guided by the analysis of responses and a threshold of >85% was decided for final round to elucidate areas of the prototype that required further technical discussion.

Results

In this report, we present a summary of the demographic characteristics of the final sample (n=114) and then we present summaries of the results of each R1 and R2 separately to show the process of convergence across rounds (n=212 and n=131, respectively). Finally, we put forward recommendations on signal functions and levels of care, which we present in the discussion section.

Demographic characteristics of final sample

Of the 279 experts invited to join the study, 212 participated in the first round of the Delphi (76% response rate). In round two, 131 participants participated (62% of those in round one) and in round three, 114 participants participated (87% of those in round two). The final sample was comprised of a diverse and balanced group of experts in maternal and newborn health from a range of settings, specialties, and professions (for example, there were 28% of respondents with an obstetric and gynaecology clinical background and 22% with paediatrics or neonatology). There was relatively equal participation throughout from those with obstetric and newborn expertise, although slightly higher participation on the maternal health side. The final sample was a higher proportion of female participants than male (70% female to 30% male). Keeping participants fully engaged once recruited is one of the challenges of conducting a three-round online Delphi study (Hsu and Sandford, 2007). Despite a relatively long duration of study and time between rounds, the study had a good retention rate of 54% across all three rounds overall².



² the size of several recent international online Delphi surveys recruiting multi-stakeholder group ranges from 39 to 838 participants completing the final round, with retention rates of 19.5 to 87.1% (Hall *et al.*, 2018b)

Table 1 The characteristics of the Delphi participants in round three (participants could select more than one group)

Table 1. Participants' professional group(s)	Number of participants (N=114)	Proportion of participants (%)
Obstetrician-Gynaecologist	32	28
Neonatologist	13	11
Paediatrician	12	11
Physician/Medical Doctor	19	17
Nurse	4	4
Neonatal Nurse	4	4
Midwife	17	15
Associate Clinician/Clinical Officer	1	1
Researcher/Academic in Maternal Health	45	39
Researcher/Academic in Newborn Health	26	23
Technical Advisor in Reproductive, Maternal, Newborn or Child Health	57	50
Programme Manager in Reproductive, Maternal, Newborn or Child Health	28	25
Policy-maker/Planner in Reproductive, Maternal, Newborn or Child Health	13	11
Government Official	5	4
Clinical Trainer or Instructor	21	18
Other	18	16
Table 2. Participants' experience working in different WHO regions	Number of participants (N=114)	Proportion of participants (%)
African region	85	75
Americas region	26	23
Eastern Mediterranean region	9	8
European region	20	18
South-East Asian region	44	39
Western Pacific region	12	11

Table 3. Participants who completed obstetric, newborn or both sections of survey	Number of participants (N=114)	Proportion of participants (%)
Completed obstetric and newborn section	59	52
Completed obstetric section only	32	28
Completed newborn section only	23	20

A world map illustrating the global distribution of the genus *Euphorbia*. The map uses a color scheme where green indicates the presence of the genus and grey indicates its absence. Green areas are concentrated in North America (including Alaska, Canada, and the United States), Mexico, Central America, the Caribbean, Europe, North Africa, the Middle East, India, Southeast Asia, Australia, and parts of South America and Africa. Grey areas cover South America, Russia, China, and parts of Africa and Asia.

Thematic analysis of the round one qualitative data identified numerous sub-themes with three over-arching themes: 1) a general endorsement of the signal function approach 2) a focus on emergency care and 3) a shift away from the arrangement of signal functions in two levels.

General endorsement of signal function approach

"I feel the core signal functions should remain as clear and simple as possible and that the set of indicators should continue to have a clear place (assessing a facility's performance in managing complications of mothers and newborns) in the increasingly complex landscape of health system measurement." R1 participant

“Because they are well supported by epidemiological studies, short and explicit, it has even been possible in many countries to include the EmONC [signal functions] in the national HMIS, as in Nepal.” R1 participant

15 | Page

of the newborns and the explicit incorporation/mention of other emergency care for women that need to be updated". At the same time, there was clear preference for linkages between obstetric and newborn care to ensure integration, promote togetherness of the mother baby dyad and encourage strengthening the system as a continuum.

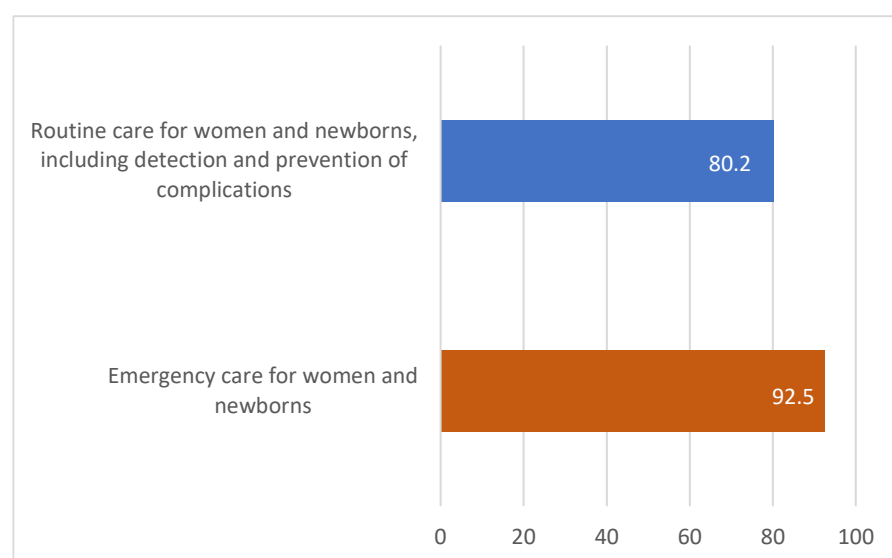
"Women and their babies should be treated together in the same location, as much as possible, and health service planning should reflect that." R1 participant

Overall, these responses suggested a strong desire to maintain the concept of signal functions within the EmONC framework, but to update it to better reflect the mother-newborn dyad and ensure that with the addition of newborn signal functions, obstetric signal functions were revised accordingly.

Focus on emergency care

An explicit objective of the first round was to explore respondents' perceptions of the focus of the revised signal functions in a revised EmONC framework. Results showed a wide spectrum of opinions from participants. In the quantitative results when asked whether signal functions should cover routine or emergency care, 93% of respondents indicated emergency care and 80% of respondent indicated routine care (including detection and prevention of complications).

Figure 5. Participants' views on whether emergency and routine care should be covered by the revised signal functions (n=212)



Within the free text qualitative responses, maintaining a focus on emergency care was framed as essential.

"Emergency care is essential if we are to prevent the most severe morbidity and mortality... this includes the skills of personnel and supplies, but also mindsets and culture regarding responsiveness" R1 participant

This was seen as especially important for high mortality settings.

"Irrespective of improving the quality of routine care, the health care systems in Low Middle Income Countries (LMICs) remain fragile, so emergency care ought to be prioritized especially improving on the emergency preparedness and complication readiness of the health facilities." R1 participant

Despite this, a large group of participants put forward a strong argument for including routine care and dimensions of care beyond clinical care alone emphasising that *“good emergency care and prevention of complications is equally important”*. Most participants strongly endorsed the idea of broader dimensions of care being better reflected in the revised EmONC framework and although attention to emergency care may be the priority for this framework, especially for the highest mortality settings, it is not enough to reduce mortality and morbidity. Furthermore, a broadening of the dimensions of care better reflects the changing landscape of maternal and newborn health.

“Routine care continues to be a feeder for the experience of the health system, and trust and experience with routine care influences uptake of emergency care.” R1 participant

Whilst all participants articulated the importance of broader dimensions of care, especially quality, routine and respectful care, including routine care to the signal functions *“risks huge overlap with other assessments like SPA/SARA”* and that *“signal functions by definition shouldn’t be everything because then they become the standards.”* There were concerns that *“too many different kinds of things are combined into signal functions, then the assessment of whether signal functions have been performed becomes murkier and murkier.”* Other participants proposed that routine and non-clinical care dimensions could be reflected elsewhere in the revised framework and indicator set and that routine care referred to a critical, but different set of interventions that might require a different measurement approach.

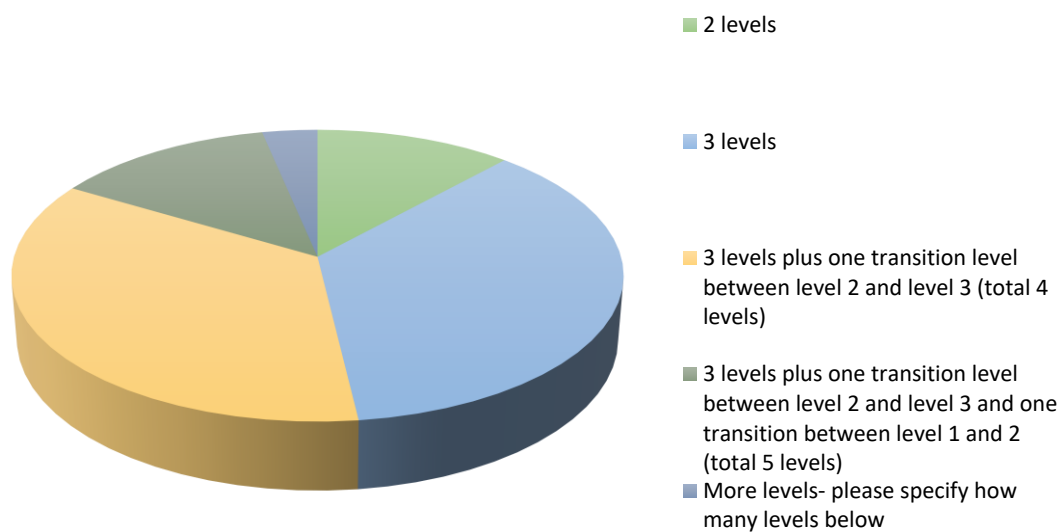
“I think signal functions should be kept as a limited number serving as tracers of clinical interventions or services. They should be complemented by indicators for non-clinical interventions or services such as referral. The non-clinical interventions may be more difficult to collect and may be collected less frequently” R1 participant

In summary, most participants recognised the need for the revision to better reflect the increased global focus on quality and respectful care, and the neglect of preventive care for all mothers and newborns, but there was not clear consensus that signal functions would be the optimal way to measure these dimensions of care.

Potential shift away from two levels of care

Round one participants were asked about the optimal number of levels of care for women and newborns with complications. Over 80% of respondents indicated more than two levels would be optimal.

Figure 6. Participants' views on optimal number of levels of care for women and newborns with complications



Overall, throughout the free text responses, participants generally endorsed the concept of signal functions reflecting different levels of care some stating that *“each [signal function] corresponds to a different level of care, with a linkage across levels”*. An optimal configuration of care for women and newborns with complications would retain this logic, but ensure that it reflected typical health system structures.

“Propose continue tiered system of signal functions reflective of acuity of care available at different tiers of facilities within a typical health system” R1 participant

Participants were concerned that *“Too many levels may affect organization, planning, and evaluation efforts”*. However, there is often need for greater nuance to reflect health system complexity that could be measured through transition levels.

“I think 3 levels of care (primary, secondary/district and tertiary regional/national is a logical framework that is likely to be relevant and useful for most countries, even if an individual country has more than 3 levels of care or includes “transition” levels.” R1 participant

In summary, the concept of arranging the signal functions by levels of care that are differentiated by functionality to perform certain interventions was broadly accepted by participants, but many were open to seeing a more nuanced reflection of health systems, especially when integrating newborn care.

Cutting across all three themes, there was a strong perception from participants on the importance of a strong referral network and the need for increased attention to referral in the revised EmONC framework.

Summary of results from round two (prioritising signal functions)

The objective of round two of the Delphi study was to prioritise the top nine emergency signal functions based on a set of criteria (Box 1) in order to generate a shorter list of signal functions for

the revised framework. There were a total of 131 participants included in round two³, which represents a loss of 38% of participants from round one to round two.

In order to identify the top nine signal functions selected by participants in round the ratings given by participants were assigned an equivalent rank score, with a rank of 1 assigned a score of 1, a rank of 2 assigned a score of 2 and so on. Mean scores were calculated for each signal function separately for obstetric and newborn responses to identify the top nine signal functions selected or each set with the lowest score corresponding to the highest mean rank.

Tables 4a and 4b show the top nine signal functions that were prioritised for the subsequent Delphi round for obstetric and newborn care, respectively.

In appendix 7, we summarise the free text responses on proposed amendments to the individual signal functions for round two and show the average rank scores for each signal function. This was used as the basis for discussion with technical experts to form the signal function lists and prototype for round three.

Table 4a. Results from round two showing top nine prioritised emergency obstetric care signal functions (n=107)

	Obstetric signal functions
1	Administer appropriate medications to treat post-partum haemorrhage (PPH) (appropriate medications in the algorithm for PPH e.g. oxytocin or ergometrine (or combination of oxytocin and ergometrine), or oral misoprostol, or prostaglandin or heat stable carbetocin or tranexamic acid).
2	Administer magnesium sulfate for pre-eclampsia or eclampsia
3	Administer parenteral antibiotics (e.g. ampicillin, gentamicin) (maternal)
4	Perform manual uterine exploration and removal of placenta
5	Administer maternal antihypertensives (e.g. alpha methyl dopa, hydralazine, labetalol, nifedipine)
6	Provide intravenous (IV) infusion/IV fluid replacement therapy (e.g. maternal resuscitation)
7	Perform removal of retained products of conception (e.g. manual vacuum aspiration), dilation and curettage, medical management)
8	Perform caesarean section
9	Perform blood transfusion

³ Of the (N=131) responses to round two :

- 110 (84%) participants completed in English
- 16 (12%) participants completed in French
- 5 (4%) participants completed in Spanish.

Table 4b. Results from round two showing top nine prioritised emergency newborn care signal functions (n=102)

	Newborn signal functions
1	Perform neonatal resuscitation with bag and mask
2	Initiate kangaroo mother care (for LBW/preterm newborns)
3	Administer antenatal corticosteroids (ACS) (e.g. dexamethasone, betamethasone) to women at risk of preterm birth
4	Administer parenteral antibiotics (e.g. gentamicin, ampicillin) (newborn)
5	Administer oxygen therapy with pulse oximetry
6	Perform assisted feeding with expressed breastmilk (e.g. cup and/or nasogastric feeding)
7	Administer magnesium sulfate to women at risk of preterm birth
8	Administer phototherapy for hyperbilirubinemia (jaundice)
9	Provide thermal care (e.g. radiant warmer, incubator, heated cot) for preterm/LBW newborns

Summary of results from round three (rating of signal functions and levels of care in a prototype)

For round three, participants were shown a prototype of the revised EmONC signal functions arranged by levels of care (Figure 3) and were asked to rate their opinions in a series of questions on levels of care and signal functions. There were a total of 114 participants to round three⁴, which represents a loss of 13% of participants from round two to round three.

Overall, for both the obstetric and newborn care signal functions, there was a high level of consensus on both the signal functions and their placement at specific levels of care in the prototype with some clear areas for further discussion and recommendations. Below we present the main quantitative results followed by a summary of the free text themes. Guided by the data and the round three aims, we decided on a threshold of 85% for consensus to help identify areas lacking consensus that would require further technical input and discussion. Participants were asked to comment if they disagreed or strongly disagreed with many of the questions, therefore, themes that came out of the free text comments are arranged by specific question with other themes that emerged from the free text comments summarised at the end of this section.

Levels of care

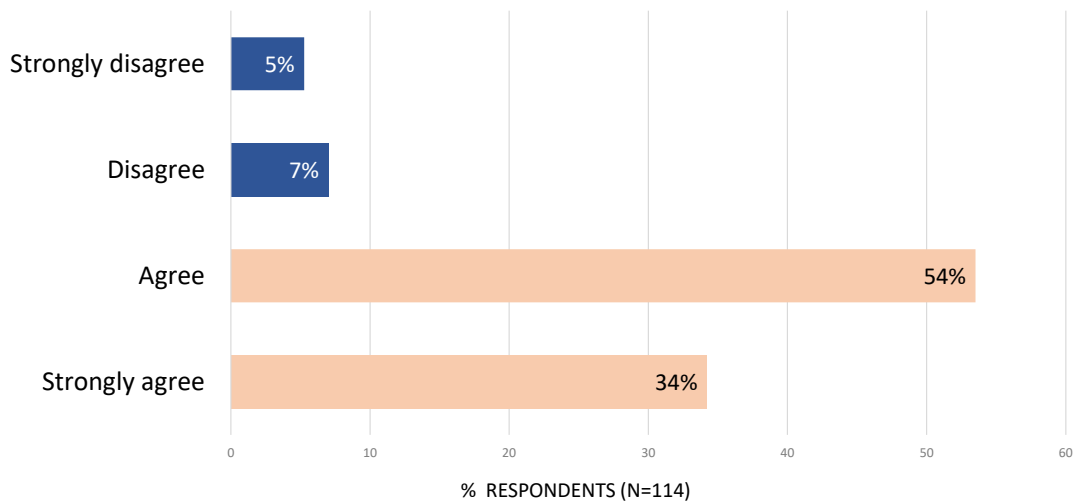
For the questions in Section A of round three on levels of care, 88% of participants agreed or strongly agreed with the proposal to use three levels of care as shown in the prototype (Figure 7). With the naming of levels of care, whilst 87% of participants agreed or strongly agreed with both

⁴ Of the N=114 responses to round three:

- 97 (85%) participants completed in English
- 13 (11%) participants completed in French
- 4 (4%) participants completed in Spanish.

naming the middle level “comprehensive” and the highest level “intensive” there was less clear consensus on the naming of the lowest level of care (Figures 8-10). Only 72% of participants agreed or strongly agreed with naming the lowest level of care “first line”; this falls below the threshold of 85% for consensus that was defined for the study (Figure 8).

Figure 7. Bar graph showing participants’ opinion on using three levels of care as shown in the round three prototype



On the question asking participants’ opinion on using three levels of care, two main themes that emerged from the free text comments of those that disagreed or strongly disagreed. A group of participants had a preference for more levels (usually four levels) and a set of participants that had a preference for maintaining the status quo of two levels.

Figure 8. Participants’ opinion on the proposal to name the lowest level of care “first line” as shown in the prototype

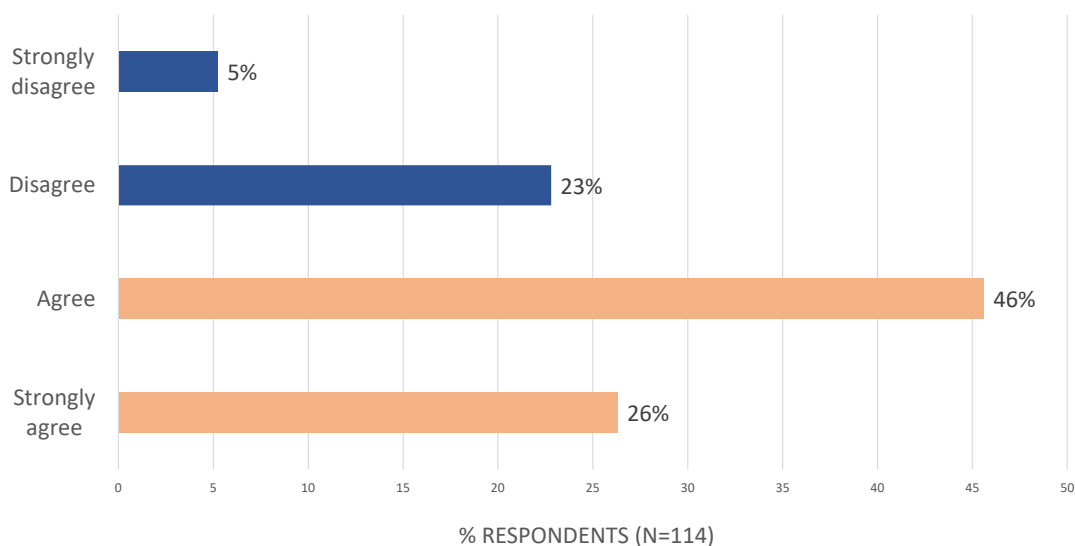


Figure 9. Participants' opinion on the proposal to name the middle level of care "comprehensive" as shown in the prototype

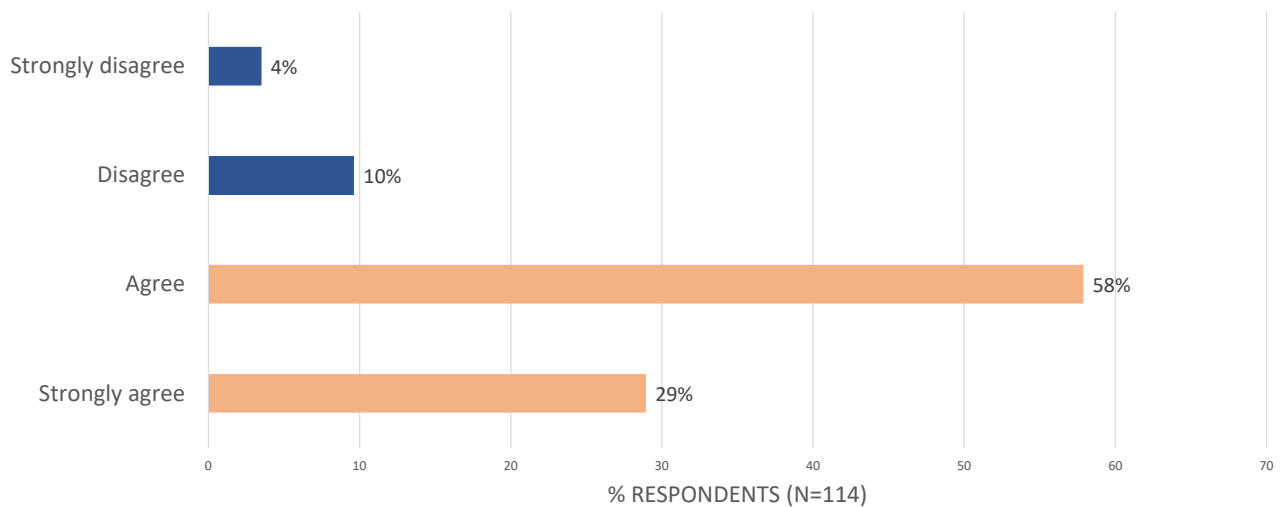
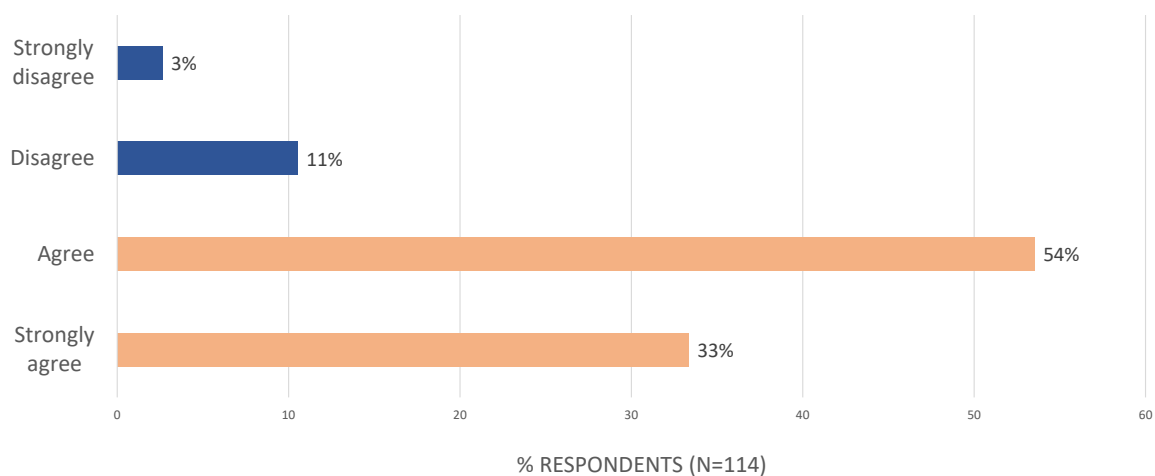


Figure 10. Participants' opinion on the proposal to name the highest level of care "intensive" as shown in the prototype



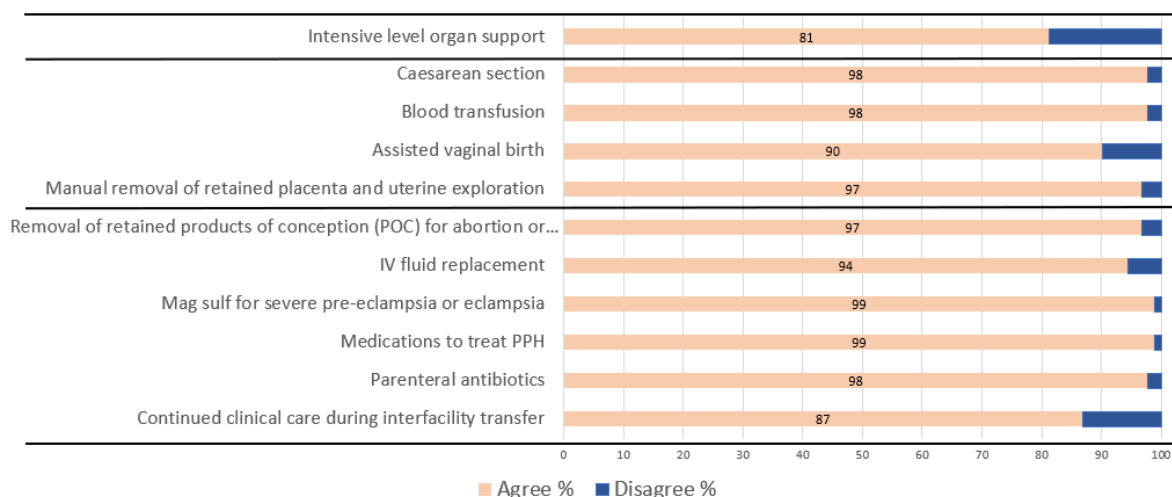
On the question asking participants opinion on naming the lowest level of care "first line", two main themes emerged from the free text comments of those that disagreed or strongly disagreed. Some of those that disagreed had a preference for maintaining the basic terminology, arguing it was not clear what added value the change brought and that the change could cause confusion in implementation. Secondly, there were concerns from participants about the term "first line" and the potential for it to be confused or misconstrued in implementation and measurement.

