OVERVIEW OF KEY ELEMENTS FOR A HYBRID CLASSIFICATION SYSTEM FOR CAUSES OF STILLBIRTHS AND NEONATAL DEATHS IN DATA-RICH SETTINGS

A background document for for a workshop on classification
organized by a working group of the International Stillbirth Alliance's Scientific Advisory Committee (SAC)
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prepared by

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CONTENTS

1. Introduction 5
2. Background & purpose 7
3. Basic principles of the system 8
   3.1 Purpose of the system 9
   3.2 Underlying cause 11
   3.3 Associated conditions 13
   3.4 Type of death 15
   3.5 ICD-10 codes 16
4. Structure of the system 17
   4.1 Hierarchical approach 18
   4.2 Number of levels 19
5. Causes to include in the system 20
   5.1 Number of causes 21
   5.2 Major cause groups 22
   5.3 Congenital anomaly 25
   5.4 Infection 26
   5.5 Placental & cord conditions 27
   5.6 Other neonatal & fetal conditions 30
   5.7 Other maternal conditions 33
   5.8 Intrapartum-related conditions 36
   5.9 Prematurity-associated conditions 38
   5.10 Additional categories 39
   5.11 Definitions of causes 41
6. Features to ensure high-quality performance of the system 42
   6.1 Rules for assigning causes 43
   6.2 Accessibility 44
   6.3 Minimum dataset (MDS) 45
7. Testing & rollout of the system 47
   7.1 Criteria for assessing success 48
   7.2 Dissemination 49
   7.3 Evaluation and revision 50

8. Basic data on other national systems 51
8.1 Introduction 51
8.2 Canada's Public Health Agency 2008 51
8.3 Brazilian List of Avoidable Deaths 51
8.4 Bangladesh NIPORT 2004 51
8.5 National Services Scotland 2013-obstetric 52
8.6 UK: CMACE 2010-maternal & fetal 53
8.7 UK, Wales: CMACE 2011-maternal & fetal 53
8.8 Ireland: Manning 2013-maternal & fetal 54
8.9 South Africa: MRC 2002-PPIP 55
8.10 Lithuania: Basys 2014 55
9. ICD-PM 56
Causes 56
Rules 57
10. Delphi systems 59
Cole 1986 59
Classification categories 59
Definitions 59
Rules 60
CODAC 62
Classification categories 62
Definitions 63
Rules 64
Tulip 65
Classification categories 65
Definitions 66
Rules 66
PSANZ-PDC 68
Congenital anomaly 68
Perinatal infection 70
Hypertension 72
Antepartum haemorrhage (APH) 72
Maternal Conditions 73
Complications of multiple pregnancy 74
Specific perinatal conditions 74

Hypoxic peripartum death 76
Placental dysfunction or placental pathology 77
Spontaneous preterm labour or rupture of membranes (ROM (<37 weeks gestation) 78
Unexplained antepartum fetal death 80
Neonatal death without obstetric antecedent 80
Kotecha 82
Classification categories: 82
INCODE 83
Classification categories 83
Definitions 84
Rules 85
11. Sources used 86

1. INTRODUCTION

This document was developed in consultation with the classification working group of the Scientific Advisory Committee of the International Stillbirth Alliance in preparation for a workshop on classification systems for data-rich settings that is to be held in association with, and prior to, the 2017 annual International Stillbirth Alliance conference in Cork, Ireland. The document is lengthy but we hope useful both for those who will be at the workshop and those who cannot attend but will be included in a subsequent process to ultimately result in a new "hybrid" classification system for causes of stillbirth and neonatal death in data-rich settings. We have attempted to include in this background document much of the information that workshop participants might wish to have to hand during the workshop as they discuss various key aspects of such a system.

The document is organized into 11 sections, as follows:

- Section 1- This introduction
- Section 2- Background & Purpose: Provides a brief justification for this document
- Sections 3-7: These cover all the key features of a classification system, in each case providing (a) **Background information** on the topic, drawn from selected existing classification systems and (b) a **Proposal** for workshop participants and others to consider.
    - Section 3: Covers the five basic principles of the system: its purpose, its focus on an underlying cause, its inclusion of associated conditions, its inclusion of stillbirths and neonatal deaths, and its inclusion of ICD-10 codes.
    - Section 4: Covers the two key structural aspects of the system: whether it is hierarchical or not, and how many levels it has.
    - Section 5: Covers the causes to be included in the system. This section starts with a review of the number of causes that should be included and the major causal groups. It then briefly discusses each of these groups as follows: Congenital anomaly, infection, placental and cord conditions, other neonatal and fetal conditions, other maternal conditions, intrapartum-related conditions, prematurity-related conditions, and other main categories (terminations of pregnancy, accidents, unexplained, and unclassifiable). The section concludes with a brief review of the definitions of causes.
    - Section 6: Covers key features that will help ensure high-quality system performance, including: availability of rules for assigning cause of death, accessibility (including e-accessibility and language issues), and the minimum dataset required for optimal system use.
    - Section 7: Covers issues related to testing and roll-out of the system, including criteria for assessing success, dissemination of the system, and provision for its evaluation and revision.
- Section 8 provides basic information on all known "national" systems for classification of causes of stillbirths and neonatal deaths, most of which are located in data-rich settings (high-income countries). The rationale is that for wide use of a hybrid system in data-rich settings, the features of systems currently used in these settings should be viewed as a guide to what users require. Systems used in non-high-income settings are also of interest in the sense that these settings may be on the path to high-income status in the coming decades, e.g. by 2030 which is the stated "due-date" for achieving the global stillbirth rate reduction to 12 per 1000 births, and hence the requirements of users of systems in these countries are also relevant to the workshop discussion.

- Sections 9-10 include lists of causes and, where available, rules and definitions, for the systems that form the basis of the "background" sections elsewhere in this document, and are provided for easy reference during the workshop.
- Section 11 lists sources used.

For ease in navigating the document, please use the Table of contents and the Navigation pane in MS Word. While the overall document is long, individual sections are quite brief and we hope they will stand alone for ease of use during the workshop and subsequent process.

2. BACKGROUND & PURPOSE

The **ultimate objective** of the exercise of which this document forms a part is the creation, dissemination and widespread use of a hybrid classification system for causes of stillbirth & neonatal death suitable for settings with rich data availability that has been signed on to by key stakeholders, maps fully to the ICD-PM, and meets user needs.

Findings from a recent systematic review of classification systems for causes of stillbirth and neonatal death and assessment of alignment of those systems with characteristics for an effective global system identified by a panel of experts (the "Delphi characteristics") summarize the **justification** for such an effort:

> *No system [of 81 identified] was aligned with more than 9 of [the total of] 17 characteristics. This lack of alignment of current systems with the characteristics of an "ideal" classification system for causes of perinatal death may contribute to the ongoing development of new and modified systems at the rate of ten a year for the previous five years, possibly hindering the potential for widespread acceptance of one classification system…[Rather than identifying a "best" system,] we have instead identified the most-aligned of a group that still lacks some essential features needed for effective global use. For instance, Frøen 2009-Codac, which we found to be the most-aligned system, and which was recently adopted by the UK for use in its national perinatal mortality surveillance, has shown a high proportion of stillbirths classified with "unknown" as the primary cause of death (47 % and 46 % from the first two annual reports in 2013 and 2014, respectively) [20, 21]. This high rate of "unknown" stillbirths using Codac in a high-income country has occurred despite education and training for the designated hospital-based staff who submit the data….**Despite the large number of classification systems recently used and/or developed (81), there remains an unmet need for a system that is aligned with expert-identified characteristics** [bolding our own]. To increase acceptance by potential users, ease of use and accessibility will be important, including availability online and in multiple languages, provision of links to data produced by the system, and education and training for potential users.*

The **purpose** of this document is to briefly but comprehensively summarize useful information about classification systems for causes of stillbirth and neonatal death in high-income and other data-rich settings, for use by workshop participants and other key stakeholders aiming to address the need for improved classification in these settings.

We draw mainly on the systems that were found to be most aligned with the "Delphi characteristics" and have been used in high-income settings, along with the WHO's recently-released ICD-PM and INCODE which was developed in the U.S. for use on stillbirths, as well as other key publications on pertinent issues such as placental causes of perinatal mortality. See Section 11 for a list of sources used. The main systems referenced in this document are:

- the 5 top scoring systems against the 17 Delphi characteristics that (a) include SB & NND and (b) have been used in HIC: Codac, PSANZ-PDC, Tulip, Cole 1986, and Kotecha—a clinic-pathological system used in Wales alongside Codac.
- ICD-PM (the WHO-developed and 2016-released application of the ICD-10 to perinatal mortality)
- INCODE, which although not high-scoring by the Delphi panel, is a key system due to its development and use in the high-income setting of the U.S.