There was a higher level of consensus on the naming of the middle and highest level of care (comprehensive and intensive) with over 85% of participants agreeing with using these names. Of the 14% that disagreed or strongly disagreed, there was some concern over the use of the term comprehensive if the signal functions were to change from previous iterations of the framework. For the 14% who disagreed with the term intensive, disagreement was more related to concerns about the intensive level rather than the naming of the level itself.

Obstetric signal functions

For the obstetric signal functions, participants rated all signal functions included in the prototype above the 85% threshold for consensus, apart from intensive level organ support, which 81% of participants agreed should be included in the revised framework.

Figure 11. Based on the criteria, the following obstetric signal functions should be included in the revised EmONC framework⁵ (signal functions arranged by levels, as shown in the prototype)



As far as placement of the obstetric signal functions by levels of care in the prototype, participants agreed (>85% consensus) with the placement of all the signal functions at the lowest and highest levels. It was the placement of the following obstetric signal functions at comprehensive level that did not meet the 85% threshold for consensus:

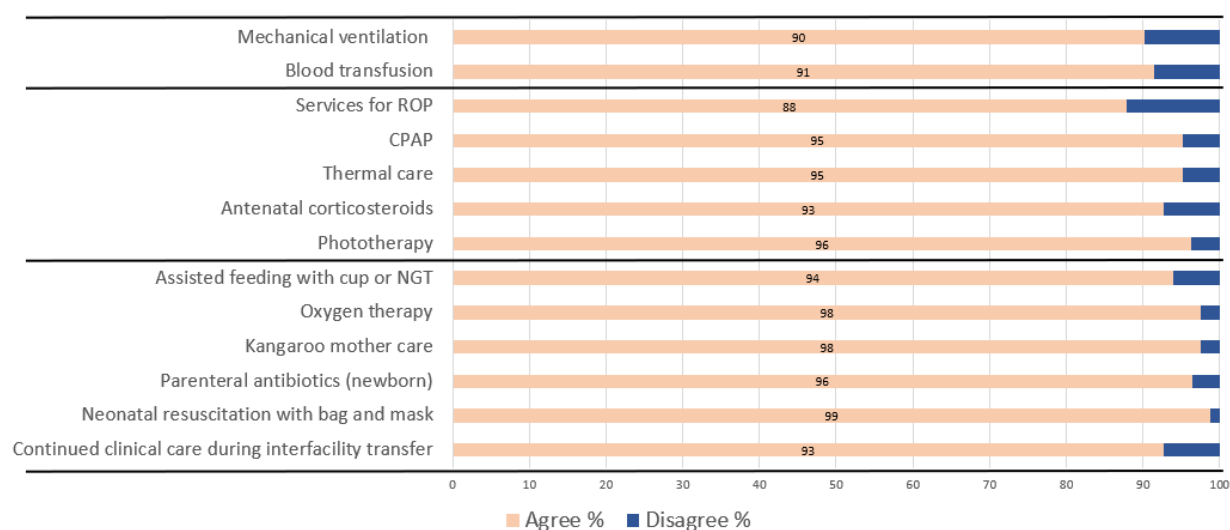
- **Manual removal of the placenta and uterine exploration:** Only 70% of participants agreed with the placement of this signal function at the comprehensive level, as shown in the prototype; 30% of respondents thought it should be placed at the lowest level.
- **Assisted vaginal birth:** For this signal function, 78% of respondents agreed it should be placed at the comprehensive level of care; 21% of respondents thought it should be placed at first line level and 1% thought it should be placed at intensive level.

Newborn signal functions

For the newborn signal functions, participants rated all signal functions included in the prototype above the 85% threshold for consensus. Services for ROP was the one least participants agreed should be included with still 88% of participants agreeing it should be included in the revised framework.

⁵ Due to a bug in the survey software, one respondent answered Q6 about obstetric signal functions twice in the same entry. Their response to each sub-section of the question was consistent between the two answers, except for one. The respondent's answer to the one inconsistent sub-section was excluded and all others were retained with a single copy of the answers in the dataset.

Figure 12. Based on the criteria, the following newborn signal functions should be included in the revised EmONC framework (signal functions arranged by levels as shown in the prototype)



As far as placement of the newborn signal functions by levels of care in the prototype, there were signal functions at each level of care, which did not reach the 85% threshold for consensus.

Lowest level signal functions

- **Oxygen therapy:** 80% of participants agreed with the placement of oxygen therapy at the lowest level, however, 18% thought it should be placed at the comprehensive level and 1% thought it should be placed at the intensive level

Comprehensive level signal functions

- **Services for ROP:** 78% of participants agreed with the placement of ROP services at the comprehensive level of care, 22% of participants thought it should be placed at the intensive level.
- **Thermal care:** 83% of participants agreed with the placement of thermal care at comprehensive level, 16% of participants thought it should be placed at the first line level and 1% at the intensive level.

Intensive level signal functions

- **Blood transfusion:** 80% of participants agreed with the placement of blood transfusion at the intensive level, but 18% of participants thought it should be placed at the comprehensive level of care and 1% thought it should be placed at the lowest level of care.

In appendix 10, we summarise the free text responses on proposed amendments to the individual signal functions for round three.

Overall synthesis of Delphi rounds

To synthesise the findings across the Delphi rounds, see Appendix 11 for cascade charts for obstetric and newborn signal functions showing the logic of the main causes of causes of mortality and morbidity and the elimination of signal functions across Delphi rounds.

Recommendations (April 2023)

We completed a three round online Delphi study with the aim of building expert consensus on signal functions and levels of care for the revisioning EmONC project. We adopted a highly iterative approach to the study overall, utilising elements of HCD, and incorporating regular expert input and evidence synthesis. Thematic analysis of qualitative data from round one of the Delphi study found three main themes 1) Endorsement of the signal function approach 2) Focus on emergency, clinical care at and around the time of birth 3) Shift away from two-level configuration of basic and comprehensive, especially for integrating newborn care. In addition, round one highlighted the importance of quality routine care and referral in the EmONC revisioning overall. Round two participants ranked a list of 28 signal functions, reducing the number of signal functions to help create a more parsimonious list. Based on collated feedback, evidence synthesis and technical input, round three sought feedback on a prototype with 23 signal functions and three levels of care. Following the final round, there was a high level of consensus amongst participants with most questions reaching the threshold of >85% of participants agreeing or strongly agreeing. The 85% consensus threshold was used to identify areas of the prototype that required further technical discussion and expert input.

Areas of prototype with lack of consensus

For each area of the prototype with lack of consensus (<85% consensus for any given question), we provide a short outline of the issues identified from free text comments and provide recommendations based on technical inputs from the Re-Visioning EmONC project expert groups and workstreams.

Naming of levels of care

There was overall consensus on maintaining the nomenclature for comprehensive level and the proposed naming of the new, higher level of care as intensive, there was lack of consensus on the proposed changed naming of first line (28% participants disagreed or strongly disagreed)

Recommendation: Revert to naming the lowest level “basic” for consistency. Overall, participants felt it was better to avoid unnecessary changes to nomenclature. For consistency, maintaining the terminology for the lowest level makes more sense from a measurement and implementation point of view.

Signal functions that rated below consensus threshold

The following signal functions were borderline (see Figure 10 and 11): Intensive level organ support and continued clinical care for interfacility transfer.

Recommendation: Both intensive level organ support and continued clinical care for interfacility transfer represent newly proposed signal functions that cover a critical area of EmONC that has emerged from evidence synthesis and expert input. Rather than removing these signal functions entirely, these signal functions require further definition and refinement in the last phase of the Re-Visioning EmONC project. There is a working group on referral and a specific workstream (WS1) dedicated to signal functions who can be consulted on this over the remaining months of the project.

Placement of signal functions at levels of care

Overall, even with a high level of consensus on the signal functions, there was a general feeling there were too many signal functions (23 in total in the prototype) and some signal functions that lacked consensus on their inclusion at a specific level of care.

Obstetric signal functions that did not meet the 85% threshold for consensus:

Manual removal of the placenta and uterine exploration: Only 70% of participants agreed with the placement of this signal function at the comprehensive level, as shown in the prototype; 30% of respondents thought it should be placed at the lowest level..

Assisted vaginal birth: For this signal function, 78% of respondents agreed it should be placed at the comprehensive level of care; 21% of respondents thought it should be placed at first line level and 1% thought it should be placed at intensive level. Both these signal functions have historically been included at the basic level, however, EmONC assessments have often found these to be the least performed signal functions. For the final round of the Delphi, we trialed including them at comprehensive level, but making clear that whilst they are required at comprehensive and intensive level, they can (and often will) be part of service delivery at basic EmONC facilities.

Recommendation: Maintain these signal functions at basic level.

Newborn signal functions which did not reach the 85% threshold for consensus.

Oxygen therapy: Both the survive and thrive report on transforming care for small and sick newborns (WHO and UNICEF, 2019) and the recently published ENAP targets for 2030 (UNICEF and WHO, 2020) recommend oxygen for small and sick newborn inpatient care at level 2 units. The WHO standards for improving the quality of care for small and sick newborns in health facilities (WHO, 2020) clearly describe the need for monitoring with pulse oximetry and the requirements for specific infrastructure and equipment that may not be feasible at a lower level (e.g. oxygen-air blenders, humidifiers). However, this this does not cover the need for oxygen pre-referral and in emergency situations.

Recommendation: Discussions with newborn expert group following round two of the Delphi agreed that oxygen should be retained at basic level with clear articulation in the handbook on the importance of the correct infrastructure and equipment for safe use and monitoring of oxygen for inpatient care in a comprehensive level facility.

Thermal care: Thermal care is part of care for all babies from drying and skin-to-skin at birth to use of radiant warmers and heated cots for small babies, making it difficult to measure as an emergency signal function. Discussion with newborn expert group found that thermal care may not meet the specific criteria for a signal function and has the potential to undermine KMC by reinforcing the stigma that that KMC is somehow inferior and less technical and effective than use of technology driven warming devices.

Recommendation: Thermal care should be included as a routine care signal function or indicator and the requisite infrastructure and equipment articulated as part of the accompanying measures on readiness. This reduces the number of newborn signal functions and the potential overlap between KMC and thermal care, making sure that togetherness of mother and baby is emphasised.

Services for ROP: Discussions with newborn expert group iterated the importance of a signal function on ROP (including screening and treatment), but there were concerns about the feasibility of implementation at comprehensive level.

Recommendation: ROP services can be retained as a signal functions but the wording and definition refined as part of the final stages of the project and moved to the intensive level or as a transitional intervention at the comprehensive level.

Blood transfusion: Blood transfusion is a core neonatal skill and part of the WHO guidelines for small and sick newborn care. However, unlike blood transfusion for obstetric care, it is not directly related to a main cause of morbidity or mortality. There were also concerns about whether it would measure both exchange transfusion and transfusion of blood products.

Recommendation: In view of the need for parsimony and some of the issues with measuring blood transfusion as a signal function, recommend that it could be removed from the list of signal functions for newborns.

Figure 13 below shows the recommended signal functions and levels of care based on the results of the Delphi study and subsequent technical discussions as of April 2023.

Figure 13. Recommendations on signal functions and levels of care

Obstetric ↓	Neonatal ↓
All interventions at levels below plus:	
Intensive EmONC	<ul style="list-style-type: none"> • Intensive level organ support • Mechanical ventilation • Services for retinopathy of prematurity
All interventions at level below plus:	
Comprehensive EmONC	<ul style="list-style-type: none"> • Caesarean section • Blood transfusion • Antenatal corticosteroids • CPAP • Phototherapy
Basic EmONC	<ul style="list-style-type: none"> • Assisted vaginal birth • Manual removal of placenta and uterine exploration • Removal of retained products of conception • Provide IV fluid replacement therapy • Medications to treat PPH • Magnesium sulfate • Parenteral antibiotics • Oxygen therapy • KMC • Assisted feeding with expressed breastmilk • Parenteral antibiotics • Neonatal resuscitation w/bag and mask • Continued clinical care during interfacility transfer

Strengths and Limitations

This is the first study using the Delphi approach to build consensus on an integrated set of obstetric and newborn care signal functions and levels of care. Its strength lies in the iterative approach and the diverse expert participant group from many clinical, a wide range of resources settings, specialities and experience working in different geographies. The opportunity for participants to complete in three different languages opened participation to non-English speakers. The response rate was good, particularly given the context of the pandemic/post pandemic and showed that there was interest in the projects broader aims. This study does, however, have limitations. Participants working at the frontline of planning and managing EmONC facilities were some of the hardest to recruit, likely due to competing schedules and the fact that many are also providing frontline clinical or field work. Our sampling relied on a convenience sampling approach, utilising mailing list and advertising to contacts within the wider groups' existing contacts, which may have meant that some groups were over represented (i.e. those in the existing network). Despite the option to complete the survey in three different languages, our attrition rates were highest in the French and Spanish participants and we had lower response rates in these languages, especially in the second round. Subsequently, some expert participants who could have otherwise provided valuable input may not have been included in the final round. Whilst a Delphi study approach was seen as the most appropriate approach for achieve the specific objective of this study, such expert opinion

approaches have their own limitations. Acquiescence bias is a clear limitation. We adopted a consensus threshold of 85% for the final round. Whilst this decision was based on and informed by the analysis, a threshold is arbitrary and had a different threshold been selected, this could change the final recommendations. However, rather than using the threshold as a way of making final decisions, we used it to guide and help elucidate and focus technical discussions for consensus building and technical discussions. Whilst every effort was made to ensure equal weight was given to all expert and technical input from multiple groups, there were inevitable areas where pragmatic judgments had to be made. We have made every effort to document all the stages of the study and the technical discussions and include the iterations of the study in the appendices of this report.

References

- Azungah, T. (2018) 'Qualitative research: deductive and inductive approaches to data analysis', *Qualitative Research Journal*, 18(4), pp. 383–400. Available at: <https://doi.org/10.1108/QRJ-D-18-00035>.
- Boulkedid, R. *et al.* (2011) 'Using and Reporting the Delphi Method for Selecting Healthcare Quality Indicators: A Systematic Review', *PLoS ONE*, 6(6), p. 9.
- Briedenhann and Butts (2008) 'Application of the Delphi Technique to Rural Tourism Project Evaluation', *Current Issues in Tourism*, 9(2), pp. 171–190.
- Cole, Z.D., Donohoe, H.M. and Stellefson, M.L. (2013) 'Internet-Based Delphi Research: Case Based Discussion', *Environmental management*, 51(3), pp. 511–523. Available at: <https://doi.org/10.1007/s00267-012-0005-5>.
- Dalkey, N.C. (1969) *The Delphi Method: An Experimental Study of Group Opinion*. RAND Corporation. Available at: https://www.rand.org/pubs/research_memoranda/RM5888.html (Accessed: 28 March 2023).
- Donohoe, H.M. and Needham, R.D. (2009) 'Moving best practice forward: Delphi characteristics, advantages, potential problems, and solutions', *International Journal of Tourism Research*, 11(5), pp. 415–437. Available at: <https://doi.org/10.1002/jtr.709>.
- Hall, D.A. *et al.* (2018a) 'Recruiting and retaining participants in e-Delphi surveys for core outcome set development: Evaluating the COMiT-ID study', *PLOS ONE*, 13(7), p. e0201378. Available at: <https://doi.org/10.1371/journal.pone.0201378>.
- Hall, D.A. *et al.* (2018b) 'Recruiting and retaining participants in e-Delphi surveys for core outcome set development: Evaluating the COMiT-ID study', *PLOS ONE*, 13(7), p. e0201378. Available at: <https://doi.org/10.1371/journal.pone.0201378>.
- Holey, E.A. *et al.* (2007) 'An exploration of the use of simple statistics to measure consensus and stability in Delphi studies', *BMC medical research methodology*, 7, p. 52. Available at: <https://doi.org/10.1186/1471-2288-7-52>.
- Hsu, C.-C. and Sandford, B.A. (2007) 'Minimizing Non-Response in The Delphi Process: How to Respond to Non-Response', *Practical assessment, research, and evaluation*, 12(17), pp. 1–6. Available at: <https://doi.org/10.7275/BY88-4025>.
- O'Connor, C. and Joffe, H. (2020) 'Intercoder Reliability in Qualitative Research: Debates and Practical Guidelines', *International Journal of Qualitative Methods*, 19, p. 1609406919899220. Available at: <https://doi.org/10.1177/1609406919899220>.
- Powell, C (2002) 'The Delphi technique: myths and realities', *Journal of Advanced Nursing*, 41(4), pp. 376–382.
- UNICEF and WHO (2020) *Ending preventable newborn deaths and stillbirths by 2030*. Available at: <https://www.unicef.org/reports/ending-preventable-newborn-deaths-stillbirths-quality-health-coverage-2020-2025> (Accessed: 19 April 2023).

WHO *et al.* (2009) *Monitoring emergency obstetric care: a handbook*. Available at: <https://www.who.int/publications-detail-redirect/9789241547734> (Accessed: 21 October 2022).

WHO (2020) *Standards for improving the quality of care for small and sick newborns in health facilities*. Available at: <https://www.who.int/publications-detail-redirect/9789240010765> (Accessed: 19 April 2023).

WHO and UNICEF (2019) *Survive and thrive: transforming care for every small and sick newborn*. Available at: <https://www.who.int/publications-detail-redirect/9789241515887> (Accessed: 7 April 2023).

WHO, UNICEF, and UNFPA (1997) *Guidelines for monitoring the availability and use of obstetric services*. Available at: <https://www.publichealth.columbia.edu/sites/default/files/pdf/unguidelinesen.pdf> (Accessed: 21 October 2022).

Williams, P.L. and Webb, C. (1994) 'The Delphi technique: a methodological discussion', *Journal of Advanced Nursing*, 19(1), pp. 180–186. Available at: <https://doi.org/10.1111/j.1365-2648.1994.tb01066.x>.

Appendices

Appendix 1. Participant Information Sheet and Consent Form

Participant Information Sheet

Title of Project: A modified Delphi study on obstetric and newborn care signal functions

Introduction

The 1997 Guidelines for monitoring the availability and use of obstetric services describe a set of connected indicators to measure and monitor the availability, utilization, and quality of emergency obstetric care in low- and middle-income countries (LMICs). This framework is built around signal functions, which are a shortlist of nine key medical interventions that can "signal" the level of functionality of a health facility. Facilities are subsequently designated as having provided either basic emergency obstetric care (BEmOC) if they can perform seven of the signal functions or comprehensive emergency obstetric care (CEmOC) if they have performed all nine the signal functions over a defined period (typically three months). The framework has been enormously influential over the last 30 years. It is now found in virtually all LMIC health plans for maternal and newborn health (MNH), and often forms the basis for planning for infrastructure, human resources, equipment, supplies, transport, and referral related to care during childbirth. But much has changed in the health systems and MNH landscape in the last 30 years. This modified Delphi study is part of the Re-Visioning EmONC project; an initiative to review, rethink, and revise the EmONC monitoring framework.

The Re-Visioning Emergency Obstetric and Newborn Care (EmONC) Project is led by a Steering Committee coordinated by the Averting Maternal Death and Disability (AMDD) program at Columbia University Mailman School of Public Health, and includes the London School of Hygiene and Tropical Medicine, UNICEF, UNFPA, and WHO. The entire project is framed and implemented using principles of human-centered design to ensure that the revised EmONC framework meets the needs and real world conditions at the national and sub-national policy level and at the frontlines of health systems in LMICs at different stages of the obstetric transition.

In view of your expertise in maternal and newborn health, we would like to invite you to take part in a Delphi study that we are carrying out as part of the Re-Visioning EmONC project. This information sheet will provide you with more details on the study and what participation will involve.

What is the purpose of the study?

The purpose of this online modified Delphi study on obstetric and newborn care signal functions is to solicit knowledge and a level of consensus from experts in maternal and newborn health like you in order to review, rethink and revise the existing obstetric care signal functions and levels of care. The project is committed to fully integrating newborn care signal functions as part of the revision.

Why have I been asked to take part?

You have been invited to join this expert panel because of your clinical and/or health systems expertise in the field of maternal and newborn health. Within the expert panel, we are aiming for experts in a range of roles and from a diverse range of geographies with a combination of ground-level experience, clinical and/or health systems related knowledge in global maternal and newborn health.

Do I have to take part?

It is up to you to decide to take part or not and we recognise that a Delphi study is a commitment of time. If you agree to join the expert panel and participate in the study, then we will then ask you to sign an online consent form before you can complete the study questions.

What is the process for the study and what will I have to do?

A Delphi study is a structured process which aims to build consensus by presenting questionnaires to a selected panel of experts in a series of rounds. Rounds are usually repeated until a level of consensus is reached. This modified Delphi study will be carried out through three rounds of online questionnaires. The first questionnaire will be made available on 17th November 2021 and will ask more open questions that allow you to provide free text responses. There will be approximately 8 weeks between subsequent questionnaire rounds.

Subsequent questionnaires provide you with feedback on the results from the previous rounds and will ask you to rate signal functions options based on this feedback. We may also provide you with other relevant information or research to help you to respond to the questionnaire. We will allow approximately 8 weeks between rounds aiming to start in-November 2021 and aiming to finish in April-May 2022.

At the end of the rounds we may hold a final consensus building workshop. Further details on this will be available closer to the time, but we anticipate a commitment of half a day for this workshop.

Is my participation confidential?

A traditional Delphi study is completely anonymous, however, because this study involves some interaction of participants through a potential workshop at the end of the study complete anonymity of the study is not possible. You may know some of the other participants through professional connections. That is why this study is referred to as a modified Delphi. Whilst participation cannot be fully anonymous, we will anonymise all your responses for the purpose of the analyses and anything you write in free text will be anonymised when collated as feedback. Direct quotes from your responses may be used in the draft study report, but will be anonymised.

What are the possible risks and disadvantages?

There are very few risks of taking part in this Delphi study other than the commitment of time. Some may find the consensus process challenging and whilst we will do whatever we can to manage diverse opinions, there will always be some compromise to reach consensus. Participants should be aware that whilst they can withdraw from the study at any time and all demographic information will be removed, it may not be possible to remove all contributions that they have made to previous rounds. This is due to the iterative process of

the survey and survey tools which may have incorporated some of their inputs into the subsequent rounds of survey tools.

What are the possible benefits?

Your contribution to the Delphi study will help us to ensure that the revision of the EmONC framework better reflects the current global health landscape and, most importantly, the health system needs of women and newborns. The EmONC framework, widely used in LMIC health planning, has the potential to positively influence health services and subsequent health outcomes for mothers and newborns. Participating in this study helps us to ensure we make informed evidence-based recommendations for the revision of the EmONC framework and allows participants, most of whom will have an interest in the results of the study, to contribute their perspectives to the review, revise and rethink process.

What if something goes wrong?

If you have a concern about any aspect of this study, you should contact the researchers who will do their best to answer your questions and concerns.

Can I change my mind about taking part?

You can withdraw at any point, but information collected from previous rounds may still be used as it is not always possible to remove data from previous rounds when it has already been analysed and shared as part of the feedback for each round.

What will happen to information collected about me?

The information from this study will be analysed and synthesised for this research project. Your personal details, meaning your name and other identifiable information, will be kept in a different safe place to the other study information and will be destroyed within 10 years of the end of the study. At the end of the project, the study data will be archived in the LSHTM data repository <https://datacompass.lshtm.ac.uk/information.html>. Your personal information will not be included and there is no way that you can be identified.

What will happen to the results of this study?

The findings from the Delphi study will be synthesised as part of the Re-Visioning EmONC project and used to recommend a revised framework of signal functions. The study results will be written up as a report and may be written as a publication to be published in a global health journal as part of the study dissemination. You will be given the option for your name to be included in this publication as part of the expert group, but this is optional. If you participate in all rounds of the Delphi, the final draft manuscript will be shared with you and you will be given the option for your name to be included. Otherwise, your personal information will not be included in the study report and there is no way that you can be identified from it.

Who is organising and funding this study?

This study is funded by LSHTM through a subaward from the Bill and Melinda Gates Foundation to Columbia University Averting Maternal Death and Disability (AMDD) programme.

Who has reviewed this study?

This study has been reviewed and given favourable opinion by The London School of Hygiene and Tropical Medicine Research Ethics Committee (LSHTM Ethics Ref No. 26292).

Further information and contact details

Thank you for taking time to read this information sheet. If you think you will take part in the study please read and sign the online consent form before completing the questionnaire.

If you have any questions or require any further information, please contact Sarah Moxon sarah.moxon@lshtm.ac.uk

Statement	Please tick each of the following statements to proceed to the survey questions.
I confirm that I have read and understood the participant information about the modified Delphi study on obstetric and newborn care signal functions (sent in the invitation email). I have had the opportunity to consider the information.	
I understand that my consent is voluntary and that I am free to withdraw this consent at any time without giving any reason and without my legal rights being affected.	
I understand that information submitted in questionnaires will be transcribed and reviewed by researchers in the study and that directly identifiable details will be removed from this transcription for confidentiality.	
I understand that information that I submit in the questionnaires for this study will be used by researchers in the study and I give permission for these individuals to have access to my fully anonymised records.	
I understand that the study is carried out in a series of rounds and that if I withdraw in a later round of the study it won't be possible to withdraw information that was provided in previous rounds of the study.	
I agree that anonymised direct quotes from my responses may be used in the study report, publications and/or presentations on the results of this study.	
I understand that the anonymised data from this study will be stored in a data repository and that access to this data will only be provided at the discretion of the principal investigator by means of a request form.	
I agree to taking part in the above named study.	

Appendix 2. Recruitment survey invitation email

Subject line:

We welcome you to join our Delphi study on obstetric and newborn signal functions and levels of care

Dear Colleague,

Due to your expertise in maternal and newborn health, we invite you to take part in an online Delphi survey on obstetric and newborn signal functions and levels of care.

This consultation is part of the Re-Visioning Emergency Obstetric and Newborn Care (EmONC) project; an initiative to review, rethink, and revise the [Emergency Obstetric care \(EmOC\) monitoring framework](#). The project is coordinated by the Averting Maternal Death and Disability (AMDD) program at Columbia University Mailman School of Public Health, in collaboration with UNICEF, UNFPA, WHO and the London School of Hygiene & Tropical Medicine with the aim of creating a revised obstetric and newborn care framework with indicators, tools, and guidance that meet country needs.

*The Emergency Obstetric Care (EmOC) framework, originally published in 1997, is built around **signal functions**, categorised by two **levels of care**: basic and comprehensive. This common language for policy makers, measurement experts, clinicians and researchers has been enormously influential, but much has changed in the maternal and newborn health landscape since it was last revised in 2009.*

Using a Delphi survey format, the purpose of this study is to build consensus on obstetric and newborn care signal functions and organisation of levels of care in low- and middle-income countries. This round of the survey will take about 20-30+ minutes to complete. A modified survey, based on expert participants' input in this round, will then be returned to you twice over the next 3-6 months with the goal of reaching expert consensus.

We would be grateful for your contribution as an expert to the Re-Visioning EmONC project by participating in this Delphi survey process. Participants who complete all rounds of the survey will be offered collaborative group authorship on the resulting Delphi study publication.

Please complete the survey here:

English: <https://www.smartsurvey.co.uk/s/Round1EmONC/>

French: <https://www.smartsurvey.co.uk/s/SONUDelphiRIFR/>

Spanish: <https://www.smartsurvey.co.uk/s/AONUDelphiRIES/>

*by **6th December 2021.***

If you have any questions at any time, please feel free to get in touch.

Thank you and best regards,

*Dr Sarah Moxon, Dr Sudha Sharma and Dr Jalemba Aluvaala
On behalf of the Re-Visioning EmONC Steering Committee*

Appendix 3. Recruitment survey

The Re-Visioning EmONC Delphi Registration Survey

Thank you for showing an interest in our Delphi study on obstetric and newborn care signal functions and levels of care!

The 2009 WHO publication *Monitoring emergency obstetric care: A Handbook*[1] describes a set of connected indicators to measure and monitor the availability, utilization, and quality of emergency obstetric care (EmOC) in low- and middle-income countries. This framework is built around signal functions, which are a shortlist of nine key medical interventions that can "signal" the level of functionality of a health facility. Facilities are subsequently classified as having provided either basic emergency obstetric care (BEmOC) if they performed seven of the signal functions, or comprehensive emergency obstetric care (CEmOC) if they have performed all nine of the signal functions over a defined period. The framework has been enormously influential since the original publication. But much has changed in health systems and the maternal and newborn health landscape since then.

This Delphi study is part of the **Re-Visioning Emergency Obstetric and Newborn Care (EmONC) Project**, an initiative to review, rethink, and revise the EmOC monitoring framework. The Re-Visioning EmONC project is coordinated by the Averting Maternal Death and Disability (AMDD) program at Columbia University Mailman School of Public Health, in collaboration with the London School of Hygiene and Tropical Medicine, UNICEF, UNFPA, and WHO with the aim of creating a revised framework with indicators, tools, and guidance that meet country needs. The entire project is framed and implemented using principles of human-centered design to ensure that the revised framework meets the needs, quality of care standards and real world conditions at the national and sub-national policy level and at the frontlines of health systems in low- and middle-income countries.

The Delphi study on obstetric and newborn signal functions and levels of care is one part of this project. The aim of this Delphi study is to build consensus on the obstetric and newborn signal functions and their organisation across levels of care in low- and middle-income countries. The survey will generate input from clinical and maternal and newborn health experts from different fields and settings worldwide. The project is committed to integrating maternal and newborn care.

The Delphi Survey will include three or more sequential surveys, which will take an estimated 20-30+ minutes each to complete and will be sent out over a period of 3-6 months. Participants who complete **all rounds** of the survey will be offered group authorship on the resulting Delphi study publication.

We are looking for expert assistance with this process. If you would like to be involved, please fill in the following questions to tell us a little about yourself and your expertise for eligibility, to be contacted with the first round survey. All rounds of the survey will be available in English, French and Spanish.

Thanks!

Dr Sarah Moxon and Dr Sudha Sharma
On behalf of the Re-Visioning EmONC Steering Committee

The survey is coordinated by the London School of Hygiene & Tropical Medicine and Columbia University as part of the Re-visioning EmONC project, which is funded by a grant from The Bill and Melinda Gates Foundation.

[1] <https://www.who.int/reproductivehealth/publications/monitoring/9789241547734/en/>

2. Consent

Please complete the following: *

Yes No

I consent to provide my name, email address and other information requested in the following questions for the purpose of my possible inclusion in the Delphi study on EmONC signal functions and levels of care. This information will only be used by the survey team to assess my inclusion and to send me the survey. I understand that the information will be permanently deleted from stored files if I do not meet the inclusion criteria, if I inform the survey team that I do not wish to participate, and once the survey is complete.

☐ ☐

1. Have you ever, or do you currently work in Reproductive, Maternal, Newborn or Child Health (RMNCH)? *

☐

Yes

☐

No

4. Information about you

Name (First and Last) *

Email (please use the same email address in every survey you take part in) *

2. Are you a:
(select all that apply) *

- ☐ 1. Obstetrician-Gynaecologist
- ☐ 2. Neonatologist
- ☐ 3. Pediatrician
- ☐ 4. Physician/Medical Doctor
- ☐ 5. Nurse
- ☐ 6. Neonatal Nurse
- ☐ 7. Midwife
- ☐ 8. Associate Clinician/Clinical Officer
- ☐ 9. Researcher/Academic in Maternal Health
- ☐ 10. Researcher/Academic in Newborn Health
- ☐ 11. Technical Advisor in Reproductive, Maternal, Newborn or Child Health
- ☐ 12. Programme Manager in Reproductive, Maternal, Newborn or Child Health
- ☐ 13. Policy-maker/Planner in Reproductive, Maternal, Newborn or Child Health
- ☐ 14. Government Official
- ☐ 15. Clinical Trainer or Instructor
- ☐ 16. Other (please specify):

3. How many years of experience do you have working in RMNCH? *

- ☐ Less than 2 years
- ☐ 2-5 years
- ☐ 6-10 years
- ☐ 11-20 years
- ☐ More than 20 years

4. Are you trained as a clinician? *

- ☐ Yes
- ☐ No

5. Are you currently providing clinical care in Maternal and Newborn Health? *

- ☐ Yes
- ☐ No

6. In which type of setting(s) are you currently providing clinical care? *

- ☐ Community
- ☐ Health post
- ☐ Health centre
- ☐ Hospital
- ☐ Other (please specify):

7. In which sector do you provide clinical care? (select all that apply) *

☐

Public

☐

Private

8. Which WHO regions of the world do you have significant experience working in Maternal and Newborn Health? (select all that apply) *

☐

African Region

☐

Americas Region

☐

Eastern Mediterranean Region

☐

European Region

☐

South-East Asian Region

☐

Western Pacific Region

9. In which country do you have the most experience working in Maternal and Newborn Health? *

10. In which country are you currently based? *

11. Which settings have you worked in? *

☐

1. High-income country only

☐

2. Low and Middle-income country only

☐

3. A combination of High and Low and Middle-income countries

12. Please write the name of the primary institution where you are currently employed/affiliated:

13. Which language would you prefer to take the survey in? *

☐

English

☐

Spanish

☐

French

☐

Other (please specify):

14. To which gender identity do you most identify? *

☐

1. Female

☐

2. Male

☐

3. Transgender female

☐

4. Transgender male

☐

5. Prefer not to say

☐

6. Not listed, option to specify:

15. Any questions or comments?

Thank you so much for answering these questions!

If you meet the inclusion criteria, a member of the survey team will contact you by email with further information and a link to the first Delphi survey.

If you have any questions at any time, including how your data will be used and stored, please feel free to get in touch with Dr Sarah Moxon, (Sarah.Moxon@lshtm.ac.uk).

Appendix 4. Round one survey

Re-Visioning EmONC Delphi Survey Round 1

1. Introduction

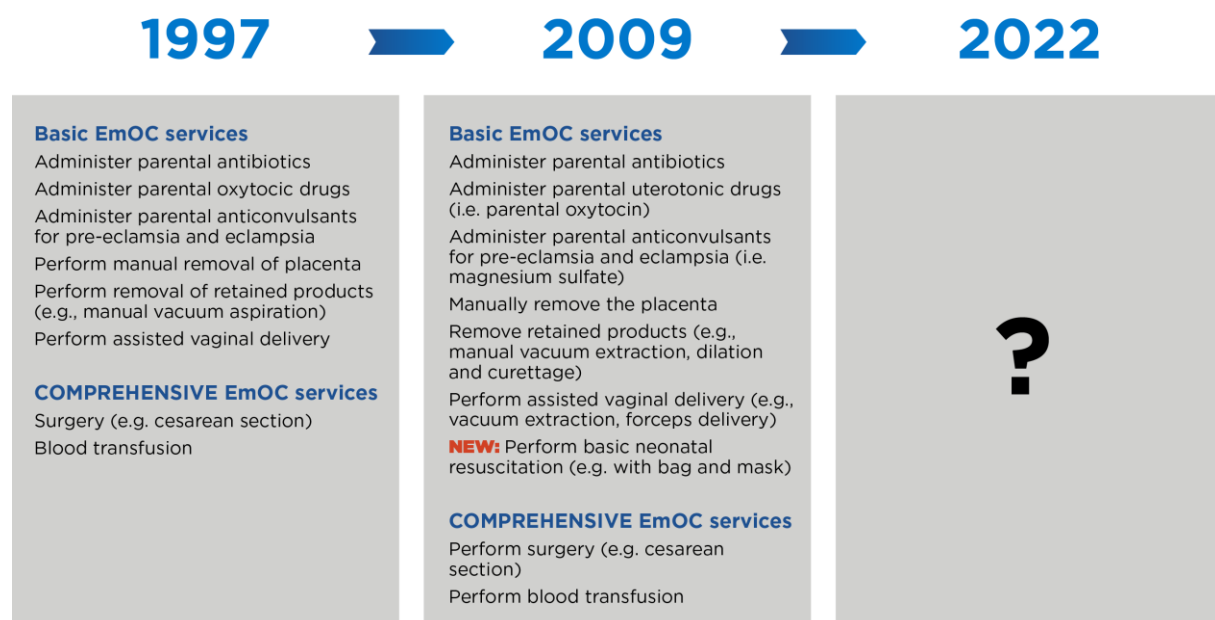
INTRODUCTION

Welcome to Round 1 of the Emergency Obstetric Newborn Care (EmONC) Delphi survey!

Background

Twenty-five years ago the novel emergency obstetric care (EmOC) framework provided for the first time guidelines for monitoring the availability and use of obstetric services. The set of connected indicators standardised measurement and monitoring of the availability, utilisation, and quality of EmOC in low- and middle-income countries (LMICs). The original EmOC framework, built around signal functions, categorised two levels of care: basic and comprehensive (Figure 1). This common language for policy makers, measurement experts, clinicians and researchers has been enormously influential. The 2009 update (Figure 1) led by Averting Maternal Death and Disability (AMDD) and UN agencies published Monitoring emergency obstetric care: A Handbook. Since then, the term "EmONC" has been adopted and the maternal and newborn health (MNH) landscape has continued to progress; this has included an increase in health facility delivery.

Figure 1. Basic and Comprehensive Emergency Obstetric Care (EmOC) signal functions from 1997 to present



Re-Visioning Emergency Obstetric and Newborn Care (EmONC) Project

The Re-Visioning Emergency Obstetric and Newborn Care (EmONC) Project is led by a Steering Committee coordinated by the Averting Maternal Death and Disability (AMDD) program at Columbia University Mailman School of Public Health, in collaboration with the London School of Hygiene & Tropical Medicine, UNICEF, UNFPA, and WHO. The overall aim is to create a revised framework for obstetric and newborn care with indicators,

tools, and guidance that can meet country needs in 2022 and beyond. Separate workstreams in the Re-Visioning EmONC project are looking in detail at: 1) signal functions; 2) levels of care; 3) quality of care, including potential new indicators on readiness and experience of care; and 4) the framework and indicators, as a connected set, informed by country case studies and global experience of their use.

The Delphi Survey

A Delphi study is a widely used methodology to build consensus among a panel of experts through a series of interrelated survey rounds. As part of the Re-Visioning EmONC project, this online Delphi survey (LSHTM Ethics Ref No. 26292) seeks to provide input specifically on the A) signal functions and B) levels of care for the framework. Due to your clinical and programme expertise in maternal and newborn health, you are being invited to join this Delphi survey to build consensus on an optimal (but adaptable) service delivery framework that integrates maternal and newborn care.

This online Delphi survey will include three or more rounds of interrelated surveys, which will be sent out over the next 3-6 months. Each round will take an estimated 20-30+ minutes to complete. Participants who complete all rounds of the survey will be offered collaborative group authorship on the resulting Delphi survey publication.

The first round of this Delphi survey includes open-ended questions that will invite you to share your opinion regarding:

Section A) Which aspects of maternal and newborn care that the revised signal functions should capture.

Section B) Which criteria should influence how levels of care for maternal and newborn care should be organised.

2. Consent

CONSENT FORM *

	Yes	No
I confirm that I have read and understood the participant information about the modified Delphi study on obstetric and newborn care signal functions and levels of care (sent in the invitation email). I have had the opportunity to consider the information.	☐	☐
I understand that my consent is voluntary and that I am free to withdraw this consent at any time without giving any reason and without my legal rights being affected.	☐	☐
I understand that information submitted in questionnaires will be transcribed and reviewed by researchers in the study and that directly identifiable details will be removed from this transcription for confidentiality.	☐	☐

	Yes	No
I understand that information that I submit in the questionnaires for this study will be used by researchers in the study and I give permission for these individuals to have access to my fully anonymised records.	☐	☐
I understand that the study is carried out in a series of rounds and that if I withdraw in a later round of the study it won't be possible to withdraw information that was provided in previous rounds of the study.	☐	☐
I agree that anonymised direct quotes from my responses may be used in the study report, publications and/or presentations on the results of this study.	☐	☐
I understand that the anonymised data from this study will be stored in a data repository and that access to this data will only be provided at the discretion of the principal investigator by means of a request form.	☐	☐
I consent to provide my email address for the purpose of this study, which will be used to contact me and identify my responses by the study team, and that my email will be deleted from stored files at the end of the study.	☐	☐
I agree to taking part in the above named study.	☐	☐

3. Contact Information

1. Have you ever, or do you currently work in Reproductive, Maternal, Newborn or Child Health (RMNCH)? *

☐ Yes

☐ No

Name (First and Last) *

Email (please use the same email address in every survey you take part in) *

SECTION A: Which aspects of maternal and newborn care should the revised signal functions capture?

SIGNAL FUNCTIONS – A RECAP

The term "signal functions", in this context, means a short list of key interventions intended to "signal" health system capability to deliver a certain level of care.

In 1997 the original list of EmOC signal functions was based on providing emergency obstetric care for complications in childbirth. At the time, most births in LMICs were at home and health facilities were mainly accessed for emergency obstetric care. Now in the sustainable development goal (SDG) era >80% of global births are in health facilities and guidelines and updated standards for improving the quality of care for women and newborns in LMICs have been published.

Newborn resuscitation was added as a signal function in 2009 (Figure 1), but it is widely accepted that a greater focus on newborn care is now needed. The Re-Visioning EmONC project aspires to reflect the need for synergy for women and newborns in facility capacity for high-quality, respectful care.

Re-Visioning Signal Functions

The existing EmOC signal functions (1997 and 2009) are based on providing emergency care for obstetric complications. The original signal functions are:

Inpatient clinical interventions or services (and therefore contain an action verb) e.g. "administer" (which assumes that minimum equipment, drugs and human resources are available)

Evidence based and/or based on up to date guidelines

Indicative of the level of care of a facility

Key to averting maternal mortality

Since the original EmOC signal functions were designed, poor quality of care has been recognised as a major contributor to the slow progress in ending preventable maternal and newborn death and disability, and stillbirths. Quality of care has two interrelated dimensions - provision of care and patient experience of care. Quality of care standards for maternal and newborn care and small and sick newborns are published that explicitly define what is required in order to achieve high-quality care.

The Re-Visioning EmONC project is committed to integrating maternal and newborn care in the revised list of signal functions.

The revised indicator set for the 2022 Re-Visioning EmONC project is expected to include signal functions and separate indicators for quality of care including experience of care as well as new indicators for facility readiness (e.g. infrastructure, referral, human resources).

In this Re-Visioning EmONC project, as well as integrating newborn care more fully, we also have the opportunity to re-visit signal functions and to consider covering aspects of care beyond the management of obstetric emergencies.

2. Type of care

For 2022 onwards, signal functions should cover these types of care (tick all that you think apply). For each one ticked please give your rationale in the comments box below. *

☐

Emergency care for women and newborns

☐

Routine care for women and newborns, including detection and prevention of complications

Comments:

3. Type of interventions

Signal functions should cover these types of care (tick all that you think apply). For each one ticked please give your rationale in the comments box below.*

☐

Clinical interventions or services (e.g. medical treatments/drugs or procedures) for women and newborns

☐

Non-clinical interventions or services (e.g. include broader dimensions of facility-based care such as organisation of referral) for women and newborns

Comments:

4. Timing of care

Signal functions should cover these areas of care (tick all that you think apply). For each one ticked please give your rationale in the comments box below. *

☐

Intrapartum care (for both women and newborns)

☐

Care during pregnancy

☐

Postnatal care (for both women and newborns)

☐

Care for small and sick newborns

☐

Post abortion care

☐

Other (please specify):

Comments:

5. If we maintain current assumptions based on signal functions as interventions/services to treat complications:

a) Which priority complications for women should be included? (Include as many as you wish)

b) Which priority complications for newborns should be included? (Include as many as you wish)

SECTION B. Which criteria should influence how levels of maternal and newborn care should be organised

The original EmOC signal function framework (1997 and 2009) was based on two levels of care, basic and comprehensive. These levels reflected health system capability to deliver care determined by signal functions of interventions to treat complications: eight obstetric and one neonatal. These two levels of facility care also broadly correspond to competencies for midwives (basic EmOC) or physicians (comprehensive EmOC).

Levels of care can be organised around interventions/signal functions or other criteria. The Re-Visioning EmONC project is committed to exploring an optimal configuration of levels of care both within and between health facilities for both women and newborns.

6. If you think about defining levels of care for women and newborns, which important health system criteria should be considered?

Are interventions/signal functions sufficient to differentiate levels of care or which other criteria should be considered?

7. Linkage between maternal and newborn levels of care

The 2009 signal function framework has maternal and newborn signal functions grouped together for levels of care.

Should the revised 2022 framework group maternal and newborn signal functions together or separately for levels of care? Please explain your rationale in the comments box. *

☐

Together

☐

Separately

☐

No preference

Comments:

8. Current levels of care for women and newborns in national health systems

Think about the levels in your national health system (or a system you are very familiar with). Some countries have 2 or 3 levels, others have 6 or more.

Please describe how many levels of care there are in the setting you work in or know best and fill in one criterion of care for women and one for newborns that is used to designate these levels. Please name the levels beginning with level 1 as the lowest health system level, then level 2 as the next level up until all levels are numbered.

Please add any comments in the comments box below the table.

Name of level	Women	Newborn

Comments:

9. Optimal configuration of levels of care

Newborn care levels have recently been envisaged with 3 levels plus a transitional level between levels 2 and 3 (Figure 2). Transition means delivering more care than a lower level, but not all the care required to classify as a higher level of care.

Figure 2. Newborn care interventions by health system levels

Level 1: Primary care	<p>Immediate newborn care (e.g. delayed cord clamping, drying, skin-to-skin contact), neonatal resuscitation when necessary, early initiation and support for breastfeeding.</p> <p>Essential newborn care, identification and referral of complications, targeted care as necessary (e.g. prevention of mother-to-child transmission of HIV).</p>
Level 2: Secondary care	<p>Thermal care, including Kangaroo Mother Care for all stable neonates weighing < 2000g, assisted feeding and intravenous fluids, safe administration of oxygen, detection and management of neonatal sepsis with injected antibiotics, detection and management of neonatal jaundice with phototherapy, detection and management of neonatal encephalopathy, detection of congenital abnormalities and referral or management of birth defects.</p> <p>Transitional care, including management of preterm respiratory distress with continuous positive airway pressure, follow-up of at-risk newborns, exchange transfusion.</p>
Level 3: Tertiary care	<p>Mechanical assisted ventilation, advanced feeding support (for example, parenteral nutrition), investigation of and treatment for congenital conditions, screening for and treatment of retinopathy of prematurity.</p>

Source: World Health Organization. Survive and Thrive Transforming care for every small and sick newborn. 2019.

<https://apps.who.int/iris/bitstream/handle/10665/326495/9789241515887-eng.pdf>(accessed 25 Jan 2021).

What is the optimal number of levels of care for women and newborns with complications?
Please give your rationale in the comments box below. *

☐

2 levels

☐

3 levels

☐

3 levels plus one transition level between level 2 and level 3 (total 4 levels)

☐

3 levels plus one transition level between level 2 and level 3 and one transition between level 1 and 2 (total 5 levels)

☐

More levels- please specify how many levels below

Comments:

8. Information about you

To ensure that our survey includes a diverse panel of experts, please complete the section below to tell us a bit about yourself.

10. Are you a:
(select all that apply) *

☐

1. Obstetrician-Gynaecologist

☐

2. Neonatologist

☐

3. Paediatrician

☐

4. Physician/Medical Doctor

☐

5. Nurse

☐

6. Neonatal Nurse

- ☐ 7. Midwife
- ☐ 8. Associate Clinician/Clinical Officer
- ☐ 9. Researcher/Academic in Maternal Health
- ☐ 10. Researcher/Academic in Newborn Health
- ☐ 11. Technical Advisor in Reproductive, Maternal, Newborn or Child Health
- ☐ 12. Programme Manager in Reproductive, Maternal, Newborn or Child Health
- ☐ 13. Policy-maker/Planner in Reproductive, Maternal, Newborn or Child Health
- ☐ 14. Government Official
- ☐ 15. Clinical Trainer or Instructor
- ☐ 16. Other (please specify):
-

11. How many years of experience do you have working in RMNCH? *

- ☐ Less than 2 years
- ☐ 2-5 years
- ☐ 6-10 years
- ☐ 11-20 years
- ☐ More than 20 years

12. Are you trained as a clinician? *

- ☐ Yes

☐

No

13. Are you currently providing clinical care in Maternal and Newborn Health? *

☐

Yes

☐

No

14. In which type of setting(s) are you currently providing clinical care? *

☐

Community

☐

Health post

☐

Health centre

☐

Hospital

☐

Other (please specify):

15. In which sector do you provide clinical care? (select all that apply) *

☐

Public

☐

Private

16. Which WHO regions of the world do you have significant experience working in Maternal and Newborn Health? (select all that apply) *

☐

African Region

☐

Americas Region

☐

Eastern Mediterranean Region

☐ European Region

☐ South-East Asian Region

☐ Western Pacific Region

17. In which country do you have the most experience working in Maternal and Newborn Health? *

18. In which country are you currently based? *

19. Which settings have you worked in? *

☐ 1. High-income country only

☐ 2. Low and Middle-income country only

☐ 3. A combination of High and Low and Middle-income countries

20. Please write the name of the primary institution where you are currently employed/affiliated:

21. To which gender identity do you most identify? *

☐ 1. Female

☐ 2. Male

☐ 3. Transgender female

☐ 4. Transgender male

☐ 5. Prefer not to say

☐

6. Not listed, option to specify:

Thank you so much for completing the Round 1 Survey!

We will email you a link to the Round 2 Survey in the next 1-2 months. If you have any questions, please contact: Sarah.Moxon@lshtm.ac.uk.

Best regards,

Dr Sarah Moxon and Dr Sudha Sharma

On behalf of the EmONC Steering Committee

Appendix 5. Round two survey

Delphi study on obstetric and newborn signal functions and levels of care: ROUND 2

1. Introduction

Delphi study on obstetric and newborn care signal functions for the Re-Visioning Emergency Obstetric and Newborn care (EmONC) Project

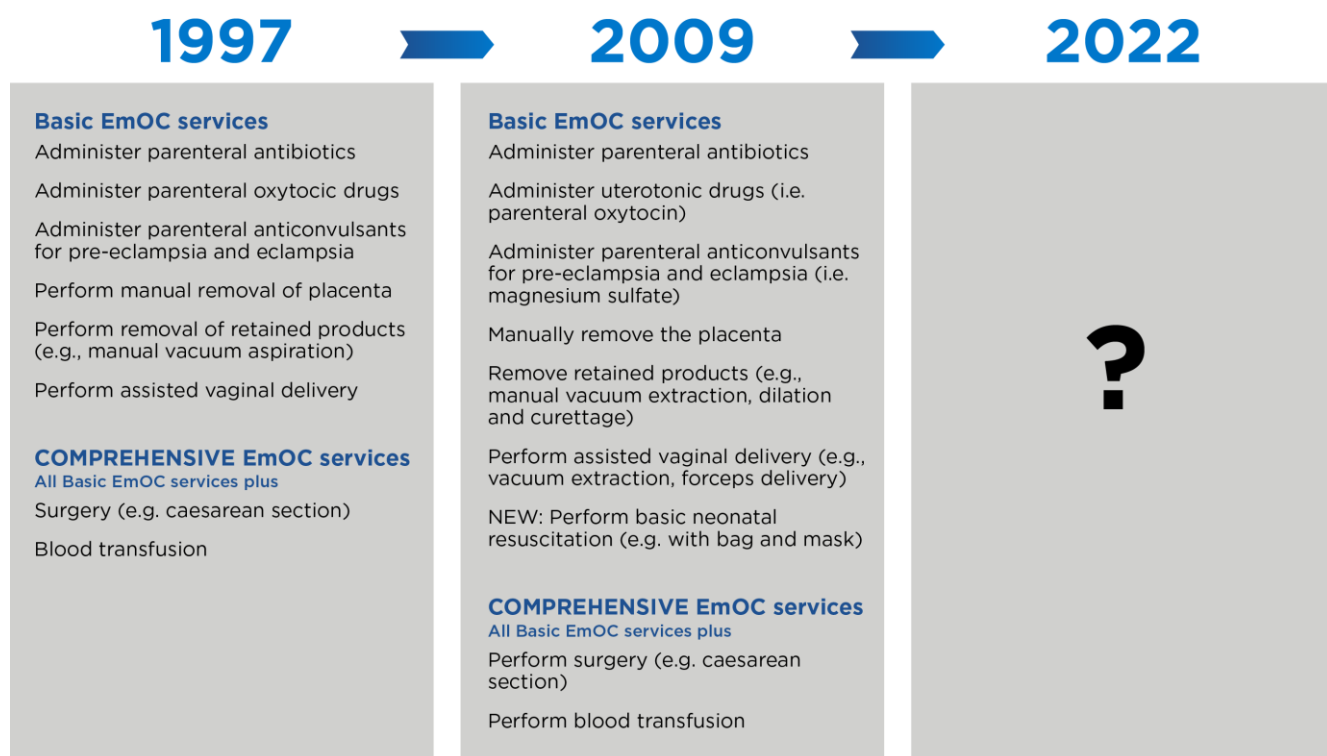
Thank you for your participation in round one of the Delphi study on obstetric and newborn care signal functions and levels of care for the Re-Visioning EmONC project. In total, 212 experts participated, sharing many insightful responses and comments.

Welcome to Round Two!

Background

Twenty-five years ago, the novel emergency obstetric care (EmOC) framework provided for the first time **guidelines** for monitoring the availability and use of obstetric services. The set of connected indicators standardised measurement and monitoring of the availability, utilisation, and quality of EmOC in low- and middle-income countries (LMICs). The original EmOC framework, built around ***signal functions***, categorised two ***levels of care***: basic and comprehensive (Figure 1). This common language for policy makers, program planners, measurement experts, clinicians and researchers has been enormously influential. Since then, the term "EmONC" has been adopted and the maternal and newborn health (MNH) landscape has continued to progress; this has included an increase in health facility delivery.

Figure 1. Basic and Comprehensive Emergency Obstetric Care (EmOC) signal functions from 1997 to present



The Re-Visioning Emergency Obstetric and Newborn Care (EmONC) Project

The Re-Visioning Emergency Obstetric and Newborn Care (EmONC) Project is led by a Steering Committee coordinated by the Averting Maternal Death and Disability (AMDD) program at Columbia University Mailman School of Public Health, in collaboration with UNICEF, UNFPA, WHO and the London School of Hygiene & Tropical Medicine. The overall aim is to create a revised framework for obstetric and newborn care with indicators, tools, and guidance that can meet country needs in 2022 and beyond.

The Delphi study

A Delphi study is a widely used methodology to build consensus among a panel of experts through a series of interrelated survey rounds; this is round two of what we expect to be a total of three rounds. As part of the Re-Visioning EmONC project, the overall aim of this Delphi study (LSHTM Ethics Ref No. 26292) is to build consensus on maternal and newborn signal functions and levels of care for a revised EmONC framework.

Round Two of the Delphi Survey

Round two of this Delphi study is focused on **prioritising obstetric and newborn emergency signal functions** for the revised EmONC framework. We will provide a clear definition of signal functions and their desired characteristics and ask you to select priority emergency signal functions for the revised framework based on these.

The content presented for this round of the Delphi is grounded in the results from the first round of this Delphi study, as well as background work, which was refined during a Re-Visioning EmONC technical workshop in May 2022.

What are emergency signal functions?

Emergency signal functions are: **a parsimonious list of clinical tracer interventions, representing key processes of care, to treat the main complications of childbirth that would otherwise result in maternal or newborn death and disability, or stillbirth.** They are a simple measure of ***whether the facility performed the function.*** Signal functions are usually captured through surveys and/or routine data collection processes at the facility level.

What else will be in the revised EmONC framework?

Emergency signal functions will be used as part of the revised EmONC framework to monitor the availability of emergency obstetric services and small and sick newborn care. The framework will also include additional input indicators such as infrastructure, drugs, and equipment, as well as output and outcome indicators that assess access and quality, including experience of care. Routine care signal functions such as essential newborn care and active management of third stage of labour (AMTSL) will also be included as a separate domain of the revised framework, but are not included in this round, which focuses on emergency signal functions. **All these additional indicators are not part of the signal functions being addressed in this Delphi round two, which focuses only on emergency care signal functions.**

What are the key characteristics of emergency obstetric and newborn signal functions?

An ideal obstetric and newborn care emergency signal function for the revised framework should be:

- ☐ **CRITICAL:** The signal function should represent a clinical intervention or service performed by health workers to manage one or more complication(s) that would otherwise result in major cause/s of maternal or newborn death and disability, or stillbirth.
- ☐ **a TRACER:** Performance of the intervention or service ideally indicates that multiple other components of treatment or aspects of care are also present (e.g., performance of surgery generally indicates the availability of anaesthesia).
- ☐ **FREQUENT:** The intervention or service should be performed often enough to reflect ongoing performance or functionality of the facility.
- ☐ **SIMPLE:** Not necessarily simple to perform, but the intervention or service should be clearly and operationally defined and feasible to measure reliably across contexts.*

*For new signal functions (especially some newborn signal functions) it might be several years before they can be measured reliably in many contexts, therefore, the proposed signal function should be a clearly defined intervention such that in future it can be measured reliably across contexts.

2. Your information

Name (First and Last, as you entered it in the round one survey): *

Email (please use the same email address that you used in the round one survey): *

In the past, for which purpose(s) have you used the EmONC framework? Please describe in the comments box below. *

3. Please select your sections

The first section presents the proposed emergency obstetric care signal functions, the second section presents the small and sick newborn signal functions. Click to select the section(s) you would like to complete. *

☐

Obstetric

☐

Newborn

☐

Obstetric and newborn

Emergency obstetric care signal functions

As you review these emergency signal functions, consider the following context:

Imagine you are working in a managerial or planning role at a district hospital in a low- or middle-income setting that you know well. The facility has a delivery caseload of at least 1000 births per year. There is a labour and delivery ward, an obstetric surgery operating room, and a neonatal unit. Think about the type of supplies, equipment, and staffing capacity typically available as well as some of the regular challenges facing the facility in this context.

Listed below are ***emergency obstetric signal functions***. Choose the nine most important emergency signal functions for the low- and middle income facility context you imagined. While prioritising, consider the key characteristics of a signal function for the revised framework as defined below:

CRITICAL: The signal function should represent a clinical intervention or service performed by health workers to manage one or more complication(s) that would otherwise result in major cause/s of maternal or newborn death and disability, or stillbirth.

a TRACER: Performance of the intervention or service ideally indicates that multiple other

components of treatment or aspects of care are also present (e.g., performance of surgery generally indicates the availability of anaesthesia).

FREQUENT: The intervention or service should be performed often enough to reflect ongoing performance or functionality of the facility.

SIMPLE: Not necessarily simple to perform, but the intervention or service should be clearly and operationally defined and feasible to measure reliably across contexts.*

*For new signal functions (especially some newborn signal functions) it might be several years before they can be measured reliably in many contexts, therefore, the proposed signal function should be a clearly defined intervention such that in future it can be measured reliably across contexts.

1. Drag and drop (or number) the top nine signal functions that you think should be prioritised for the revised EmONC framework based on the information above. The numbers 1-9 will be used to count your top nine signal functions, not to rank them in order of importance.

The document attached to your email invitation contains a table with additional information for each proposed signal function. You can also view the document using this QR code:

Drag and drop (or number) your top nine below: *

Administer parenteral antibiotics (e.g. ampicillin, gentamicin) (maternal)	<input type="text"/>
Administer appropriate medications to treat post-partum haemorrhage (PPH) (appropriate medications in the algorithm for PPH e.g. oxytocin or ergometrine (or combination of oxytocin and ergometrine), or oral misoprostol, or prostaglandin or heat stable carboprost or tranexamic acid).	<input type="text"/>
Administer magnesium sulfate for pre-eclampsia or eclampsia	<input type="text"/>
Administer maternal antihypertensives (e.g. alpha methyl dopa, hydralazine, labetalol, nifedipine)	<input type="text"/>
Provide intravenous (IV) infusion/IV fluid replacement therapy (e.g. maternal resuscitation)	<input type="text"/>
Perform manual uterine exploration and removal of placenta	<input type="text"/>
Perform removal of retained products of conception (e.g. manual vacuum aspiration), dilation and curettage, medical management)	<input type="text"/>
Perform assisted vaginal birth (e.g. vacuum extractor, forceps)	<input type="text"/>
Perform blood transfusion	<input type="text"/>
Perform caesarean section	<input type="text"/>
Perform mechanical ventilation	<input type="text"/>
Provide high dependency/intensive-care	<input type="text"/>

Provision of continued emergency clinical obstetric and newborn care during interfacility transfer

☐

Is there an additional emergency obstetric signal function that you think is essential to add? If so, please list below.

Do you have any comments/suggestions on the wording of any of the signal functions?

Small and Sick Newborn Care Signal Functions

As you review these small and sick newborn care signal functions, consider the following context:

Imagine you are working in a managerial or planning role at a district hospital in a low- or middle-income setting that you know well. The facility has a delivery caseload of at least 1000 births per year. There is a labour and delivery ward, an obstetric surgery operating room, and a neonatal unit. Think about the type of supplies, equipment, and staffing capacity typically available as well as some of the regular challenges facing the facility in this context.

Listed below are *small and sick newborn signal functions*. Choose the nine most important signal functions for the LMIC facility context you imagined. While prioritising, consider the key characteristics of a signal function for the revised framework as defined below:

CRITICAL: The signal function should represent a clinical intervention or service performed by health workers to manage one or more complication(s) that would otherwise result in major cause/s of maternal or newborn death and disability, or stillbirth.

a TRACER: Performance of the intervention or service ideally indicates that multiple other components of treatment or aspects of care are also present (e.g., performance of surgery generally indicates the availability of anaesthesia).

FREQUENT: The intervention or service should be performed often enough to reflect ongoing performance or functionality of the facility.

SIMPLE: Not necessarily simple to perform, but the intervention or service should be clearly and operationally defined and feasible to measure reliably across contexts.*

*For new signal functions (especially some newborn signal functions) it might be several years before they can be measured reliably in many contexts, therefore, the proposed signal function should be a clearly defined intervention such that in future it can be measured reliably across contexts.

2. Drag and drop (or number) the top nine signal functions that you think should be prioritised for the revised EmONC framework based on the information above. The numbers 1-9 will be used to count your top nine signal functions, not to rank them in order of importance.

The document attached to your email invitation contains a table with additional information for each proposed signal function. You can also view the document using this QR code:

Drag and drop (or number) your top nine below: *

Administer antenatal corticosteroids (ACS) (e.g. dexamethasone, betamethasone) to women at risk of preterm birth

Administer magnesium sulfate to women at risk of preterm birth

Perform neonatal resuscitation with bag and mask

Initiate kangaroo mother care (for LBW/preterm newborns)

Administer oxygen therapy with pulse oximetry

Administer parenteral antibiotics (e.g. gentamicin, ampicillin) (newborn)

Perform assisted feeding with expressed breastmilk (e.g. cup and/or nasogastric feeding)

Administer phototherapy for hyperbilirubinemia (jaundice)

Administer parenteral anticonvulsants for seizures (newborn) (e.g. phenobarbitone)

Perform blood transfusion (newborn)

Administer CPAP (newborn)

Perform services for retinopathy of prematurity

Administer intravenous (IV) fluids (newborn)

Provide thermal care (e.g. radiant warmer, incubator, heated cot) for preterm/LBW newborns

Administer methylxanthines (e.g. caffeine) for preterm newborns for prevention and treatment of apnoea

Provision of continued emergency clinical obstetric and newborn care during interfacility transfer

Is there an additional small and sick newborn signal function that you think is essential to add? If so, please list below.

Do you have any comments/suggestions on the wording of any of the signal functions?

Emergency obstetric care signal functions

As you review these emergency signal functions, consider the following context:

Imagine you are working in a managerial or planning role at a district hospital in a low- or middle-income setting that you know well. The facility has a delivery caseload of at least 1000 births per year. There is a labour and delivery ward, an obstetric surgery operating room, and a neonatal unit. Think about the type of supplies, equipment, and staffing capacity typically available as well as some of the regular challenges facing the facility in this context.

Listed below are ***emergency obstetric signal functions***. Choose the nine most important emergency signal functions for the low- or middle-income facility context you imagined. While prioritising, consider the key characteristics of a signal function for the revised framework as defined below:

CRITICAL: The signal function should represent a clinical intervention or service performed by health workers to manage one or more complication(s) that would otherwise result in major cause/s of maternal or newborn death and disability, or stillbirth.

a TRACER: Performance of the intervention or service ideally indicates that multiple other components of treatment or aspects of care are also present (e.g., performance of surgery generally indicates the availability of anaesthesia).

FREQUENT: The intervention or service should be performed often enough to reflect ongoing performance or functionality of the facility.

SIMPLE: Not necessarily simple to perform, but the intervention or service should be clearly and operationally defined and feasible to measure reliably across contexts.*

*For new signal functions (especially some newborn signal functions) it might be several years before they can be measured reliably in many contexts, therefore, the proposed signal function should be a clearly defined intervention such that in future it can be measured reliably across contexts.

3. Drag and drop (or number) the top nine signal functions that you think should be prioritised for the revised EmONC framework based on the information above. The numbers 1-9 will be used to count your top nine signal functions, not to rank them in order of importance.

The document attached to your email invitation contains a table with additional information for each proposed signal function. You can also view the document using this QR code:
 Drag and drop (or number) your top nine below: *

Administer parenteral antibiotics (e.g. ampicillin, gentamicin) (maternal)	<input type="text"/>
Administer appropriate medications to treat post-partum haemorrhage (PPH) (appropriate medications in the algorithm for PPH e.g. oxytocin or ergometrine (or combination of oxytocin and ergometrine), or oral misoprostol, or prostaglandin or heat stable carbetocin or tranexamic acid).	<input type="text"/>
Administer magnesium sulfate for pre-eclampsia or eclampsia	<input type="text"/>
Administer maternal antihypertensives (e.g. alpha methyldopa, hydralazine, labetalol, nifedipine)	<input type="text"/>
Provide intravenous (IV) infusion/IV fluid replacement therapy (e.g. maternal resuscitation)	<input type="text"/>
Perform manual uterine exploration and removal of placenta	<input type="text"/>
Perform removal of retained products of conception (e.g. manual vacuum aspiration, dilation and curettage, medical management)	<input type="text"/>
Perform assisted vaginal birth (e.g. vacuum extractor, forceps)	<input type="text"/>
Perform blood transfusion	<input type="text"/>
Perform caesarean section	<input type="text"/>
Perform mechanical ventilation	<input type="text"/>
Provide high dependency/intensive-care	<input type="text"/>
Provision of continued emergency clinical obstetric and newborn care during interfacility transfer	<input type="text"/>

Is there an additional emergency obstetric signal function that you think is essential to add? If so, please list below.

Do you have any comments/suggestions on the wording of any of the signal functions?

Small and Sick Newborn Care Signal Functions

As you review these small and sick newborn signal functions, consider the following context:

Imagine you are working in a managerial or planning role at a district hospital in a low- or middle-income setting that you know well. The facility has a delivery caseload of at least 1000 births per year. There is a labour and delivery ward, an obstetric surgery operating room, and a neonatal unit. Think about the type of supplies, equipment, and staffing capacity typically available as well as some of the regular challenges facing the facility in this context.

Listed below are ***small and sick newborn signal functions***. Choose the nine most important emergency signal functions for the low- or middle-income facility context you imagined. While prioritising, consider the key characteristics of a signal function for the revised framework as defined below:

CRITICAL: The signal function should represent a clinical intervention or service performed by health workers to manage one or more complication(s) that would otherwise result in major cause/s of maternal or newborn death and disability, or stillbirth.

a TRACER: Performance of the intervention or service ideally indicates that multiple other components of treatment or aspects of care are also present (e.g., performance of surgery generally indicates the availability of anaesthesia).

FREQUENT: The intervention or service should be performed often enough to reflect ongoing performance or functionality of the facility.

SIMPLE: Not necessarily simple to perform, but the intervention or service should be clearly and operationally defined and feasible to measure reliably across contexts.*

*For new signal functions (especially some newborn signal functions) it might be several years before they can be measured reliably in many contexts, therefore, the proposed signal function should be a clearly defined intervention such that in future it can be measured reliably across contexts.

4. Drag and drop (or number) the top nine signal functions that you think should be prioritised for the revised EmONC framework based on the information above. The numbers 1-9 will be used to count your top nine signal functions, not to rank them in order of importance.

The document attached to your email invitation contains a table with additional information for each proposed signal function. You can also view the document using this QR code:

Drag and drop (or number) your top nine below: *

Administer antenatal corticosteroids (ACS) (e.g. dexamethasone, betamethasone) to women at risk of preterm birth

Administer magnesium sulfate to women at risk of preterm birth

Perform neonatal resuscitation with bag and mask	☐
Initiate kangaroo mother care (for LBW/preterm newborns)	☐
Administer oxygen therapy with pulse oximetry	☐
Administer parenteral antibiotics (e.g. gentamicin, ampicillin) (newborn)	☐
Perform assisted feeding with expressed breastmilk (e.g. cup and/or nasogastric feeding)	☐
Administer phototherapy for hyperbilirubinemia (jaundice)	☐
Administer parenteral anticonvulsants for seizures (newborn) (e.g. phenobarbitone)	☐
Perform blood transfusion (newborn)	☐
Administer CPAP (newborn)	☐
Perform services for retinopathy of prematurity	☐
Administer intravenous (IV) fluids (newborn)	☐
Provide thermal care (e.g. radiant warmer, incubator, heated cot) for preterm/LBW newborns	☐
Administer methylxanthines (e.g. caffeine) for preterm newborns for prevention and treatment of apnoea	☐
Provision of continued emergency clinical obstetric and newborn care during interfacility transfer	☐

Is there an additional small and sick newborn signal function that you think is essential to add? If so, please list below.

Do you have any comments/suggestions on the wording of any of the signal functions?

Thank you so much for completing the round two survey!

Participants who complete all rounds of the survey will be offered collaborative group authorship on the resulting Delphi survey publication.

Once analysis of round two is complete, we will contact you with a link to the round three

survey. If you have any questions, please contact: Sarah.Moxon@lshtm.ac.uk.

Best regards,

Dr Sarah Moxon, Dr Sudha Sharma and Dr Jalemba Aluvaala

On behalf of the Re-Visioning EmONC Project Steering Committee

Appendix 6: EmONC Signal Functions for Delphi R2

Obstetric signal functions

Historical status	Signal function	Measurement through interview with in-charge and/or cross checking through register review and/or patient records	Intervention description
Existing (basic & comprehensive)	Administer parenteral* antibiotics (e.g. ampicillin, gentamicin) (maternal)	In the last...has the facility administered parenteral antibiotics for suspected or confirmed maternal infection?	Parenteral antibiotics are used for suspected or established severe maternal infection or maternal sepsis (e.g., reproductive tract infection following abortion or childbirth). Their use is also recommended in cases of maternal generalised bacteraemia and septicaemia.
Existing (basic & comprehensive)	Administer appropriate medications to treat post-partum haemorrhage (PPH) (appropriate medications in the algorithm for PPH e.g. oxytocin or ergometrine (or combination of oxytocin and ergometrine), or oral misoprostol, or prostaglandin or heat stable carbetocin or tranexamic acid).	In the last...has the facility administered appropriate medications to prevent or treat excessive bleeding after delivery?	Uterotonics (oxytocin alone as the first choice) are used to treat PPH most commonly caused by atonic uterus. They can also be used to treat bleeding after an incomplete late abortion along with other definitive treatment. In settings where oxytocin is unavailable, the use of other injectable uterotonics (if appropriate ergometrine or the fixed drug combination of oxytocin and ergometrine) or oral misoprostol is recommended. The use of tranexamic acid is recommended for the treatment of PPH if oxytocin and other uterotonics fail to stop bleeding or if it is thought that the bleeding may be partly due to trauma. Heat stable carbetocin can also be used in certain contexts.
Existing (basic & comprehensive)	Administer magnesium sulfate for pre-eclampsia or eclampsia	In the last...has the facility administered magnesium sulfate for severe preeclampsia/eclampsia?	Magnesium sulfate is given to women diagnosed with severe pre-eclampsia or eclampsia to prevent and treat convulsions.
New	Administer maternal antihypertensives (e.g.	In the last...has the facility administered an	Antihypertensives are used to manage both gestational and

	alpha methyldopa, hydralazine, labetalol, nifedipine)	appropriate antihypertensive for severe preeclampsia or eclampsia?	chronic hypertension. For women diagnosed with severe pre-eclampsia or eclampsia where blood pressure remains high, antihypertensives are administered by IV route, orally or sublingually.
New	Provide intravenous (IV) infusion/IV fluid replacement therapy (e.g. maternal resuscitation)	In the last...has the facility administered IV fluids in labour or in the postpartum period to treat shock?	Intravenous replacement fluids in labour as replacement therapy or in the postpartum period to treat shock are the first-line treatment for hypovolaemia due to haemorrhage (antepartum/post-partum), sepsis or other cause. In case of post-partum haemorrhage it maintains the circulation whilst interventions to control bleeding are performed and assessment for whether blood transfusion is needed.
Existing (basic & comprehensive)	Perform manual uterine exploration and removal of placenta	in the last...has the facility performed manual uterine exploration and manual removal of retained placenta?	This procedure addresses retained placenta or fragments of the placenta. It entails full antiseptic procedure, pain relief, and insertion of gloved hand into the uterus to locate the edge of the placenta, separating the placenta in its entirety from the uterine wall and removing it.
Existing (basic & comprehensive)	Perform removal of retained products of conception (POC) (e.g. manual vacuum aspiration (MVA), dilation and curettage (D&C), medical management)	In the last...has the facility performed MVA or D&C for removing retained products of conception?	Retained POC can occur as a result of an incomplete spontaneous or induced abortion. MVA procedure entails inserting an appropriate sized cannula into the uterus, creating vacuum in a plastic syringe, connecting it to the cannula and removing the POC with gentle aspiration using a rotating movement. POC can also be removed by dilatation of cervix and curettage with a sharp curette but MVA is a comparatively safer procedure.
Existing (basic & comprehensive)	Perform assisted vaginal birth (e.g. vacuum extractor, forceps)	In the last...has the facility performed assisted vaginal delivery for any maternal or fetal indication?	This procedure is performed during the second stage of labour to deliver the baby for indications of fetal distress or prolonged second stage of labour. Prerequisite conditions are a skilled health provider, the cervix is fully dilated and fetal head has descended sufficiently.
Existing (comprehensive)	Perform blood transfusion	In the last...has the facility performed blood transfusion for any maternal indication?	The need for the transfusion of whole blood or blood products can occur due to antepartum or postpartum haemorrhage leading to shock, loss of a large volume of blood such as with ruptured ectopic pregnancy or at operative birth, coagulation disorders or

			severe anaemia late in pregnancy.
Existing (comprehensive)	Perform caesarean section	In the last...has the facility performed caesarean section for any maternal or fetal indication?	Caesarean section is performed for multiple maternal and fetal indications that commonly include prolonged or obstructed labour, fetal distress, malpresentation or placenta previa. It is assumed that if caesarean section is performed the facility is also capable of providing anaesthesia.
New	Perform mechanical ventilation	In the last...has the facility treated any pregnant or postpartum woman in the high dependency or intensive care unit with mechanical ventilation?	Assisted ventilation may be needed in cases of respiratory failure due to severe life threatening condition/s during pregnancy or in the postpartum period. This is usually provided in the intensive care unit along with other supportive measures.
New	Provide high dependency/intensive-care	In the last...has the facility treated any pregnant or postpartum woman in the high-dependency or intensive care unit?	Critically ill pregnant women need multi-organ support to prevent mortality and morbidity. This is best provided in a high-dependency/ intensive care unit with nurses/midwives and doctors with intensive care skills.

* Parenteral includes administration of a drug through the intravenous route or as intra-muscular injections.

Content above has been adapted from:

World Health Organization, UNFPA, UNICEF. *Managing Complications in Pregnancy and Childbirth: a guide for midwives and doctors* – 2nd edition, Geneva: World Health Organization; 2017. Licence: CC BY-NC-SA 3.0 IGO.

Referral signal function for obstetric and newborn care

New	Provision of continued emergency clinical obstetric and newborn care during interfacility transfer	In the last... has the facility coordinated transport with a clinically trained health worker (and adequate equipment) to ensure ongoing provision of emergency obstetric and newborn care during transfer between facilities?	Continued emergency clinical obstetric and neonatal care during interfacility transfer refers to transport of obstetric and newborn patients with a clinically trained health worker and adequate equipment to ensure ongoing provision of emergency care during transfer between facilities.
-----	---	--	---

* Parenteral includes administration of a drug through the intravenous route or as intra-muscular injections.

Newborn signal functions

Historical status	Signal function	Measurement through interview with in-charge and/or cross checking through register review and/or patient records	Intervention description/definition
New	Administer antenatal	In the last...has the facility administered ACS	The administration of ACS to women at risk of imminent

	corticosteroids (ACS) (e.g. dexamethasone, betamethasone) to women at risk of preterm birth	(dexamethasone, betamethasone) to women at risk of imminent preterm birth to stimulate fetal lung maturation?	preterm birth is used to stimulate fetal lung maturation and refers to dexamethasone or betamethasone administered by intramuscular injection for women at risk of imminent preterm birth (anticipated within the subsequent 7 days) from 24 weeks to 34 weeks gestation according to WHO guidelines. The recommendation is that ACS is only offered at a level where resuscitation, thermal care, feeding support, infection treatment and safe oxygen are available. ACS are contraindicated for women with chorioamnionitis.
New	Administer magnesium sulfate to women at risk of preterm birth	In the last...has the facility administered magnesium sulfate to women at risk of preterm birth for fetal neuroprotection?	The use of magnesium sulfate is recommended for women at risk of imminent preterm birth before 32 weeks of gestation for prevention of cerebral palsy in the infant and child. Magnesium sulfate for neuroprotection is recommended if preterm birth is likely within the next 24 hours.
Existing (basic & comprehensive)	Perform neonatal resuscitation with bag and mask	In the last...has the facility performed neonatal resuscitation with a bag and mask?	Basic newborn resuscitation at the time of birth comprises of a set of interventions required to establish breathing and circulation in a newborn who is not spontaneously breathing/crying at birth. This procedure includes providing positive-pressure ventilation with a bag and mask equipment of an appropriate size (i.e. not referring to simple stimulation by rubbing, drying).
New	Initiate kangaroo mother care (for LBW/preterm newborns)	In the last...has the facility initiated LBW or preterm newborns in kangaroo mother care position whereby newborns are held in prolonged, continuous direct skin-to-skin contact on the mother's chest?	Kangaroo mother care is an approach to care of preterm and/or LBW infants. The signal function refers to initiation of newborns held in the kangaroo position most of the day whereby the infant is placed and held in direct skin-to-skin contact on the mother's (or other caregiver's) chest in an up-right position. The aim is for early initiation of KMC and for continuous performance (>18 hours per day). Other key components of KMC are support for exclusive and early breastmilk provision and timely discharge from the hospital with appropriate follow-up. When babies are not in KMC position with mother or other

			care-giver appropriate thermal care should be provided.
New	Administer oxygen therapy with pulse oximetry	In the last... has the facility administered oxygen therapy to newborns with pulse oximetry?	Small and sick newborns with hypoxia require appropriate oxygen therapy. Pulse oximetry determines the presence of hypoxia and hyperoxia, and guides safe administration of oxygen therapy which involves administration of oxygen via neonatal nasal prong using low-flow metres, air oxygen blenders and humidifiers.
New	Administer parenteral* antibiotics (e.g. gentamicin, ampicillin) (newborn)	In the last... has the facility administered parenteral antibiotics (e.g. gentamicin, ampicillin) to newborns with suspected bacterial infection?	Parenteral antibiotics are used for suspected or established infections including the clinical syndromes of sepsis, meningitis or pneumonia in newborns based on clinical presentation diagnosed via clinical algorithm or confirmed via positive blood culture.
New	Perform assisted feeding with expressed breastmilk (e.g. cup and/or nasogastric feeding)	In the last... has the facility performed assisted feeding of newborns with expressed breastmilk via cup and/or nasogastric tube?	Assisted feeding of newborns is performed for babies that may not be able to effectively breastfeed due to prematurity, small size or sickness and refers to the provision of cup and/or gastric tube feeding of newborns using expressed breastmilk.
New	Administer phototherapy for hyperbilirubinemia (jaundice)	In the last... has the facility administered phototherapy to newborns with jaundice?	Jaundice is common in all newborns and without treatment can lead to severe illness (e.g. kernicterus) and death. Administering phototherapy for neonatal hyperbilirubinemia refers to treatment with effective, safe phototherapy e.g. high-intensity light emitting diodes (LED).
New	Administer parenteral* anticonvulsants for seizures (newborn) (e.g. phenobarbitone)	In the last... has the facility administered parenteral anticonvulsants (e.g., phenobarbitone) for newborn seizures?	Neonatal seizures are some of the most frequent neurological events in newborns, reflecting a variety of pre-, peri- or postnatal disorders of the central nervous system. After excluding hypoglycaemia, administering parenteral anticonvulsants refers to the management of seizures in newborns using phenobarbitone as the first-line medication.
New	Perform blood transfusion (newborn)	In the last...has the facility performed transfusion of blood products to newborns?	The need for transfusion of blood or blood products can occur due to multiple complications including anaemia of prematurity, post-jaundice management or other conditions. Blood transfusion for newborns requires fresh, irradiated blood that is negative for

			cytomegalovirus and warmed for administration with management of the newborn for transfusion reactions.
New	Administer CPAP (newborn)	In the last... has the facility administered continuous positive airway pressure (CPAP) for newborns?	Continuous positive airway pressure is a non-invasive type of respiratory support which can be delivered without endotracheal intubation and is used for small and sick newborns (especially preterm) with surfactant deficiency.
New	Perform services for retinopathy of prematurity	In the last... has the facility performed services (screening and/or treatment) for retinopathy of prematurity?	Retinopathy of prematurity, a complication of preterm birth, is a vision threatening disease associated with abnormal retinal vascular development that can lead to blindness and visual impairment. Services for retinopathy of prematurity require inpatient screening of eligible at-risk infants for ROP by trained technician or ophthalmologist. Infants identified as requiring treatment will require laser treatment by indirect delivery or intravitreal injection of AntiVEGF agents for infants developing signs of sight threatening (Type 1) ROP. At most secondary level facilities only screening will be possible (by trained technicians or ophthalmologist) and infants will require a referral to an appropriate centre for treatment.
New	Administer intravenous (IV) fluids (newborn)	In the last... has the facility administered IV fluids to newborns?	Intravenous fluids (containing glucose) are required for some newborns with delayed or impaired sucking, or those with severe illness. Following WHO guidelines, fluids are administered through an infusion pump and a neonatal burette, the volume is recorded, and the IV site is checked regularly.
New	Provide thermal care (e.g. radiant warmer, incubator, heated cot) for preterm/LBW newborns	In the last... has the facility performed thermal care for preterm newborns using a radiant warmer or incubator.	Preterm newborns and/or LBW infants at risk of hypothermia, who are unstable or who cannot be cared for in kangaroo mother care, require thermal care using a clean incubator or under radiant warmer. Close temperature monitoring is also required.
New	Administer methylxanthines (e.g. caffeine) for preterm newborns for prevention and	In the last... has the facility administered methylxanthines (e.g. caffeine) for preterm newborns for the prevention and treatment of apnoea.	Recurrent apnoea is common in preterm infants. Methylxanthines (caffeine as the preferred drug) are used for preterm newborns <32 weeks to stimulate breathing

	treatment of apnoea		and reduce apnoea and its consequences.
--	---------------------	--	---

*Parenteral includes administration of a drug through the intravenous route or as intra-muscular injections.

Content above has been adapted from:

World Health Organization, UNFPA, UNICEF (2017). *Managing Complications in Pregnancy and Childbirth: a guide for midwives and doctors* – 2nd edition, Geneva: World Health Organization

World Health Organization (2020). *Standards for improving quality of care for small and sick newborns in health facilities*. Geneva: World Health Organization

World Health Organization (2015) *World Health Organization recommendations on interventions to improve preterm birth outcomes*. Geneva: World Health Organization.

Appendix 7: Detailed results on EmONC Signal Functions for Delphi R2

7a. Emergency obstetric signal functions

Historical status	Selected by Delphi R2 (yes/no)	Signal function	Proposed change to wording of signal function from Delphi R2	Intervention description	Other notes
Existing (basic & comprehensive)	Yes	Administer parenteral* antibiotics (e.g. ampicillin, gentamicin) (maternal)	Administer <i>appropriate</i> parenteral antibiotics (maternal)	Parenteral antibiotics are used for suspected or established severe maternal infection or maternal sepsis (e.g., reproductive tract infection following abortion or childbirth). Their use is also recommended in cases of maternal generalised bacteraemia and septicaemia.	Broad spectrum antibiotics often in use – should not specify gentamicin and ampicillin. Metronidazole often used. Concerns about misuse/overuse of antibiotics in many settings.
Existing (basic & comprehensive)	Yes	Administer appropriate medications to treat post-partum haemorrhage (PPH) (appropriate medications in the algorithm for PPH e.g. oxytocin or ergometrine (or combination of oxytocin and ergometrine), or oral misoprostol, or prostaglandin or heat stable carbetocin or tranexamic acid).	<i>Administer appropriate medications to treat post-partum haemorrhage (PPH) including uterotonic and tranexamic acid</i>	Uterotonics (oxytocin alone as the first choice) are used to treat PPH most commonly caused by atonic uterus. They can also be used to treat bleeding after an incomplete late abortion along with other definitive treatment. In settings where oxytocin is unavailable, the use of other injectable uterotonics (if appropriate ergometrine or the fixed drug combination of oxytocin and ergometrine) or oral misoprostol is recommended. The use of	Concerns that this was too wordy, confusing, and composite with some issues with the proposed algorithm of drugs. Note that heat stable carbetocin (HSC) not used for treatment. TXA should be used in all cases of PPH. Many suggestions for simplification. ?Remove mention of heat stable carbetocin.

Historical status	Selected by Delphi R2 (yes/no)	Signal function	Proposed change to wording of signal function from Delphi R2	Intervention description	Other notes
				tranexamic acid is recommended for the treatment of PPH if oxytocin and other uterotonics fail to stop bleeding or if it is thought that the bleeding may be partly due to trauma. Heat stable carbetocin can also be used in certain contexts.	
Existing (basic & comprehensive)	Yes	Administer magnesium sulfate for pre-eclampsia or eclampsia	Administer magnesium sulfate for <i>severe</i> pre-eclampsia or eclampsia	Magnesium sulfate is given to women diagnosed with severe pre-eclampsia or eclampsia to prevent and treat convulsions.	Suggestions that severe should be added as a qualifier to the signal function
New	Yes	Administer maternal antihypertensives (e.g. alpha methyldopa, hydralazine, labetalol, nifedipine)		Antihypertensives are used to manage both gestational and chronic hypertension. For women diagnosed with severe pre-eclampsia or eclampsia where blood pressure remains high, antihypertensives are administered by IV route, orally or sublingually.	Comments that this is not an emergency intervention – need further clarification on what anti-hypertensive route and situation. Comments also to combine magnesium sulfate and anti-hypertensives (in the same way that PPH medications are mixed).
New	Yes	Provide intravenous (IV) infusion/IV fluid replacement therapy (e.g. maternal resuscitation)		Intravenous replacement fluids <i>during pregnancy and</i> labour as replacement therapy or in the postpartum period to treat shock are the first-line treatment for hypovolaemia due to haemorrhage (ante-partum/post-partum), sepsis or other cause. In case of post-partum haemorrhage it maintains the circulation whilst interventions to control bleeding are performed and assessment for whether blood transfusion is needed.	Comments that this is difficult to frame as an indicator or signal function without sufficient explanation to differentiate between routine administration of IV fluids and IV fluids for treatment of shock. Also respondents notes that if a facility is administering parenteral antibiotics or blood transfusion it can also provide IV fluid for maternal resuscitation.
Existing (basic & comprehensive)	Yes	Perform manual uterine exploration and removal of placenta	Perform manual uterine exploration and removal of	This procedure addresses retained placenta or fragments of the placenta. It entails full antiseptic	Requests to specify under GA/analgesia and to specify that the procedure is for

Historical status	Selected by Delphi R2 (yes/no)	Signal function	Proposed change to wording of signal function from Delphi R2	Intervention description	Other notes
			placenta <i>for retained placenta</i>	procedure, pain relief, and insertion of gloved hand into the uterus to locate the edge of the placenta, separating the placenta in its entirety from the uterine wall and removing it.	retained placenta. This is often confused with removal or retained products therefore needs to be more specific.
Existing (basic & comprehensive)	Yes	Perform removal of retained products of conception (POC) (e.g. manual vacuum aspiration (MVA), dilation and curettage (D&C), medical management)	Perform removal of retained products of conception (POC) (e.g. manual vacuum aspiration (MVA), dilation and curettage (D&C), medical management) <i>for post-abortion care</i> <i>OR</i> <i>Manage post-abortion complications through removal of retained products of conception (POC) (e.g. manual vacuum aspiration (MVA), dilation and curettage (D&C), medical management)</i>	Retained products of conception (POC) can occur as a result of an incomplete spontaneous or induced abortion. MVA procedure entails inserting an appropriate sized cannula into the uterus, creating vacuum in a plastic syringe, connecting it to the cannula and removing the POC with gentle aspiration using a rotating movement. POC can also be removed by dilatation of cervix and curettage with a sharp curette but MVA is a comparatively safer procedure.	Comments here to be more explicit that this refers to post-abortion care. Is there a need to integrate abortifacient medical products to the signal function.
Existing (basic & comprehensive)	No	Perform assisted vaginal birth (e.g. vacuum extractor, forceps)		This procedure is performed during the second stage of labour to deliver the baby for indications of fetal distress or prolonged second stage of labour. Prerequisite conditions are a skilled health provider, the cervix is fully dilated and fetal head has descended sufficiently.	Suggestion to remove altogether – often confused with attended delivery and confusion with French language. Forceps delivery is not practiced except in exceptional cases at the tertiary level. Vacuum cup is important but rarely used for several reasons. Suggestions to add Kiwi type vacuum.
Existing (comprehensive)	Yes	Perform blood transfusion		The need for the transfusion of whole blood or blood products can occur due to antepartum or postpartum haemorrhage leading to shock, loss of a large	Suggestion that could also add substitutes/blood replacement.

Historical status	Selected by Delphi R2 (yes/no)	Signal function	Proposed change to wording of signal function from Delphi R2	Intervention description	Other notes
				volume of blood such as with ruptured ectopic pregnancy or at operative birth, coagulation disorders or severe anaemia late in pregnancy.	
Existing (comprehensive)	Yes	Perform caesarean section	Perform <i>emergency</i> caesarean section OR <i>Perform surgery including caesarean section and exploratory laparotomy</i>	Caesarean section is performed for multiple maternal and fetal indications that commonly include prolonged or obstructed labour, fetal distress, malpresentation or placenta previa. It is assumed that if caesarean section is performed the facility is also capable of providing anaesthesia.	Concerns about being clear on the use of c-section for obstetric indications (avoiding misuse) Do not want to miss out the management of ectopic pregnancy.
New	No	Perform mechanical ventilation	No suggestions	Assisted ventilation may be needed in cases of respiratory failure due to severe life threatening condition/s during pregnancy or in the postpartum period. This is usually provided in the intensive care unit along with other supportive measures.	Needs to be more clearly defined if to be included.
New	No	Provide high dependency/intensive-care	No suggestions	Critically ill pregnant women need multi-organ support to prevent mortality and morbidity. This is best provided in a high-dependency/intensive care unit with nurses/midwives and doctors with intensive care skills.	Needs to be more clearly defined if to be included.

* Parenteral includes administration of a drug through the intravenous route or as intramuscular injections.

Content above has been adapted from:

World Health Organization, UNFPA, UNICEF. *Managing Complications in Pregnancy and Childbirth: a guide for midwives and doctors* – 2nd edition, Geneva: World Health Organization; 2017. Licence: CC BY-NC-SA 3.0 IGO.

7b Referral signal function for obstetric and newborn care

Historical status	Selected by Delphi R2 (yes/no)	Signal function	Proposed change to wording of signal function from Delphi R2	Intervention description	Other notes
New	No	Provision of continued emergency clinical obstetric and newborn care during interfacility transfer	<i>Provision of continued clinical care during interfacility transfer</i> <i>OR</i> <i>Coordinated transport to a higher level facility</i>	Continued emergency clinical obstetric and neonatal care during interfacility transfer refers to transport of obstetric and newborn patients with a clinically trained health worker and adequate equipment to ensure ongoing provision of emergency care during transfer between facilities.	Would rely on improved documentation to make measurement more feasible. Concerns that this is not simple enough for a signal function. Necessary to specify what care for this function and by whom for it to be effective. Needs more refining e.g. in vehicle equipped to support continuous oxygen, fluids by accompanying HW (otherwise could be a health worker in the back of a taxi).

*** Parenteral includes administration of a drug through the intravenous route or as intra-muscular injections.**

7c. Small and sick newborn signal functions

Historical status	Selected by Delphi R2 (yes/no)	Signal function	Proposed change to wording of signal function	Intervention description/definition	Other notes
New	Yes	Administer antenatal corticosteroids (ACS) (e.g. dexamethasone, betamethasone) to women at risk of preterm birth	Administer <i>complete course</i> of antenatal corticosteroids to women at risk of preterm birth	The administration of ACS to women at risk of imminent preterm birth is used to stimulate fetal lung maturation and refers to dexamethasone or betamethasone administered by intramuscular injection for women at risk of imminent preterm birth (anticipated with the subsequent 7 days) from 24 weeks to 34 weeks gestation according to WHO guidelines. The recommendation is that ACS is only offered at a level where resuscitation, thermal care, feeding support, infection treatment and safe oxygen are available. ACS are contraindicated for women with chorioamnionitis.	Administered to woman on labour and delivery ward (not to newborn) therefore should be included as part of obstetric signal functions.
New	Yes	Administer magnesium sulfate to women at risk of preterm birth		The use of magnesium sulfate is recommended for women at risk of imminent preterm birth before 32 weeks of gestation for prevention of cerebral palsy in the infant and child. Magnesium sulfate for neuroprotection is recommended if preterm birth is likely within the next 24 hours.	Same as above comment due to timing of intervention.
Existing (basic & comprehensive)	Yes	Perform neonatal resuscitation with bag and mask		Basic newborn resuscitation at the time of birth comprises of a set of interventions required to establish breathing and circulation in a newborn who is not spontaneously breathing/crying at birth. This procedure includes providing positive-pressure ventilation with a bag and mask equipment of an	Comment that this should include all steps of resuscitation.

Historical status	Selected by Delphi R2 (yes/no)	Signal function	Proposed change to wording of signal function	Intervention description/definition	Other notes
				appropriate size (i.e. not referring to simple stimulation by rubbing, drying).	
New	Yes	Initiate kangaroo mother care (for LBW/preterm newborns)	<p><i>Provide at least 3 days continuous KMC</i></p> <p>OR</p> <p><i>Initiate KMC or other thermal care (for LBW/preterm newborns)</i></p> <p>OR</p> <p>Initiate immediate kangaroo mother care (for LBW/preterm newborns)</p>	<p>Kangaroo mother care is an approach to care of preterm and/or LBW infants. The signal function refers to initiation of newborns held in the kangaroo position most of the day whereby the infant is placed and held in direct skin-to-skin contact on the mother's (or other caregiver's) chest in an up-right position. The aim is for early initiation of KMC and for continuous performance (>18 hours per day). Other key components of KMC are support for exclusive and early breastmilk provision and timely discharge from the hospital with appropriate follow-up. When babies are not in KMC position with mother or other caregiver appropriate thermal care should be provided.</p>	<p>Difficult to prioritise between KMC and radiant warmer as an emergency intervention (with KMC for non-stable babies still not mainstream).</p> <p>Should be separated by:</p> <ul style="list-style-type: none"> - Hemodynamically stable – KMC - Hemodynamically unstable – radiant warmer/incubator/heated cot
New	Yes	Administer oxygen therapy with pulse oximetry	<p>Administer oxygen therapy with pulse oximetry for respiratory support</p> <p>Administer oxygen safely when necessary, with regular monitoring</p> <p>OR</p> <p>Administer oxygen therapy and check oxygen saturation with pulse oximetry</p>	<p>Small and sick newborns with hypoxia require appropriate oxygen therapy. Pulse oximetry determines the presence of hypoxia and hyperoxia, and guides safe administration of oxygen therapy which involves administration of oxygen via neonatal nasal prong using low-flow metres, air oxygen blenders and humidifiers.</p>	<p>Oxygen is important - but it needs to be delivered in a cautiously and safely for a baby for whom it is deemed necessary. Concerns about linking pulse oximetry to oxygen as may give false security that high saturations are better.</p>

Historical status	Selected by Delphi R2 (yes/no)	Signal function	Proposed change to wording of signal function	Intervention description/definition	Other notes
New	Yes	Administer parenteral* antibiotics (e.g. gentamicin, ampicillin) (newborn)		Parenteral antibiotics are used for suspected or established infections including the clinical syndromes of sepsis, meningitis or pneumonia in newborns based on clinical presentation diagnosed via clinical algorithm or confirmed via positive blood culture.	
New	Yes	Perform assisted feeding with expressed breastmilk (e.g. cup and/or nasogastric feeding)	Perform assisted feeding with expressed breastmilk <i>or donor milk</i> (e.g. cup and/or nasogastric feeding)	Assisted feeding of newborns is performed for babies that may not be able to effectively breastfeed due to prematurity, small size or sickness and refers to the provision of cup and/or gastric tube feeding of newborns using expressed breastmilk.	Should include donor milk here Concerns that this function should also focus on direct breast feeding.
New	Yes	Administer phototherapy for hyperbilirubinemia (jaundice)	Administer phototherapy for <i>measured</i> hyperbilirubinemia	Jaundice is common in all newborns and without treatment can lead to severe illness (e.g. kernicterus) and death. Administering phototherapy for neonatal hyperbilirubinemia refers to treatment with effective, safe phototherapy e.g. high-intensity light emitting diodes (LED).	
New	No	Administer parenteral* anticonvulsants for seizures (newborn) (e.g. phenobarbitone)		Neonatal seizures are some of the most frequent neurological events in newborns, reflecting a variety of pre-, peri- or postnatal disorders of the central nervous system. After excluding hypoglycaemia, administering parenteral anticonvulsants refers to the management of seizures in newborns using phenobarbitone as the first-line medication.	

Historical status	Selected by Delphi R2 (yes/no)	Signal function	Proposed change to wording of signal function	Intervention description/definition	Other notes
New	No	Perform blood transfusion (newborn)		The need for transfusion of blood or blood products can occur due to multiple complications including anaemia of prematurity, post-jaundice management or other conditions. Blood transfusion for newborns requires fresh, irradiated blood that is negative for cytomegalovirus and warmed for administration with management of the newborn for transfusion reactions.	
New	No	Administer CPAP (newborn)	<i>Initiate and manage CPAP for respiratory support</i>	Continuous positive airway pressure is a non-invasive type of respiratory support which can be delivered without endotracheal intubation and is used for small and sick newborns (especially preterm) with surfactant deficiency.	
New	No	Perform services for retinopathy of prematurity (ROP)	<i>Screen for neonatal retinopathy of prematurity (ROP)</i>	Retinopathy of prematurity, a complication of preterm birth, is a vision threatening disease associated with abnormal retinal vascular development that can lead to blindness and visual impairment. Services for retinopathy of prematurity require inpatient screening of eligible at-risk infants for ROP by trained technician or ophthalmologist. Infants identified as requiring treatment will require laser treatment by indirect delivery or intravitreal injection of AntiVEGF agents for infants developing signs of sight threatening (Type 1) ROP. At most secondary level facilities only screening will be	Services could cause some confusion as to whether this is screening or treatment or prevention.

Historical status	Selected by Delphi R2 (yes/no)	Signal function	Proposed change to wording of signal function	Intervention description/definition	Other notes
				possible (by trained technicians or ophthalmologist) and infants will require a referral to an appropriate centre for treatment.	
New	No	Administer intravenous (IV) fluids (newborn)		Intravenous fluids (containing glucose) are required for some newborns with delayed or impaired sucking, or those with severe illness. Following WHO guidelines, fluids are administered through an infusion pump and a neonatal burette, the volume is recorded, and the IV site is checked regularly.	Could IV fluids, blood transfusion be combined? (this would make a composite signal function).
New	Yes	Provide thermal care (e.g. radiant warmer, incubator, heated cot) for preterm/LBW newborns	<i>Provide thermoregulation using a functional radiant warmer/incubator</i>	Preterm newborns and/or LBW infants at risk of hypothermia, who are unstable or who cannot be cared for in kangaroo mother care, require thermal care using a clean incubator or under radiant warmer. Close temperature monitoring is also required.	Some thermal care can be done at lower levels but incubator should not. Should change wording of signal function so that this can be provided at a lower level of care.
New	No	Administer methylxanthines (e.g. caffeine) for preterm newborns for prevention and treatment of apnoea		Recurrent apnoea is common in preterm infants. Methylxanthines (caffeine as the preferred drug) are used for preterm newborns <32 weeks to stimulate breathing and reduce apnoea and its consequences.	

*Parenteral includes administration of a drug through the intravenous route or as intramuscular injections.

Content above has been adapted from:

World Health Organization, UNFPA, UNICEF (2017). *Managing Complications in Pregnancy and Childbirth: a guide for midwives and doctors* – 2nd edition, Geneva: World Health Organization

World Health Organization (2020). *Standards for improving quality of care for small and sick newborns in health facilities*. Geneva: World Health Organization

World Health Organization (2015) *World Health Organization recommendations on interventions to improve preterm birth outcomes*. Geneva: World Health Organization.

7d Average rank score obstetric signal functions

Rank	Signal function	Average rank
1	Administer appropriate medications to treat post-partum haemorrhage (PPH) (appropriate medications in the algorithm for PPH e.g. oxytocin or ergometrine (or combination of oxytocin and ergometrine), or oral misoprostol, or prostaglandin or heat stable carbetoicin or tranexamic acid).	1.96
2	Administer magnesium sulfate for pre-eclampsia or eclampsia	3.39
3	Administer parenteral antibiotics (e.g. ampicillin, gentamicin) (maternal)	3.94
4	Perform manual uterine exploration and removal of placenta	6.51
5	Administer maternal antihypertensives (e.g. alpha methyldopa, hydralazine, labetalol, nifedipine)	6.70
6	Provide intravenous (IV) infusion/IV fluid replacement therapy (e.g. maternal resuscitation)	6.73
7	Perform removal of retained products of conception (e.g. manual vacuum aspiration), dilation and curettage, medical management)	6.78
8	Perform caesarean section	7.07
9	Perform blood transfusion	7.18
10	Perform assisted vaginal birth (e.g., vacuum extractor, forceps)	7.98
11	Provision of continued emergency clinical obstetric and newborn care during interfacility transfer	9.72
12	Perform mechanical ventilation	11.31
13	Provide high dependency/intensive care	11.72

7e. Average rank scores newborn signal functions

Rank	Signal function	Average rank
1	Perform neonatal resuscitation with bag and mask	1.79
2	Initiate kangaroo mother care (for LBW/preterm newborns)	4.91

3	Administer antenatal corticosteroids (ACS) (e.g. dexamethasone, betamethasone) to women at risk of preterm birth	5.33
4	Administer parenteral antibiotics (e.g. gentamicin, ampicillin) (newborn)	5.36
5	Administer oxygen therapy with pulse oximetry	5.54
6	Perform assisted feeding with expressed breastmilk (e.g. cup and/or nasogastric feeding)	7.47
7	Administer magnesium sulfate to women at risk of preterm birth	8.21
8	Administer phototherapy for hyperbilirubinemia (jaundice)	8.93
9	Provide thermal care (e.g. radiant warmer, incubator, heated cot) for preterm/LBW newborns	9.04
10	Administer CPAP (newborn)	9.11
11	Administer parenteral anticonvulsants for seizures (newborn) (e.g. phenobarbitone)	9.82
12	Administer intravenous (IV) fluids (newborn)	10.64
13	Provision of continued emergency clinical obstetric and newborn care during interfacility transfer	11.13
14	Perform blood transfusion (newborn)	11.83
15	Perform services for retinopathy of prematurity	13.26
16	Administer methylxanthines (e.g. caffeine) for preterm newborns for prevention and treatment of apnoea	13.62

Appendix 8. Round three survey

Delphi study on obstetric and newborn signal functions and levels of care: ROUND 3

1. Introduction

Delphi study on obstetric and newborn care signal functions for the Re-Visioning Emergency Obstetric and Newborn care (EmONC) Project

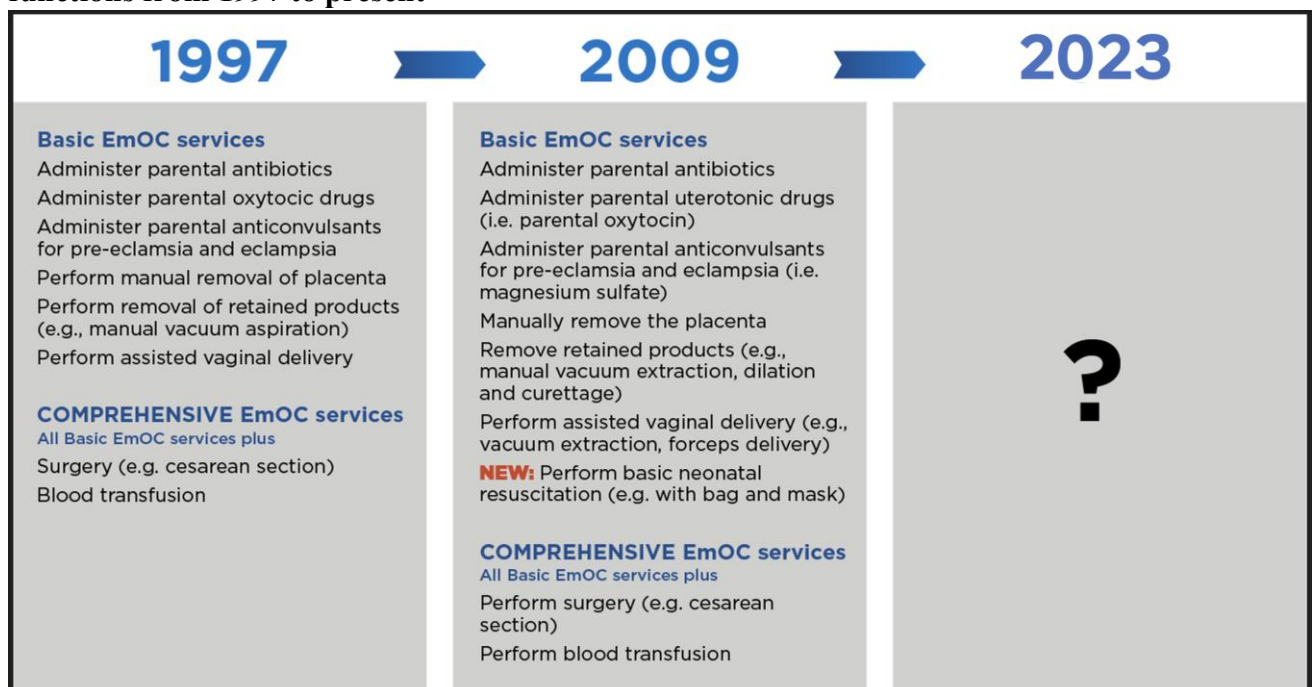
Thank you for your participation in rounds one and two of the Delphi study on obstetric and newborn care signal functions and levels of care for the Re-Visioning EmONC project. In total, 131 experts participated in round two, which was focused on prioritising emergency obstetric and newborn care signal functions for the revised EmONC framework.

Welcome to Round Three!

Background

Twenty-five years ago, the novel emergency obstetric care (EmOC) framework provided for the first time guidelines for monitoring the availability and use of obstetric services. The set of connected indicators standardised measurement and monitoring of the availability, utilisation, and quality of EmOC in low- and middle-income countries (LMICs). The original EmOC framework, built around signal functions, categorised two levels of care: basic and comprehensive (Figure 1). This common language for policy makers, program planners, measurement experts, clinicians and researchers has been enormously influential. With increased recognition of the importance of newborns in global health, the term "EmONC" has been adopted for programme implementation and the maternal and newborn health (MNH) landscape has continued to progress; this has included an increase in health facility delivery.

Figure 1. Basic and Comprehensive Emergency Obstetric Care (EmOC) signal functions from 1997 to present



The Re-Visioning Emergency Obstetric and Newborn Care (EmONC) Project

The Re-Visioning Emergency Obstetric and Newborn Care (EmONC) Project is led by a Steering Committee coordinated by the Averting Maternal Death and Disability (AMDD) program at Columbia University Mailman School of Public Health, in collaboration with UNICEF, UNFPA, WHO and the London School of Hygiene & Tropical Medicine (LSHTM). The overall aim is to create a revised framework for obstetric and newborn care with indicators, tools, and guidance that can meet country needs in 2023 and beyond.

The Delphi study on obstetric and newborn signal functions and levels of care

A Delphi study is a widely used method to build consensus among experts through a series of interrelated survey rounds. The first round of the Delphi study on obstetric and newborn

signal functions and levels of care was carried out in November-December 2021, the second round in August-September 2022, and this is the third and final of three rounds. As part of the Re-Visioning EmONC project, the overall aim of this Delphi study is to build consensus on obstetric and newborn signal functions and levels of care. The study has ethical approval from LSHTM Ethics Ref No. 26292.

Round three of the Delphi study

The objective of round three of this Delphi study is to build consensus on a configuration of EmONC signal functions linked to specific levels of care. You will be invited to answer questions and provide feedback on a prototype (a preliminary model) of the signal functions and the recommended levels of care at which these are provided. We anticipate that this will take 20 minutes to complete.

The prototype presented in this round is grounded in results from the previous two rounds of the Delphi study and from a Re-Visioning EmONC Project technical workshop held in September 2022.

What are emergency signal functions?

Emergency signal functions are: a parsimonious list of clinical tracer interventions, representing key processes of care, to treat the main complications of childbirth that would otherwise result in maternal or newborn death and disability, or stillbirth. Signal functions are a simple measure of whether the facility performed the function in a specified time period; they are usually captured through surveys and/or routine health information systems at the facility level.

What are the EmONC signal functions used for?

EmOC signal functions have been primarily used for planning purposes, to ascertain the availability of basic and comprehensive level EmOC facilities across a population. The Re-Visioning EmONC Project aims to integrate emergency newborn care signal functions to be used for the same purpose. Emergency signal functions are tracers – they do not capture all interventions performed or act as indicators of quality of care. In addition to their use for planning, signal functions have also been used for research, advocacy, accountability, and for training programmes.

What else will be in the revised EmONC framework?

In addition to signal functions, the revised EmONC framework will also include a set of updated indicators including input (e.g. infrastructure, drugs, and equipment), output and outcome indicators to assess access and quality, including experience of care. Routine care for women and newborns will also be included as a separate part of the revised framework, but is not included in this Delphi study, which focuses on emergency signal functions and levels of care.

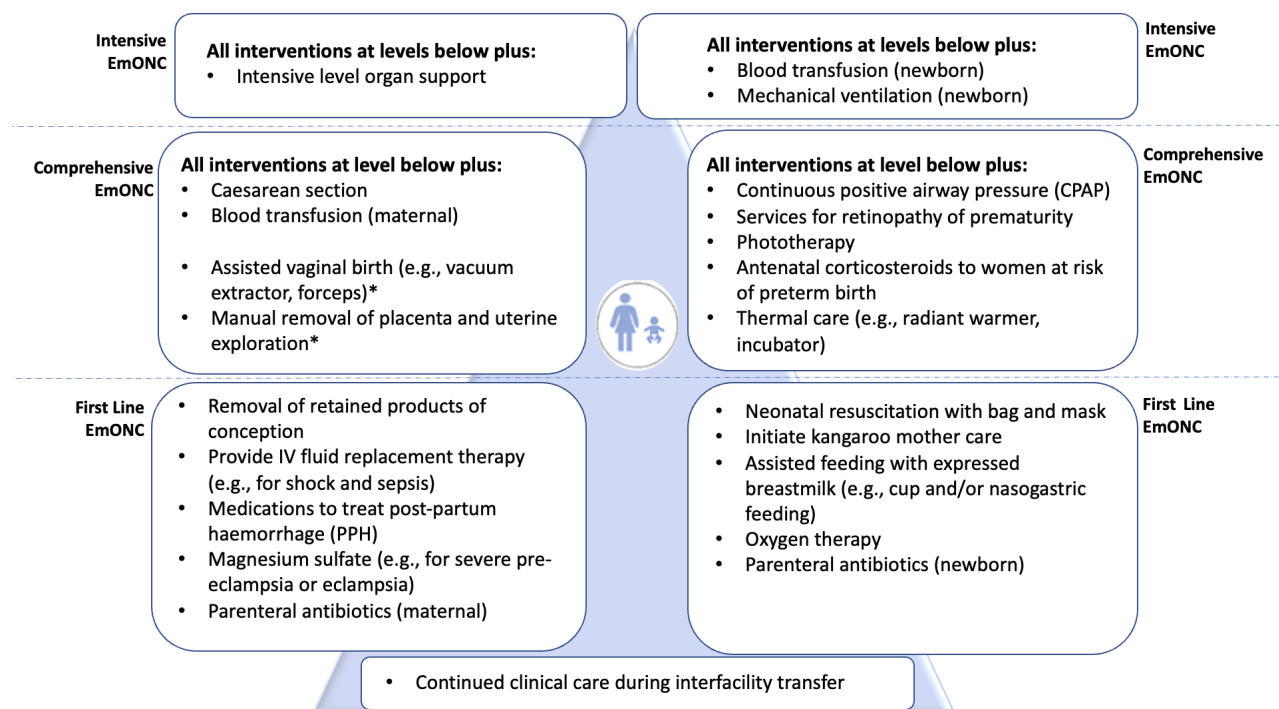
2. Your information

Name (First and Last, as you entered it in the round one survey): *

Email (please use the same email address that you used in the round one survey): *

3. Your opinion on signal functions and levels of care

Emergency obstetric and newborn care (EmONC) signal functions by three levels of care: A prototype



*These signal functions are required at comprehensive and intensive EmONC levels, but they can (and often will) be part of service delivery at first line EmONC facilities.

The document attached to your email invitation contains a table with additional information for each proposed signal function.

Section A. Levels of care

This section is about the proposed organisation of signal functions into three levels of care. In

round one of this Delphi study, 85% of participants indicated a configuration of signal functions built around three levels of care would be optimal for the revised EmONC framework.

1. What is your opinion on the proposal to use three levels of care as shown in the prototype above?

(This question is not about which signal functions are in each level in the prototype; the signal functions themselves will be discussed in the next section. We simply wish to know your opinion on using three levels of care, as compared to fewer or more levels.) *

☐

Strongly disagree

☐

Disagree

☐

Agree

☐

Strongly agree

If you disagree or strongly disagree please state your reasons in the text box below:

2. In the prototype, we have proposed naming the three levels (first line, comprehensive, intensive).

What is your opinion on naming the lowest level of care "first line"? *

☐

Strongly disagree

☐

Disagree

☐

Agree

☐

Strongly agree

If you disagree or strongly disagree please state your reasons in the text box below:

3. What is your opinion on naming the middle level of care "comprehensive"? *

☐ Strongly disagree

☐ Disagree

☐ Agree

☐ Strongly agree

If you disagree or strongly disagree please state your reasons in the text box below:

4. What is your opinion on naming the highest level of care "intensive"? *

☐ Strongly disagree

☐ Disagree

☐ Agree

☐ Strongly agree

If you disagree or strongly disagree please state your reasons in the text box below:

5. Do you have any other general comments about the naming of the three levels?

4. Select which sections to complete

Section B. Signal functions

This section is about the proposed signal functions for the three levels of care. Please choose whether you would like to complete the sections on obstetric signal functions, newborn signal functions or obstetric and newborn signal functions for levels of care. *

☐

Obstetric signal functions

☐

Newborn signal functions

☐

Obstetric and newborn signal functions

5. Obstetric

Obstetric care signal functions

An ideal EmONC signal function for the revised EmONC framework should meet these criteria:

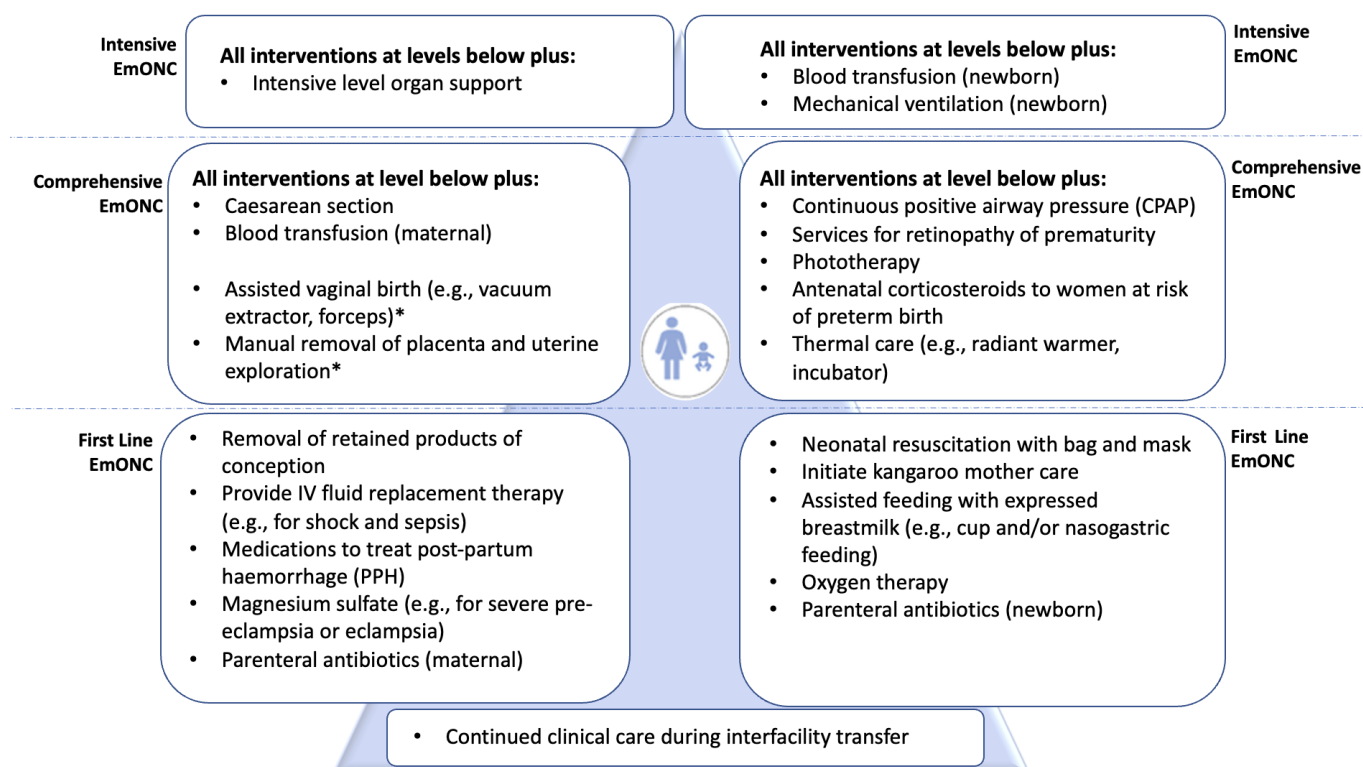
CRITICAL: The signal function should represent a clinical intervention or service performed by health workers to manage one or more complication(s) that would otherwise result in major cause/s of maternal or newborn death and disability, or stillbirth.

a TRACER: Performance of the intervention or service ideally indicates that multiple other components of treatment or aspects of care are also present (e.g., performance of surgery generally indicates the availability of anaesthesia).

FREQUENT: The intervention or service should be performed often enough to reflect ongoing performance or functionality of the facility.

SIMPLE: Not necessarily simple to perform, but the intervention or service should be clearly and operationally defined and feasible to measure reliably across contexts.

Emergency obstetric and newborn care (EmONC) signal functions by three levels of care: A prototype



*These signal functions are required at comprehensive and intensive EmONC levels, but they can (and often will) be part of service delivery at first line EmONC facilities.

6. Based on the above criteria, the following obstetric signal functions should be included in the revised EmONC framework: *

	Agree	Disagree
Administer parenteral antibiotics (maternal)	☐	☐
Administer medications to treat post-partum-haemorrhage (PPH)	☐	☐
Administer magnesium sulfate for severe pre-eclampsia or eclampsia	☐	☐
Provide IV fluid replacement therapy (e.g. for shock or sepsis)	☐	☐
Perform manual removal of retained placenta and uterine exploration	☐	☐

	Agree	Disagree
Perform removal of retained products of conception (POC) for abortion or post-abortion care (e.g., vacuum aspiration, dilation and evacuation, medical management)	☐	☐
Perform assisted vaginal birth (e.g. vacuum extractor, ventouse, forceps)	☐	☐
Perform blood transfusion	☐	☐
Perform caesarean section	☐	☐
Provide intensive level organ support	☐	☐
Provide continued clinical care during interfacility transfer	☐	☐

Comments:

7. I agree with the placement of "Administer parenteral antibiotics (maternal)" at first line level of care as proposed in the prototype. *

☐

Agree with placement at first line level

☐

Disagree- should be placed at comprehensive level

☐

Disagree- should be placed at intensive level

Comments:

8. I agree with the placement of "Administer magnesium sulfate for severe pre-eclampsia or eclampsia" at first line level of care as proposed in the prototype. *

☐

Agree with placement at first line level

☐

Disagree- should be placed at comprehensive level

☐

Disagree- should be placed at intensive level

Comments:

9. I agree with the placement of "Administer medications to treat post-partum-haemorrhage (PPH)" at first line level of care as proposed in the prototype. *

☐

Agree with placement at first line level

☐

Disagree- should be placed at comprehensive level

☐

Disagree- should be placed at intensive level

Comments:

10. I agree with the placement of "Provide IV fluid replacement therapy (e.g. for shock or sepsis)" at first line level of care as proposed in the prototype. *

☐

Agree with placement at first line level

☐

Disagree- should be placed at comprehensive level

☐ Disagree- should be placed at intensive level

Comments:

11. I agree with the placement of "Perform removal of retained products of conception (POC) for abortion or post-abortion care (e.g., vacuum aspiration, dilation and evacuation, medical management)" at the first line level of care as proposed in the prototype. *

☐ Agree with placement at first line level

☐ Disagree- should be placed at comprehensive level

☐ Disagree- should be placed at intensive level

Comments:

12. I agree with the placement of "Perform manual removal of retained placenta and uterine exploration" at the comprehensive level of care as proposed in the prototype. *

☐ Agree with placement at comprehensive level

☐ Disagree- should be placed at first line level

☐ Disagree- should be placed at intensive level

Comments:

13. I agree with the placement of "Perform assisted vaginal birth (e.g. vacuum extractor, ventouse, forceps)" at the comprehensive level of care as proposed in the prototype. *

☐

Agree with placement at comprehensive level

☐

Disagree- should be placed at first line level

☐

Disagree- should be placed at intensive level

Comments:

14. I agree with the placement of "Perform blood transfusion" at the comprehensive level of care as proposed in the prototype. *

☐

Agree with placement at comprehensive level

☐

Disagree- should be placed at first line level

☐

Disagree- should be placed at intensive level

Comments:

15. I agree with the placement of "Perform caesarean section" at the comprehensive level of care as proposed in the prototype. *

☐

Agree with placement at comprehensive level

☐

Disagree- should be placed at first line level

☐ Disagree- should be placed at intensive level

Comments:

16. I agree with the placement of "Provide intensive level organ support" at the intensive level of care as proposed in the prototype. *

☐ Agree with placement at intensive level

☐ Disagree- should be placed at first line level

☐ Disagree- should be placed at comprehensive level

Comments:

6. Newborn

Newborn Care Signal Functions

An ideal EmONC signal function for the revised EmONC framework should meet these criteria:

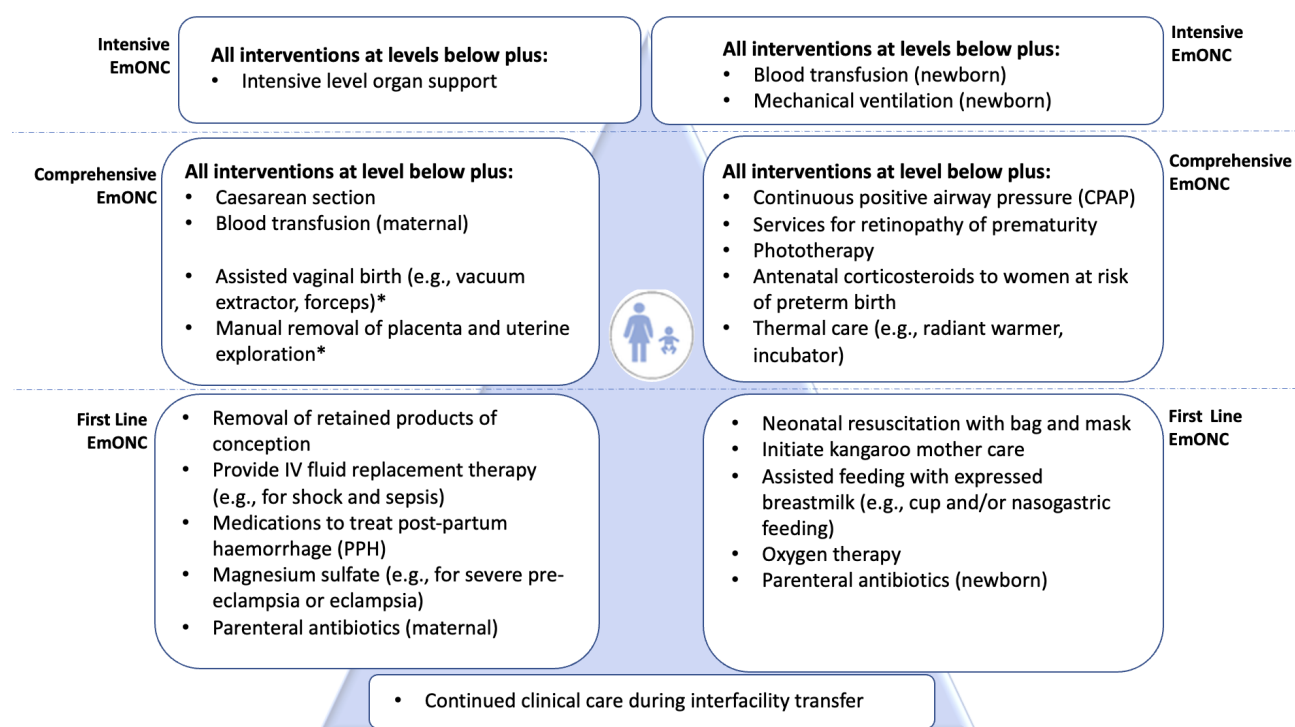
CRITICAL: The signal function should represent a clinical intervention or service performed by health workers to manage one or more complication(s) that would otherwise result in major cause/s of maternal or newborn death and disability, or stillbirth.

a TRACER: Performance of the intervention or service ideally indicates that multiple other components of treatment or aspects of care are also present (e.g., performance of surgery generally indicates the availability of anaesthesia).

FREQUENT: The intervention or service should be performed often enough to reflect ongoing performance or functionality of the facility.

SIMPLE: Not necessarily simple to perform, but the intervention or service should be clearly and operationally defined and feasible to measure reliably across contexts.

Emergency obstetric and newborn care (EmONC) signal functions by three levels of care: A prototype



*These signal functions are required at comprehensive and intensive EmONC levels, but they can (and often will) be part of service delivery at first line EmONC facilities.

17. Based on the above criteria, the following newborn signal functions should be included in the revised EmONC framework: *

	Agree	Disagree
Administer antenatal corticosteroids (ACS) to women at risk of preterm birth	☐	☐
Perform neonatal resuscitation with bag and mask	☐	☐
Initiate kangaroo mother care (for LBW/preterm newborns)	☐	☐
Administer oxygen therapy for respiratory support	☐	☐
Administer parenteral antibiotics (newborn)	☐	☐
Perform assisted feeding with expressed breastmilk (e.g. cup and/or nasogastric feeding)	☐	☐
Administer phototherapy for hyperbilirubinemia (jaundice)	☐	☐

	Agree	Disagree
Provide thermal care (e.g. with radiant warmer, incubator)	☐	☐
Perform blood transfusion (newborn)	☐	☐
Administer continuous positive airway pressure (CPAP) (newborn)	☐	☐
Administer mechanical ventilation (newborn)	☐	☐
Perform services for retinopathy of prematurity	☐	☐
Provide continued clinical care during interfacility transfer	☐	☐

Comments:

18. I agree with the placement of "Provide continued clinical care during interfacility transfer" at the first line level of care as proposed in the prototype. *

- ☐ Agree with placement at first line level
- ☐ Disagree- should be placed at comprehensive level
- ☐ Disagree- should be placed at intensive level

Comments:

19. I agree with the placement of "Perform neonatal resuscitation with bag and mask" at the first line level of care as proposed in the prototype. *

- ☐ Agree with placement at first line level

☐ Disagree- should be placed at comprehensive level

☐ Disagree- should be placed at intensive level

Comments:

20. I agree with the placement of "Initiate kangaroo mother care (for LBW/preterm newborns)" at the first line level of care as proposed in the prototype. *

☐ Agree with placement at first line level

☐ Disagree- should be placed at comprehensive level

☐ Disagree- should be placed at intensive level

Comments:

21. I agree with the placement of "Perform assisted feeding with expressed breastmilk (e.g. cup and/or nasogastric feeding)" at the first line level of care as proposed in the prototype.*

☐ Agree with placement at first line level

☐ Disagree- should be placed at comprehensive level

☐ Disagree- should be placed at intensive level

Comments:

22. I agree with the placement of "Administer oxygen therapy for respiratory support" at the first line level of care as proposed in the prototype. *

☐

Agree with placement at first line level

☐

Disagree- should be placed at comprehensive level

☐

Disagree- should be placed at intensive level

Comments:

23. I agree with the placement of "Administer parenteral antibiotics (newborn)" at the first line level of care as proposed in the prototype. *

☐

Agree with placement at first line level

☐

Disagree- should be placed at comprehensive level

☐

Disagree- should be placed at intensive level

Comments:

24. I agree with the placement of "Provide thermal care (e.g. with radiant warmer, incubator)" at the comprehensive level of care as proposed in the prototype. *

☐

Agree with placement at comprehensive level

☐

Disagree- should be placed at first line level

☐

Disagree- should be placed at intensive level

Comments:

25. I agree with the placement of "Administer antenatal corticosteroids (ACS) to women at risk of preterm birth" at the comprehensive level of care as proposed in the prototype. *

Agree with placement at comprehensive level

Disagree- should be placed at first line level

Disagree- should be placed at intensive level

Comments:

26. I agree with the placement of "Administer phototherapy for hyperbilirubinemia (jaundice)" at the comprehensive level of care as proposed in the prototype. *

Agree with placement at comprehensive level

Disagree- should be placed at first line level

Disagree- should be placed at intensive level

Comments:

27. I agree with the placement of "Perform services for retinopathy of prematurity" at the comprehensive level of care as proposed in the prototype. *

☐ Agree with placement at comprehensive level

☐ Disagree- should be placed at first line level

☐ Disagree- should be placed at intensive level

Comments:

28. I agree with the placement of "Administer continuous positive airway pressure (CPAP) (newborn)" at the comprehensive level of care as proposed in the prototype. *

☐ Agree with placement at comprehensive level

☐ Disagree- should be placed at first line level

☐ Disagree- should be placed at intensive level

Comments:

29. I agree with the placement of "Perform blood transfusion (newborn)" at the intensive level of care as proposed in the prototype. *

☐ Agree with placement at intensive level

☐ Disagree- should be placed at first line level

☐ Disagree- should be placed at comprehensive level

Comments:

30. I agree with the placement of "Administer mechanical ventilation (newborn)" at the intensive level of care as proposed in the prototype. *

Agree with placement at intensive level

Disagree- should be placed at first line level

Disagree- should be placed at comprehensive level

Comments:

7. Obstetric and Newborn

Obstetric care signal functions

An ideal EmONC signal function for the revised EmONC framework should meet these criteria:

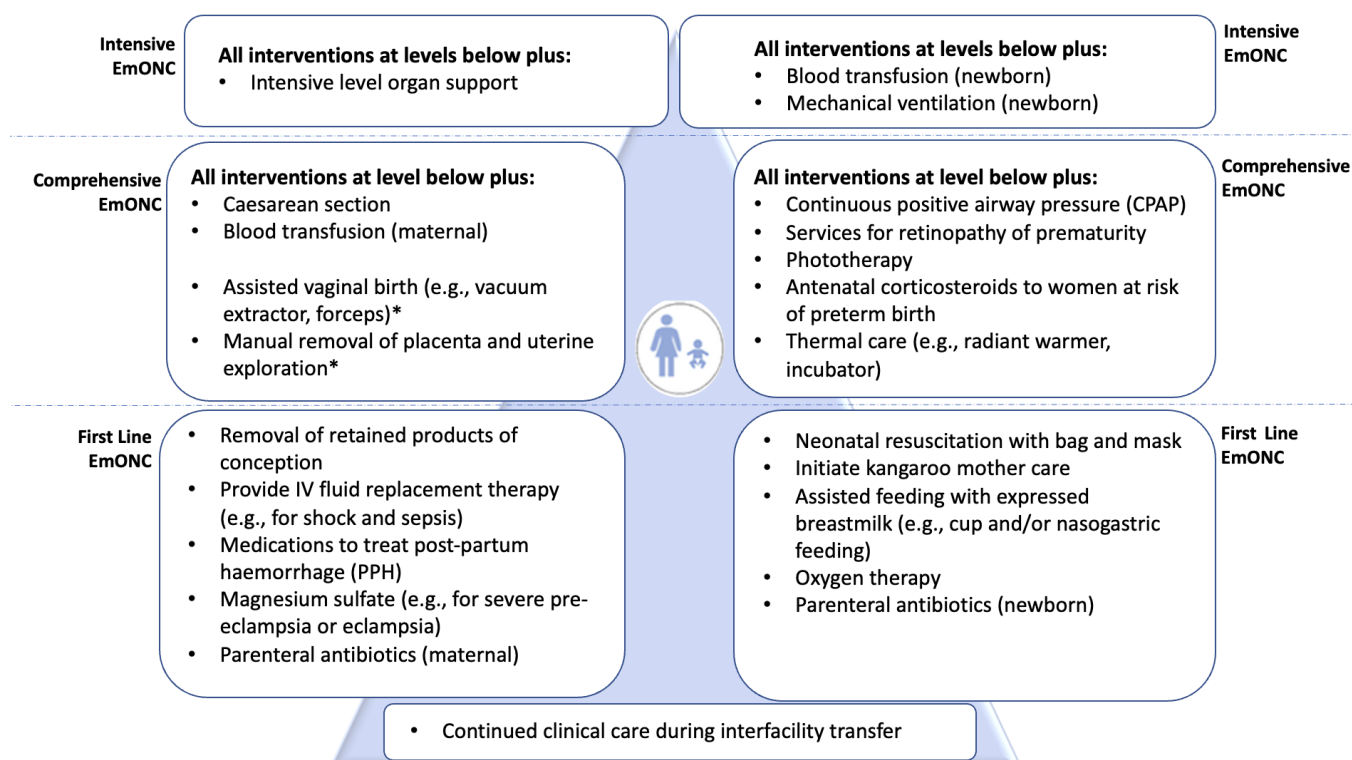
CRITICAL: The signal function should represent a clinical intervention or service performed by health workers to manage one or more complication(s) that would otherwise result in major cause/s of maternal or newborn death and disability, or stillbirth.

a TRACER: Performance of the intervention or service ideally indicates that multiple other components of treatment or aspects of care are also present (e.g., performance of surgery generally indicates the availability of anaesthesia).

FREQUENT: The intervention or service should be performed often enough to reflect ongoing performance or functionality of the facility.

SIMPLE: Not necessarily simple to perform, but the intervention or service should be clearly and operationally defined and feasible to measure reliably across contexts.

Emergency obstetric and newborn care (EmONC) signal functions by three levels of care: A prototype



*These signal functions are required at comprehensive and intensive EmONC levels, but they can (and often will) be part of service delivery at first line EmONC facilities.

31. Based on the above criteria, the following obstetric signal functions should be included in the revised EmONC framework: *

	Agree	Disagree
Administer parenteral antibiotics (maternal)	☐	☐
Administer medications to treat post-partum-haemorrhage (PPH)	☐	☐
Administer magnesium sulfate for severe pre-eclampsia or eclampsia	☐	☐
Provide IV fluid replacement therapy (e.g. for shock or sepsis)	☐	☐
Perform manual removal of retained placenta and uterine exploration	☐	☐
Perform removal of retained products of conception (POC) for abortion or post-abortion care (e.g., vacuum aspiration, dilation and evacuation, medical management)	☐	☐
Perform assisted vaginal birth (e.g. vacuum extractor, ventouse, forceps)	☐	☐

	Agree	Disagree
Perform blood transfusion	☐	☐
Perform caesarean section	☐	☐
Provide intensive level organ support	☐	☐
Provide continued clinical care during interfacility transfer	☐	☐

Comments:

32. I agree with the placement of "Administer parenteral antibiotics (maternal)" at first line level of care as proposed in the prototype. *

- ☐ Agree with placement at first line level
- ☐ Disagree- should be placed at comprehensive level
- ☐ Disagree- should be placed at intensive level

Comments:

33. I agree with the placement of "Administer magnesium sulfate for severe pre-eclampsia or eclampsia" at first line level of care as proposed in the prototype. *

- ☐ Agree with placement at first line level
- ☐ Disagree- should be placed at comprehensive level

☐ Disagree- should be placed at intensive level

Comments:

34. I agree with the placement of "Administer medications to treat post-partum-haemorrhage (PPH)" at first line level of care as proposed in the prototype. *

☐ Agree with placement at first line level

☐ Disagree- should be placed at comprehensive level

☐ Disagree- should be placed at intensive level

Comments:

35. I agree with the placement of "Provide IV fluid replacement therapy (e.g. for shock or sepsis)" at first line level of care as proposed in the prototype. *

☐ Agree with placement at first line level

☐ Disagree- should be placed at comprehensive level

☐ Disagree- should be placed at intensive level

Comments:

36. I agree with the placement of "Perform removal of retained products of conception (POC) for abortion or post-abortion care (e.g., vacuum aspiration, dilation and evacuation, medical management)" at the first line level of care as proposed in the prototype. *

☐

Agree with placement at first line level

☐

Disagree- should be placed at comprehensive level

☐

Disagree- should be placed at intensive level

Comments:

37. I agree with the placement of "Perform manual removal of retained placenta and uterine exploration" at the comprehensive level of care as proposed in the prototype. *

☐

Agree with placement at comprehensive level

☐

Disagree- should be placed at first line level

☐

Disagree- should be placed at intensive level

Comments:

38. I agree with the placement of "Perform assisted vaginal birth (e.g. vacuum extractor, ventouse, forceps)" at the comprehensive level of care as proposed in the prototype. *

☐

Agree with placement at comprehensive level

☐ Disagree- should be placed at first line level

☐ Disagree- should be placed at intensive level

Comments:

39. I agree with the placement of "Perform blood transfusion" at the comprehensive level of care as proposed in the prototype. *

☐ Agree with placement at comprehensive level

☐ Disagree- should be placed at first line level

☐ Disagree- should be placed at intensive level

Comments:

40. I agree with the placement of "Perform caesarean section" at the comprehensive level of care as proposed in the prototype. *

☐ Agree with placement at comprehensive level

☐ Disagree- should be placed at first line level

☐ Disagree- should be placed at intensive level

Comments:

41. I agree with the placement of "Provide intensive level organ support" at the intensive level of care as proposed in the prototype. *

- ☐ Agree with placement at intensive level
- ☐ Disagree- should be placed at first line level
- ☐ Disagree- should be placed at comprehensive level

Comments:

Newborn Care Signal Functions

An ideal EmONC signal function for the revised EmONC framework should meet these criteria:

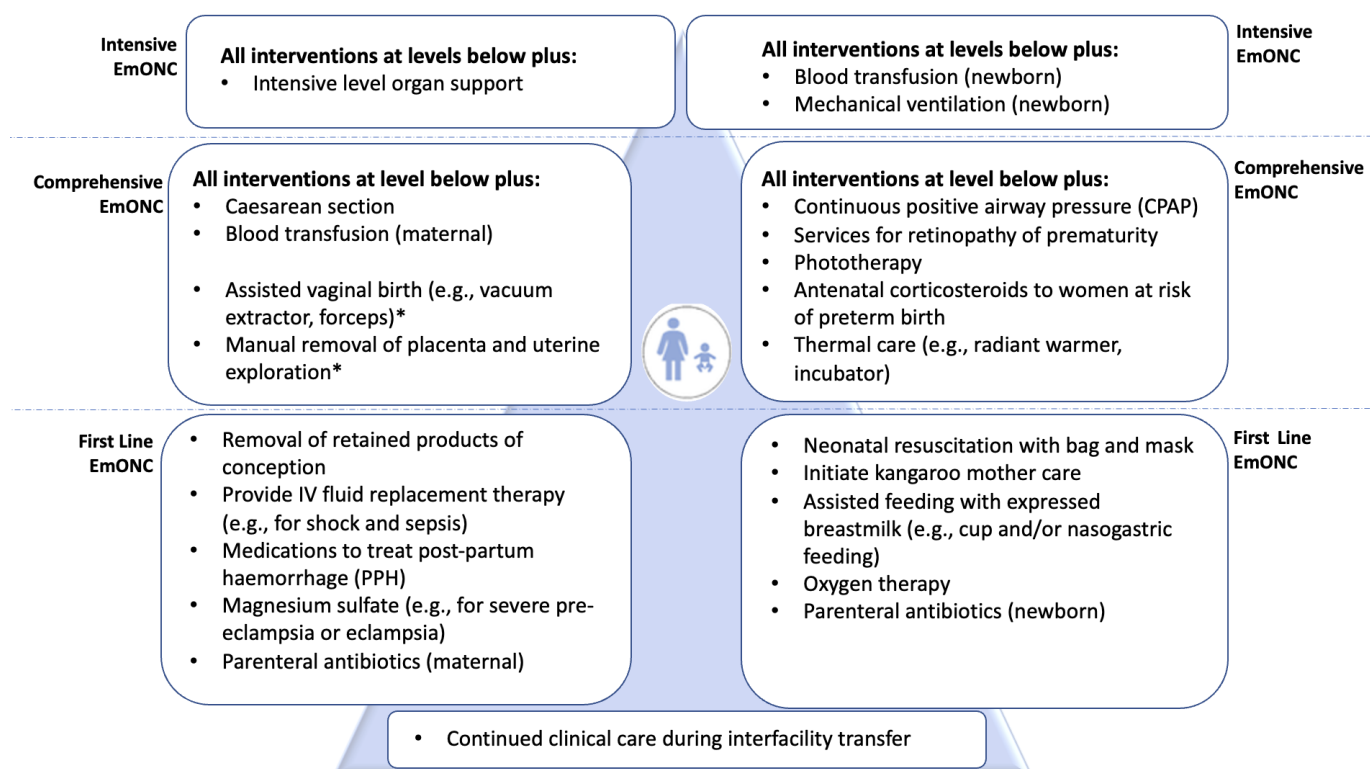
CRITICAL: The signal function should represent a clinical intervention or service performed by health workers to manage one or more complication(s) that would otherwise result in major cause/s of maternal or newborn death and disability, or stillbirth.

a TRACER: Performance of the intervention or service ideally indicates that multiple other components of treatment or aspects of care are also present (e.g., performance of surgery generally indicates the availability of anaesthesia).

FREQUENT: The intervention or service should be performed often enough to reflect ongoing performance or functionality of the facility.

SIMPLE: Not necessarily simple to perform, but the intervention or service should be clearly and operationally defined and feasible to measure reliably across contexts.

Emergency obstetric and newborn care (EmONC) signal functions by three levels of care: A prototype



*These signal functions are required at comprehensive and intensive EmONC levels, but they can (and often will) be part of service delivery at first line EmONC facilities.

42. Based on the above criteria, the following newborn signal functions should be included in the revised EmONC framework: *

	Agree	Disagree
Administer antenatal corticosteroids (ACS) to women at risk of preterm birth	☐	☐
Perform neonatal resuscitation with bag and mask	☐	☐
Initiate kangaroo mother care (for LBW/preterm newborns)	☐	☐
Administer oxygen therapy for respiratory support	☐	☐
Administer parenteral* antibiotics (newborn)	☐	☐
Perform assisted feeding with expressed breastmilk (e.g. cup and/or nasogastric feeding)	☐	☐
Administer phototherapy for hyperbilirubinemia (jaundice)	☐	☐

	Agree	Disagree
Provide thermal care (e.g. with radiant warmer, incubator)	☐	☐
Perform blood transfusion (newborn)	☐	☐
Administer continuous positive airway pressure (CPAP) (newborn)	☐	☐
Administer mechanical ventilation (newborn)	☐	☐
Perform services for retinopathy of prematurity	☐	☐
Provide continued clinical care during interfacility transfer	☐	☐

Comments:

43. I agree with the placement of "Provide continued clinical care during interfacility transfer" at the first line level of care as proposed in the prototype. *

- ☐ Agree with placement at first line level
- ☐ Disagree- should be placed at comprehensive level
- ☐ Disagree- should be placed at intensive level

Comments:

44. I agree with the placement of "Perform neonatal resuscitation with bag and mask" at the first line level of care as proposed in the prototype. *

☐

Agree with placement at first line level

☐

Disagree- should be placed at comprehensive level

☐

Disagree- should be placed at intensive level

Comments:

45. I agree with the placement of "Initiate kangaroo mother care (for LBW/preterm newborns)" at the first line level of care as proposed in the prototype. *

☐

Agree with placement at first line level

☐

Disagree- should be placed at comprehensive level

☐

Disagree- should be placed at intensive level

Comments:

46. I agree with the placement of "Perform assisted feeding with expressed breastmilk (e.g. cup and/or nasogastric feeding)" at the first line level of care as proposed in the prototype. *

☐

Agree with placement at first line level

☐

Disagree- should be placed at comprehensive level

☐

Disagree- should be placed at intensive level

Comments:

47. I agree with the placement of "Administer oxygen therapy for respiratory support" at the first line level of care as proposed in the prototype. *

☐

Agree with placement at first line level

☐

Disagree- should be placed at comprehensive level

☐

Disagree- should be placed at intensive level

Comments:

48. I agree with the placement of "Administer parenteral antibiotics (newborn)" at the first line level of care as proposed in the prototype. *

☐

Agree with placement at first line level

☐

Disagree- should be placed at comprehensive level

☐

Disagree- should be placed at intensive level

Comments:

49. I agree with the placement of "Provide thermal care (e.g. with radiant warmer, incubator)" at the comprehensive level of care as proposed in the prototype. *

☐ Agree with placement at comprehensive level

☐ Disagree- should be placed at first line level

☐ Disagree- should be placed at intensive level

Comments:

50. I agree with the placement of "Administer antenatal corticosteroids (ACS) to women at risk of preterm birth" at the comprehensive level of care as proposed in the prototype. *

☐ Agree with placement at comprehensive level

☐ Disagree- should be placed at first line level

☐ Disagree- should be placed at intensive level

Comments:

51. I agree with the placement of "Administer phototherapy for hyperbilirubinemia (jaundice)" at the comprehensive level of care as proposed in the prototype. *

☐ Agree with placement at comprehensive level

☐ Disagree- should be placed at first line level

☐ Disagree- should be placed at intensive level

Comments:

52. I agree with the placement of "Perform services for retinopathy of prematurity" at the comprehensive level of care as proposed in the prototype. *

☐ Agree with placement at comprehensive level

☐ Disagree- should be placed at first line level

☐ Disagree- should be placed at intensive level

Comments:

53. I agree with the placement of "Administer continuous positive airway pressure (CPAP) (newborn)" at the comprehensive level of care as proposed in the prototype. *

☐ Agree with placement at comprehensive level

☐ Disagree- should be placed at first line level

☐ Disagree- should be placed at intensive level

Comments:

54. I agree with the placement of "Perform blood transfusion (newborn)" at the intensive level of care as proposed in the prototype. *

☐ Agree with placement at intensive level

- ☐ Disagree- should be placed at first line level
- ☐ Disagree- should be placed at comprehensive level

Comments:

55. I agree with the placement of "Administer mechanical ventilation (newborn)" at the intensive level of care as proposed in the prototype. *

- ☐ Agree with placement at intensive level
- ☐ Disagree- should be placed at first line level
- ☐ Disagree- should be placed at comprehensive level

Comments:

8. Additional questions

56. Beyond the signal functions included in the prototype, are there signal functions for interventions for preventing stillbirth that you consider meet the signal function criteria?

57. Beyond the signal functions included in the prototype, are there signal functions that capture interventions that benefit women and newborns together that you consider meet the signal function criteria?

58. Are there any other signal functions other than those shown on the prototype that you think are essential to include in the revised EmONC framework?

9. Thank You

59. I would like to receive communications and information about the revised EmONC framework and indicators.

☐ Yes

☐ No

60. I would be interested to provide feedback on other aspects of the EmONC framework and indicators as it develops.

☐ Yes

☐ No

Thank you for participating in all three rounds of this Delphi study on obstetric and newborn care signal functions and levels of care!

Best regards,

Dr Sarah Moxon, Dr Sudha Sharma and Dr Jalemba Aluvaala

On behalf of the Re-Visioning EmONC Project Steering Committee

Appendix 9: EmONC Signal Functions for Delphi R3

Obstetric signal functions

Historical status	Signal function	Measurement through interview with in-charge	Intervention description
-------------------	-----------------	--	--------------------------

		and/or cross checking through register review and/or patient records	
Existing (basic & comprehensive)	Administer parenteral* antibiotics (maternal)	In the last...has the facility administered parenteral antibiotics for suspected or confirmed maternal infection?	Parenteral antibiotics are used for suspected or established severe maternal infection or maternal sepsis (e.g., reproductive tract infection following abortion or childbirth). Their use is also recommended in cases of maternal generalised bacteraemia and septicaemia.
Existing (basic & comprehensive)	Administer medications to treat post-partum-haemorrhage (PPH)	In the last...has the facility administered appropriate medications (including uterotonics and tranexamic acid) to treat excessive bleeding after delivery?	Uterotonics (oxytocin alone as the first choice) are used to treat PPH most commonly caused by atonic uterus. They can also be used to treat bleeding after an incomplete late abortion along with other definitive treatment. In settings where oxytocin is unavailable, the use of other injectable uterotonics or oral misoprostol is recommended. In addition to other uterotonics, the use of tranexamic acid is recommended for the treatment of PPH if it is thought that the bleeding may be partly due to trauma.
Existing (basic & comprehensive)	Administer magnesium sulfate for severe pre-eclampsia or eclampsia	In the last...has the facility administered magnesium sulfate for severe preeclampsia/eclampsia?	Magnesium sulfate is given to women diagnosed with severe pre-eclampsia or eclampsia to prevent and treat convulsions.
New	Provide IV fluid replacement therapy (e.g. for shock or sepsis)	In the last...has the facility administered IV fluids in labour or in the postpartum period to treat shock?	Intravenous replacement fluids during pregnancy and labour as replacement therapy or in the postpartum period to treat shock are the first-line treatment for hypovolaemia due to haemorrhage (antepartum/post-partum), sepsis or other cause. In case of post-partum haemorrhage it maintains the circulation whilst interventions to control bleeding are performed and assessment for whether blood transfusion is needed.
Existing (basic & comprehensive)	Perform manual removal of retained placenta and uterine exploration	in the last...has the facility performed manual uterine exploration and manual removal of retained placenta?	This procedure addresses retained placenta or fragments of the placenta. It entails full antiseptic procedure, pain relief, and insertion of gloved hand into the uterus to locate the edge of the placenta, separating the

			placenta in its entirety from the uterine wall and removing it.
Existing (basic & comprehensive)	Perform removal of retained products of conception (POC) for abortion or post-abortion care (e.g., vacuum aspiration, dilation and evacuation, medical management)	In the last...has the facility performed vacuum aspiration, dilation and evacuation or medical management for removing retained products of conception, or for inducing a safe abortion?	Retained POC can occur as a result of an incomplete spontaneous or induced abortion. Vacuum aspiration entails inserting an appropriate sized cannula into the uterus, creating vacuum in a plastic syringe, connecting it to the cannula and removing the POC with gentle aspiration using a rotating movement. POC can also be removed by dilatation and evacuation.
Existing (basic & comprehensive)	Perform assisted vaginal birth (e.g. vacuum extractor, ventouse, forceps)	In the last...has the facility performed assisted vaginal delivery for any maternal or fetal indication?	This procedure is performed during the second stage of labour to deliver the baby for indications of fetal distress or prolonged second stage of labour. Prerequisite conditions are a skilled health provider, fully dilated cervix and a fetal head that has descended sufficiently.
Existing (comprehensive)	Perform blood transfusion	In the last...has the facility performed blood transfusion for any maternal indication?	The need for the transfusion of whole blood or blood products can occur due to antepartum or postpartum haemorrhage leading to shock, loss of a large volume of blood such as with ruptured ectopic pregnancy or an operative birth, or with coagulation disorders or severe anaemia late in pregnancy.
Existing (comprehensive)	Perform caesarean section	In the last...has the facility performed caesarean section for any maternal or fetal indication?	Caesarean section is performed for multiple maternal and fetal indications that commonly include prolonged or obstructed labour, fetal distress, malpresentation or placenta previa. It is assumed that if caesarean section is performed the facility is also capable of providing anaesthesia.
New	Provide intensive level organ support	In the last...has the facility provided intensive level organ support to women for maternal indications?	Intensive-level support of one or more organs is required for women with severe complications, including severe PPH or sepsis, septic shock, acute renal failure or cerebral haemorrhage.

* Parenteral includes administration of a drug through the intravenous route or as intra-muscular injections.

Content above has been adapted from:

World Health Organization, UNFPA, UNICEF. *Managing Complications in Pregnancy and Childbirth: a guide for midwives and doctors* – 2nd edition, Geneva: World Health Organization; 2017. Licence: CC BY-NC-SA 3.0 IGO.

Newborn signal functions

Historical status	Signal function	Measurement through interview with in-charge and/or cross checking through register review and/or patient records	Intervention description/definition
New	Administer antenatal corticosteroids (ACS) to women at risk of preterm birth	In the last...has the facility administered ACS to women at risk of imminent preterm birth?	The administration of ACS to women at risk of imminent preterm birth is used to stimulate fetal lung maturation and refers to dexamethasone or betamethasone administered by intramuscular injection for women at risk of imminent preterm birth (anticipated with the subsequent 7 days) from 24 weeks to 34 weeks gestation according to WHO guidelines. The recommendation is that ACS is only offered at a level where resuscitation, thermal care, feeding support, infection treatment and safe oxygen are available. ACS are contraindicated for women with chorioamnionitis.
Existing (basic & comprehensive)	Perform neonatal resuscitation with bag and mask	In the last...has the facility performed neonatal resuscitation with a bag and mask?	Basic newborn resuscitation at the time of birth comprises of a set of interventions required to establish breathing and circulation in a newborn who is not spontaneously breathing/crying at birth. This procedure includes providing positive-pressure ventilation with a bag and mask equipment of an appropriate size (i.e. not referring to simple stimulation by rubbing, drying).
New	Initiate kangaroo mother care (for LBW/preterm newborns)	In the last...has the facility initiated kangaroo mother care position for LBW or preterm newborns whereby newborns are held in prolonged, continuous direct skin-to-skin contact on the mother's chest?	Kangaroo mother care is an approach to care of preterm and/or LBW infants. The signal function at the first line EmONC level refers to initiation of newborns held in the kangaroo position most of the day whereby the infant is placed and held in direct skin-to-skin contact on the mother's (or other caregiver's) chest in an up-right position. The aim is for early initiation of KMC and for continuous performance (>18 hours per day). KMC provided at a comprehensive or intensive care level would be provided alongside other supportive care as per

			WHO guidelines. Other key components of KMC are support for exclusive and early breastmilk provision and timely discharge from the hospital with appropriate follow-up. When babies are not in KMC position with the mother or another care-giver, appropriate thermal care should be provided.
New	Administer oxygen therapy for respiratory support	In the last... has the facility administered oxygen therapy to newborns for respiratory support?	Small and sick newborns with hypoxia require appropriate oxygen therapy. At the first line level, safe oxygen therapy may be initiated. At a comprehensive level, it would be expected that safe oxygen therapy is provided, as per small and sick newborn care guidelines. Pulse oximetry determines the presence of hypoxia and hyperoxia, and guides safe administration of oxygen therapy. At a comprehensive and intensive care level, oxygen therapy would involve administration of oxygen via neonatal nasal prong using low-flow metres with pulse oximetry, air oxygen blenders and humidifiers, which are a requirement for oxygen therapy on a neonatal unit as per <i>WHO small and sick newborn care guidelines</i> .
New	Administer parenteral* antibiotics (newborn)	In the last... has the facility administered parenteral antibiotics to newborns with suspected bacterial infection?	Parenteral antibiotics are used for suspected or established infections including the clinical syndromes of sepsis, meningitis or pneumonia in newborns based on clinical presentation diagnosed via clinical algorithm or confirmed via positive blood culture. At the first line level, antibiotics may be given at least as an intramuscular dose as pre-referral treatment as per WHO guidelines. At a comprehensive and intensive care level, antibiotics may be given as IV doses or infusions as per <i>WHO small and sick newborn care guidelines</i> .
New	Perform assisted feeding with expressed breastmilk (e.g. cup and/or nasogastric feeding)	In the last... has the facility performed assisted feeding of newborns with expressed breastmilk via cup and/or nasogastric tube?	Assisted feeding of newborns is performed for babies that may not be able to effectively breastfeed due to prematurity, small size or sickness and refers to the provision of cup and/or gastric tube feeding of newborns using expressed breastmilk or donor milk.
New	Administer phototherapy for hyperbilirubinemia (jaundice)	In the last... has the facility administered phototherapy to newborns with jaundice?	Jaundice is common in all newborns and without treatment can lead to severe illness (e.g. kernicterus) and death. Administering phototherapy for neonatal hyperbilirubinemia refers to treatment with effective, safe phototherapy e.g. high-intensity light emitting diodes (LED).

New	Provide thermal care (e.g. with radiant warmer, incubator)	In the last... has the facility performed thermal care for newborns using a radiant warmer, incubator (or equivalent warming device)?	Preterm newborns and/or LBW infants at risk of hypothermia who are unstable or who cannot be cared for in kangaroo mother care, require thermal care using a clean incubator or under radiant warmer (or equivalent warming device). Close temperature monitoring is also required.
New	Perform blood transfusion (newborn)	In the last...has the facility performed transfusion of blood products to newborns?	The need for transfusion of blood or blood products can occur due to multiple conditions. Blood transfusion for newborns should be performed with fresh, irradiated blood that is negative for cytomegalovirus and warmed for administration with close monitoring of the newborn for transfusion reactions.
New	Administer CPAP (newborn)	In the last... has the facility administered continuous positive airway pressure (CPAP) for newborns?	Continuous positive airway pressure is a non-invasive type of respiratory support which can be delivered without endotracheal intubation and is used for small and sick newborns (especially preterm) with surfactant deficiency. When administering oxygen via CPAP, attention to safe oxygen therapy as per small and sick newborn guidelines, including use of pulse oximetry at the comprehensive and intensive care level.
New	Administer mechanical ventilation (newborn)	In the last... has the facility administered mechanical ventilation (invasive respiratory support) to newborns?	Mechanical ventilation is an invasive type of respiratory support for extremely small and sick newborns involving endotracheal intubation and breathing support with a mechanical ventilator. Mechanical ventilation requires high level of monitoring and supportive care as per <i>WHO small and sick newborn guidelines</i> .
New	Perform services for retinopathy of prematurity	In the last... has the facility performed services (screening and/or treatment) for retinopathy of prematurity?	Retinopathy of prematurity, a complication of preterm birth, is a vision-threatening disease associated with abnormal retinal vascular development that can lead to blindness and visual impairment. Services for retinopathy of prematurity require inpatient screening of eligible at-risk infants for ROP by trained technician or ophthalmologist. Infants identified as requiring treatment will require laser treatment by indirect delivery or intravitreal injection of AntiVEGF agents for infants developing signs of sight threatening (Type 1) ROP. At most secondary level facilities only screening will be possible (by trained technicians or ophthalmologist) and infants will require a referral to an appropriate centre for treatment.

*Parenteral includes administration of a drug through the intravenous route or as intramuscular injections.

Content above has been adapted from:

World Health Organization, UNFPA, UNICEF (2017). *Managing Complications in Pregnancy and Childbirth: a guide for midwives and doctors* – 2nd edition, Geneva: World Health Organization

World Health Organization (2020). *Standards for improving quality of care for small and sick newborns in health facilities*. Geneva: World Health Organization

World Health Organization (2015) *World Health Organization recommendations on interventions to improve preterm birth outcomes*. Geneva: World Health Organization.

Referral signal function for obstetric and newborn care

New	Provide continued clinical care during interfacility transfer	In the last... has the facility coordinated transport with a clinically trained health worker (and adequate equipment) to ensure ongoing provision of obstetric and/or newborn care during transfer between facilities?	Continued care during interfacility transfer refers to transport of obstetric and/or newborn patients with a clinically trained health worker and adequate equipment to ensure ongoing provision of emergency care during transfer between facilities.
------------	--	---	--

Appendix 10: Feedback on EmONC Signal Functions from Delphi R3

Obstetric signal functions

Historical status	Signal function	Proposed change to wording of signal function from Delphi R3	Intervention description	Other notes
Existing (basic & comprehensive)	Administer parenteral* antibiotics (maternal)	No specific proposed changes	Parenteral antibiotics are used for suspected or established severe maternal infection or maternal sepsis (e.g., reproductive tract infection following abortion or childbirth). Their use is also recommended in cases of maternal generalised bacteraemia and septicaemia.	Often confusion over meaning of parenteral
Existing (basic & comprehensive)	Administer medications to treat post-partum-haemorrhage (PPH)	No specific proposed changes (see notes)	Uterotonics (oxytocin alone as the first choice) are used to treat PPH most commonly caused by atonic uterus. They can also be used to treat bleeding after an incomplete late abortion along with other definitive treatment. In settings where oxytocin is unavailable, the use of other injectable uterotonics or oral misoprostol is recommended. In addition to other uterotonics, the use of tranexamic acid is recommended for the treatment of PPH if it is thought that the bleeding may be partly due to trauma.	Concerns about the different medications in the algorithm and tracking their use separately. Suggestions that Anti-shock garment (NASG) could be included.
Existing (basic & comprehensive)	Administer magnesium sulfate for severe pre-eclampsia or eclampsia	No specific proposed changes	Magnesium sulfate is given to women diagnosed with severe pre-eclampsia or eclampsia to prevent and treat convulsions.	Some concerns that other drugs other than magnesium sulfate may be used for the treatment of the condition.

Historical status	Signal function	Proposed change to wording of signal function from Delphi R3	Intervention description	Other notes
New	Provide IV fluid replacement therapy (e.g. for shock or sepsis)	No specific proposed changes	Intravenous replacement fluids during pregnancy and labour as replacement therapy or in the postpartum period to treat shock are the first-line treatment for hypovolaemia due to haemorrhage (antepartum/post-partum), sepsis or other cause. In case of post-partum haemorrhage it maintains the circulation whilst interventions to control bleeding are performed and assessment for whether blood transfusion is needed.	IV fluids are available in most health facilities – some concerns that this is not needed as a specific signal function.
Existing (basic & comprehensive)	Perform manual removal of retained placenta and uterine exploration	No specific proposed changes.	This procedure addresses retained placenta or fragments of the placenta. It entails full antiseptic procedure, pain relief, and insertion of gloved hand into the uterus to locate the edge of the placenta, separating the placenta in its entirety from the uterine wall and removing it.	Ensure there is minimal confusion between MVA and manual removal of placenta
Existing (basic & comprehensive)	Perform removal of retained products of conception (POC) for abortion or post-abortion care (e.g., vacuum aspiration, dilation and evacuation, medical management)	No specific proposed changes	Retained POC can occur as a result of an incomplete spontaneous or induced abortion. Vacuum aspiration entails inserting an appropriate sized cannula into the uterus, creating vacuum in a plastic syringe, connecting it to the cannula and removing the POC with gentle aspiration using a rotating movement. POC can also be removed by dilatation and evacuation.	Concerns about D&E at the lowest level and the mix of surgical and medical methods included in the signal function.

Historical status	Signal function	Proposed change to wording of signal function from Delphi R3	Intervention description	Other notes
Existing (basic & comprehensive)	Perform assisted vaginal birth (e.g. vacuum extractor, ventouse, forceps)	No specific proposed changes	This procedure is performed during the second stage of labour to deliver the baby for indications of fetal distress or prolonged second stage of labour. Prerequisite conditions are a skilled health provider, fully dilated cervix and a fetal head that has descended sufficiently.	
Existing (comprehensive)	Perform blood transfusion	No specific proposed changes	The need for the transfusion of whole blood or blood products can occur due to antepartum or postpartum haemorrhage leading to shock, loss of a large volume of blood such as with ruptured ectopic pregnancy or an operative birth, or with coagulation disorders or severe anaemia late in pregnancy.	
Existing (comprehensive)	Perform caesarean section	Some suggestions to revert to include other surgery as well	Caesarean section is performed for multiple maternal and fetal indications that commonly include prolonged or obstructed labour, fetal distress, malpresentation or placenta previa. It is assumed that if caesarean section is performed the facility is also capable of providing anaesthesia.	Qualification or benchmarking may be needed to monitor overuse. Concerns also that anaesthesia/pain relief should not be assumed to be available and correctly used. Concerns also that laparotomy and other types of surgery may need to be measured.
New	Provide intensive level organ support	No specific proposed changes but concerns about	Intensive-level support of one or more organs is required for women with severe complications, including severe	Needs refinement and better definition – concerns that the signal function is too vague and

Historical status	Signal function	Proposed change to wording of signal function from Delphi R3	Intervention description	Other notes
		definition (see other notes)	PPH or sepsis, septic shock, acute renal failure or cerebral haemorrhage.	specific examples needed.

* Parenteral includes administration of a drug through the intravenous route or as intra-muscular injections.

Content above has been adapted from:

World Health Organization, UNFPA, UNICEF. *Managing Complications in Pregnancy and Childbirth: a guide for midwives and doctors* – 2nd edition, Geneva: World Health Organization; 2017. Licence: CC BY-NC-SA 3.0 IGO.

Newborn signal functions

Historical status	Signal function	Proposed change to wording of signal function from Delphi R3	Intervention description/definition	Other notes
New	Administer antenatal corticosteroids (ACS) to women at risk of preterm birth	No specific proposed changes	The administration of ACS to women at risk of imminent preterm birth is used to stimulate fetal lung maturation and refers to dexamethasone or betamethasone administered by intramuscular injection for women at risk of imminent preterm birth (anticipated with the subsequent 7 days) from 24 weeks to 34 weeks gestation according to WHO guidelines. The recommendation is that ACS is only offered at a level where resuscitation, thermal care, feeding support, infection treatment and safe oxygen are	Proposals to place this with obstetric signal functions given timing of care. Essential to adhere to WHO safety guidelines.

Historical status	Signal function	Proposed change to wording of signal function from Delphi R3	Intervention description/definition	Other notes
			available. ACS are contraindicated for women with chorioamnionitis.	
Existing (basic & comprehensive)	Perform neonatal resuscitation with bag and mask	No specific proposed changes	Basic newborn resuscitation at the time of birth comprises of a set of interventions required to establish breathing and circulation in a newborn who is not spontaneously breathing/crying at birth. This procedure includes providing positive-pressure ventilation with a bag and mask equipment of an appropriate size (i.e. not referring to simple stimulation by rubbing, drying).	
New	Initiate kangaroo mother care (for LBW/preterm newborns)	Initiate Perform kangaroo mother care (for LBW/preterm newborns) OR Perform immediate kangaroo mother care (for LBW/preterm newborns)	Kangaroo mother care is an approach to care of preterm and/or LBW infants. The signal function at the first line EmONC level refers to initiation of newborns held in the kangaroo position most of the day whereby the infant is placed and held in direct skin-to-skin contact on the mother's (or other caregiver's) chest in an up-right position. The aim is for early initiation of KMC and for continuous performance (>18 hours per day). KMC provided at a comprehensive or intensive care level would be provided alongside other supportive care as per WHO guidelines. Other key components of KMC are support for exclusive and early breastmilk provision and timely discharge from the hospital with appropriate follow-up. When babies are not in KMC position with the mother or another care-	Some concerns that this doesn't fit criteria for signal functions due to the multiple components/dimensions of the intervention and that it requires more complex indicator construction (e.g. composite) There are known measurement challenges with KMC that need to be explored further.

Historical status	Signal function	Proposed change to wording of signal function from Delphi R3	Intervention description/definition	Other notes
			giver, appropriate thermal care should be provided.	
New	Administer oxygen therapy for respiratory support	No specific proposed changes	Small and sick newborns with hypoxia require appropriate oxygen therapy. At the first line level, safe oxygen therapy may be initiated. At a comprehensive level, it would be expected that safe oxygen therapy is provided, as per small and sick newborn care guidelines. Pulse oximetry determines the presence of hypoxia and hyperoxia, and guides safe administration of oxygen therapy. At a comprehensive and intensive care level, oxygen therapy would involve administration of oxygen via neonatal nasal prong using low-flow metres with pulse oximetry, air oxygen blenders and humidifiers, which are a requirement for oxygen therapy on a neonatal unit as per <i>WHO small and sick newborn care guidelines</i> .	Safety concerns and need for monitoring with pulse oximetry. Many lower level facilities do not have oxygen.
New	Administer parenteral* antibiotics (newborn)	No specific proposed changes	Parenteral antibiotics are used for suspected or established infections including the clinical syndromes of sepsis, meningitis or pneumonia in newborns based on clinical presentation diagnosed via clinical algorithm or confirmed via positive blood culture. At the first line level, antibiotics may be given at least as an intramuscular dose as pre-referral treatment as per WHO guidelines. At a comprehensive and intensive care level, antibiotics may be given as IV	Often confusion over meaning of parenteral. Whilst the lowest level could give the first dose/pre-referral or IM antibiotics, a baby who needs inpatient care and antibiotics would need to be in a comprehensive or level 2 inpatient care facility. Concerns over antibiotic stewardship.

Historical status	Signal function	Proposed change to wording of signal function from Delphi R3	Intervention description/definition	Other notes
			doses or infusions as per <i>WHO small and sick newborn care guidelines</i> .	
New	Perform assisted feeding with expressed breastmilk (e.g. cup and/or nasogastric feeding)	No specific proposed changes	Assisted feeding of newborns is performed for babies that may not be able to effectively breastfeed due to prematurity, small size or sickness and refers to the provision of cup and/or gastric tube feeding of newborns using expressed breastmilk or donor milk.	Some concerns that nasogastric tube feeding not appropriate at the lowest level.
New	Administer phototherapy for hyperbilirubinemia (jaundice)	No specific proposed changes	Jaundice is common in all newborns and without treatment can lead to severe illness (e.g. kernicterus) and death. Administering phototherapy for neonatal hyperbilirubinemia refers to treatment with effective, safe phototherapy e.g. high-intensity light emitting diodes (LED).	Bilirubin testing needed as part of care package for jaundice.
New	Provide thermal care (e.g. with radiant warmer, incubator)	No specific proposed changes	Preterm newborns and/or LBW infants at risk of hypothermia who are unstable or who cannot be cared for in kangaroo mother care, require thermal care using a clean incubator or under radiant warmer (or equivalent warming device). Close temperature monitoring is also required.	Concerns that thermal care is part of care for every baby starting with drying and skin to skin at birth – some concerns that it doesn't fit criteria for a signal function and overlaps or has potential to undermine KMC at comprehensive level. Requires necessary infrastructure (e.g., is about power supply) and maintenance of equipment and supplies and may be better measured as an indicator. Concerns that this undermines KMC and implies

Historical status	Signal function	Proposed change to wording of signal function from Delphi R3	Intervention description/definition	Other notes
				that thermal care is superior or a higher level intervention than KMC.
New	Perform blood transfusion (newborn)	No specific proposed changes	The need for transfusion of blood or blood products can occur due to multiple conditions. Blood transfusion for newborns should be performed with fresh, irradiated blood that is negative for cytomegalovirus and warmed for administration with close monitoring of the newborn for transfusion reactions.	Clarification on whether inclusive of exchange transfusion
New	Administer CPAP (newborn)	No specific proposed changes	Continuous positive airway pressure is a non-invasive type of respiratory support which can be delivered without endotracheal intubation and is used for small and sick newborns (especially preterm) with surfactant deficiency. When administering oxygen via CPAP, attention to safe oxygen therapy as per small and sick newborn guidelines, including use of pulse oximetry at the comprehensive and intensive care level.	This is a key part of ENAP coverage target and is not possible to get to SDG 3.2 of NMR <12 per 1000 live births without respiratory support for preterm so CPAP needs to be widely (and effectively, safely) available
New	Administer mechanical ventilation (newborn)	No specific proposed changes but see other notes.	Mechanical ventilation is an invasive type of respiratory support for extremely small and sick newborns involving endotracheal intubation and breathing support with a mechanical ventilator. Mechanical ventilation requires high level of monitoring and	Safety concerns about this as a signal function and concerns about increasing inappropriate use (where CPAP would be more appropriate). Would mention of surfactant also make sense?

Historical status	Signal function	Proposed change to wording of signal function from Delphi R3	Intervention description/definition	Other notes
			supportive care as per <i>WHO small and sick newborn guidelines</i> .	Some suggestions to align more with obstetric intensive level signal function
New	Perform services for retinopathy of prematurity	Care for retinopathy of prematurity	Retinopathy of prematurity, a complication of preterm birth, is a vision-threatening disease associated with abnormal retinal vascular development that can lead to blindness and visual impairment. Services for retinopathy of prematurity require inpatient screening of eligible at-risk infants for ROP by trained technician or ophthalmologist. Infants identified as requiring treatment will require laser treatment by indirect delivery or intravitreal injection of AntiVEGF agents for infants developing signs of sight threatening (Type 1) ROP. At most secondary level facilities only screening will be possible (by trained technicians or ophthalmologist) and infants will require a referral to an appropriate centre for treatment.	Concerns that this doesn't fit criteria for signal function Too vague and very setting dependent Only screening often available at level 2/comprehensive. Many suggest that services to diagnose would be available at level 2 and that services to treat would only be available at intensive level.

*Parenteral includes administration of a drug through the intravenous route or as intra-muscular injections.

Content above has been adapted from:

World Health Organization, UNFPA, UNICEF (2017). *Managing Complications in Pregnancy and Childbirth: a guide for midwives and doctors* – 2nd edition, Geneva: World Health Organization

World Health Organization (2020). *Standards for improving quality of care for small and sick newborns in health facilities*. Geneva: World Health Organization

World Health Organization (2015) *WHO recommendations on interventions to improve preterm birth outcomes*. Geneva: World Health Organization.

World Health Organization (2022) *WHO recommendations on antenatal corticosteroids for improving preterm birth outcomes*. Geneva: World Health Organization.

Referral signal function for obstetric and newborn care

Historical Status	Signal function	Proposed changes to wording of signal function from Delphi R3	Intervention description/definition	Other notes
New	Provide continued clinical care during interfacility transfer	Suggestions that it could be re-phrased to include or emphasise <i>pre-transfer stabilisation</i>	Continued care during interfacility transfer refers to transport of obstetric and/or newborn patients with a clinically trained health worker and adequate equipment to ensure ongoing provision of emergency care during transfer between facilities.	Requires further definition and discussion. Concerns that criteria are very challenging to achieve for many countries.

Appendix 11 and 12. Cascade charts for obstetric and newborn care synthesising results of Delphi study across rounds.

Main causes of mortality and morbidity	Round 1 master list	Signal function list for R2	Results R2 (top nine rated)	Signal function list for R3	Results R3 (consensus threshold >85%)
Preterm birth complications	Antenatal corticosteroids for preterm labour	Administer antenatal corticosteroids (ACS) (e.g. dexamethasone, betamethasone) to women at risk of preterm birth	Administer antenatal corticosteroids (ACS) (e.g. dexamethasone, betamethasone) to women at risk of preterm birth (average rank 5.33)	Administer antenatal corticosteroids (ACS) to women at risk of preterm birth	Administer antenatal corticosteroids (ACS) to women at risk of preterm birth (93% respondents agree)
	Antenatal magnesium sulphate	Administer magnesium sulfate to women at risk of preterm birth	Administer magnesium sulfate to women at risk of preterm birth (average rank 8.21)		
	Surfactant therapy				
	Screening and treatment for ROP	Perform services for retinopathy of prematurity		Perform services for retinopathy of prematurity	Perform services for retinopathy of prematurity (88% respondents agree)
	Assessment and management of bronchopulmonary dysplasia				
	Vitamin D, Calcium, phosphorus and iron supplements for LBW newborns				
	Caffeine (methylxanthines) for preterm babies (prevention of apnoea)	Administer methylxanthines (e.g. caffeine) for preterm newborns for prevention and treatment of apnoea			
	Assessment and management of NEC				
	Kangaroo mother care	Initiate kangaroo mother care (for LBW/preterm newborns)	Initiate kangaroo mother care (for LBW/preterm newborns) (average rank 4.91)	Initiate kangaroo mother care (for LBW/preterm newborns)	Initiate kangaroo mother care (for LBW/preterm newborns) (98% respondents agree)
Intrapartum-related events	Provide thermal care (e.g. radiant warmer, incubator, heated cot) or other thermal care	Provide thermal care (e.g. radiant warmer, incubator, heated cot) for preterm/LBW newborns	Provide thermal care (e.g. radiant warmer, incubator, heated cot) for preterm/LBW newborns (average rank 9.04)	Provide thermal care (e.g. with radiant warmer, incubator)	Provide thermal care (e.g. with radiant warmer, incubator) (95% respondents agree)
	Neonatal resuscitation	Perform neonatal resuscitation with bag and mask	Perform neonatal resuscitation with bag and mask (average rank 1.79)	Perform neonatal resuscitation with bag and mask	Perform neonatal resuscitation with bag and mask (100% respondents agree)
Infections	Administer parenteral anticonvulsants and manage seizures	Administer parenteral* anticonvulsants for seizures (newborn) (e.g. phenobarbitone)			
	Antibiotics for P-PROM				
	IM antibiotics for newborn	Administer parenteral* antibiotics (e.g. gentamicin, ampicillin) (newborn)	Administer parenteral antibiotics (e.g. gentamicin, ampicillin) (newborn) (average rank 5.36)	Administer parenteral antibiotics (newborn)	Administer parenteral antibiotics (newborn) (96% respondents agree)
	IV antibiotics for infections				
Neonatal hyperbilirubinaemia	PMTCT				
	Treatment of hyperbilirubinemia (jaundice) with phototherapy	Administer phototherapy for hyperbilirubinemia (jaundice)	Administer phototherapy for hyperbilirubinemia (jaundice) (8.93)	Administer phototherapy for hyperbilirubinemia (jaundice)	Administer phototherapy for hyperbilirubinemia (jaundice) (96% respondents agree)
Combination of complications	Exchange transfusion				
	Oxygen therapy	Administer oxygen therapy with pulse oximetry	Administer oxygen therapy with pulse oximetry (average rank 5.54)	Administer oxygen therapy for respiratory support	Administer oxygen therapy for respiratory support (98% respondents agree)
	Assisted feeding	Perform assisted feeding with expressed breastmilk (e.g. cup and/or nasogastric feeding)	Perform assisted feeding with expressed breastmilk (e.g. cup and/or nasogastric feeding) (average rank 7.47)	Perform assisted feeding with expressed breastmilk (e.g. cup and/or nasogastric feeding)	Perform assisted feeding with expressed breastmilk (e.g. cup and/or nasogastric feeding) (94% respondents agree)
	Administer IV fluids				
	CPAP	Administer CPAP		Administer CPAP	Administer CPAP (95% respondents agree)
	Mechanical assisted ventilation			Administer mechanical ventilation	Administer mechanical ventilation (90% respondents agree)
	Advanced feeding support (e.g. parenteral nutrition)				
	Perform blood transfusion	Perform blood transfusion (newborn)		Perform blood transfusion	Perform blood transfusion (91% respondents agree)
	Detection and management of congenital conditions				
	Paediatric surgical care				
	Treatment of hypoglycaemia				
	Assessment and management of anaemia				
	Management of pain				
	Provision of developmentally supportive care				
	Specialised follow up of high risk				
	Discharge preparedness for home care and plan for follow up				