3. BASIC PRINCIPLES OF THE SYSTEM

3.1 Purpose of the system

Background:

- A fascinating aspect of classification systems is the multitude of systems (we found 81 used or created 2009-2014) and the continuing creation of new systems every year (an average of 10 a year). While the specific stated purpose of these systems varied, an overarching goal of identifying causes and contributing factors to inform strategies to prevent perinatal deaths is common to all.
- Stated shortcomings of existing systems, as identified in publications that presented new systems, included:
    - Not comprehensive enough (e.g., insufficient placental subcategories)
    - Don't address underlying causes or confuse them with other factors
    - Not holistic: focus on what, or when, or why, rather than all together; don't address mother, fetus and placenta together
    - If feasible for low-income countries, don't accommodate complex systems
    - Lack definitions and guidelines
    - Do not accommodate recent knowledge on causation
    - Focus either on clinical or pathological data rather than both
    - Don't focus on autopsy
    - Have a high proportion of "unexplained" deaths
    - Either ignore fetal growth restriction or consider it to be causal
- Stated rationales for the creation of new systems (in the publications that presented them) included:
    - To add features (e.g. what, where and when; levels of probability; contributing factors)
    - To add missing categories
    - To increase comprehensiveness (include clinical, pathologic, histological, and/or autopsy findings)
    - To increase accuracy and produce actionable data
    - To reach new audiences (e.g. specific HIC, developing regions)
    - To enable identification of underlying causes…or not (one system deliberately does not seek underlying causes)
    - To provide consistency (uniform & clear definitions)
    - To reduce the number of "unexplained" deaths
    - To overcome other shortcomings (e.g., improve information management, be useful for all populations, relate conceptually to the ICD)
- The stated purposes of some key systems referenced in this document was:
    - INCODE:
        - Their stated concerns with other systems: incomplete registration/ascertainment of SB; lack clear, uniform definitions and guidelines; not sufficiently complete.
        - Their stated rationale for creation of this system: aims to classify causes using best available evidence including all clinical and pathologic data; uniform definitions; and have incorporated what, where and when as per Gordijn.
    - PSANZ-PDC:
        - Their stated concerns with other systems: don't accommodate more recent knowledge on causation.

        - Their rationale for creation of this system: intended as a uniform system for Australia and New Zealand, to better assess etiology (including preventable factors), to identify the single most important factor causing death.
    - Codac:
        - Their stated concerns with other systems: some have inconsistent approaches to main SB categories, making comparison difficult
        - Their rationale for development of this system: designed to meet key requirements of a classification system including: information management (capture, storage, retrieval), useful for all populations including developing countries; relate conceptually to the ICD (including identifying underlying causes), supplementing the ICD and informing its revision; identify most clinically distinct COD, with simplicity and reproducibility via extensive subcategorization; manage the most significant data irrespective of source; preserve and manage data.
    - Tulip:
        - Their stated concerns with other systems: some focus either on clinical or pathological data rather than both; incomplete or non-existent COD definitions and guidelines; not all address mother, fetus and placenta together--the ones that do either have minimal classification of the placenta or only focus on SB; or confuse mechanisms and risk factors with COD; simple to use but too general; too high an unexplained rate; low inter-rater agreement.
        - Their rationale for development of this system: aims to design a pathophysiological classification system for PND that separates cause and mechanism of death
- With the large number of existing systems and recent ICD-PM launch, why then do we propose a new system?
    - No system of the 81 identified (created, revised or used in the period 2009-2014 globally) was aligned with more than 9 of the 17 Delphi characteristics. The vast majority were not aligned with most of them. **In short: Existing systems are not meeting the expert-identified characteristics for an effective classification system**.
    - The ICD-PM is necessarily and particularly suited to settings with limited data availability that constitute the locales of most stillbirths and neonatal deaths globally
    - There remains then a gap for a system that is fully aligned with the expert-identified characteristics for an effective classification system and with the ICD-PM, which satisfies the demand and need for classification in data-rich settings

Proposal:

- Clarify and agree on the purpose of a hybrid system including the gap it would be intended to fill.

3.2 Underlying cause

Background:

- "A global system must require the single most important factor leading to the death to be recorded" (Delphi, 86% consensus)
- Multiple definitions of "cause" are used:
    - "The disease or injury which initiated the train of morbid events leading directly to death, or the circumstances of the accident or violence which produced the fatal injury" (ICD-10)
    - "the initial, demonstrable pathophysiological entity initiating the chain of events that has irreversibly led to death" (Tulip)
    - "the underlying cause of death is the condition which led to the chain of events that resulted in the death" (PSANZ-PDC)
    - "we expect a COD other than "unknown" to be coded only if the single or combined conditions are mortal in a significant (> 0.05) proportion of cases (more than a tenfold relative risk in most developed countries)." (CODAC)
    - "the factor which probably initiated the train of events leading to death" (Cole 1986)
    - "1. Probable Cause of Stillbirth: The identified condition is, with high likelihood, the cause of the fetal death. For example, maternal diabetes would be the probable cause of fetal death for a case in which the mother has type 1 diabetes mellitus with a stillbirth that occurred during an episode of diabetic ketoacidosis. 2. Possible Cause of Stillbirth. The identified condition cannot with high likelihood be considered the cause of death, but there is reasonable certainty that this condition may be involved in a pathophysiologic sequence that led to the fetal death. For example, a fetal death occurs in a woman with poorly controlled type 1 diabetes mellitus and an elevated hemoglobin A1C with normal fetal growth. A fetal death in this circumstance cannot be definitely considered caused by the diabetes, as there are many other potential conditions that may affect this outcome." (INCODE)
- All Delphi systems require a single cause to be identified, as does ICD-10
- However, PSANZ-PDC also requires that for NND, "the main neonatal condition which caused the death is assigned according to the [PSANZ-]NDC". PPIP is another system that uses this approach.
- In contrast,
    - INCODE allows multiple causes and assigns them a probability (present, possible, and probable)
    - ICD-PM requires a "main condition" or "main cause" of the fetus ("The main disease or condition in the fetus or infant is defined in ICD-10 as the disease or condition that initiated the morbid chain of events leading to death"), but "Other diseases or conditions in fetus" are allowed

Proposal:

- Require identification of one underlying cause for each death.
- For neonatal deaths: Include a rule requiring that the underlying cause be drawn from the "neonatal conditions" causal category, with antecedent obstetric factors to be recorded as "associated conditions"
- Adopt the ICD-10 definition of "cause"

- Allow associated conditions to include secondary causes of death (which includes contributing maternal and pregnancy conditions). This would address the “main obstetric” for NND as well as the ICD-PM maternal conditions requirement.
- Consider how inclusion of the INCODE assignment of degree of probability (also addressing Codac strictures on “cause”), with a flag for “definite, probable, possible, certainty unknown” might be incorporated.

3.3 Associated conditions

Background:

- ”A global system must require associated factors to be recorded and clearly distinguished from causes of death” (Delphi, 94% consensus)
- Delphi systems: Codac, Tulip and PSANZ-PDC allow associated conditions and distinguish them fully from causes; Cole 1986, Kotecha does not include them and INCODE includes them though rating of strength of association as described above “definite, probable, possible’ as well as those not thought the be associated i.e “certainty unknown”
    - Codac:
        - ”An associated condition of stillbirth is an event, disease or condition of sufficient severity, magnitude and duration to contribute in explaining the circumstances of death in a significant proportion of such cases in a continued pregnancy in the clinical situation [in which] it was observed”
        - Allows 2 AC, one of which can be the “secondary COD”
        - AC are drawn from 8 of the 10 main causes as well as associated perinatal (eg multiples, post-term) and associated maternal (eg smoking, poverty) conditions as well as substandard care
    - Tulip:
        - Allows “**contributing factors**, defined as other known factors on the causal pathway to death, e.g. risk factors such as obesity and smoking, and **comorbidity**, defined as an event or a condition relevant for the clinical situation or the care given but not part of the causal pathway to death.”
        - Other examples of contributing factors are language/culture barrier, breech, IUGR; comorbidity example is asthma
    - PSANZ-PDC:
        - Allows up to 2 associated factors; taken from list of causes plus:
            - Genetic testing results not diagnostic
            - Maternal risk factors
            - Fetal Growth Restriction
            - Associated placental pathology
            - Associated cord pathology
        - “conditions which were considered to have contributed to the death but are not considered to be the main underlying cause. Conditions which were present but not considered to be contributory are not classified as associated conditions”
- ICD PM includes a “main maternal condition” (“one that would be considered to be reasonably integrated into the pathway leading to perinatal death”, Allanson et al.) which is tabulated with “main cause” to show linkages between the two; however, requiring both a fetal and a maternal condition did not receive >80% consensus from Delphi panel. While not technically part of the ICD-PM, WHO also recommends capturing the following:
    - Modifiable factors (related to family, administration, providers, and other): “something that may have prevented the death if a different course of action had been taken”
    - Critical delays (the three delays)

Proposal:

- Allow up to 3 associated conditions (AC). Clearly flag them as AC (vs “underlying cause”).
- Adopt Codac definition of AC.
- Agree to include the following as possible AC:

    - All causes in the “underlying cause” list
    - Risk factors (adapt Tulip & PSANZ lists; e.g. obesity, smoking, poverty, FGR)
    - Substandard care factors
    - Other comorbidities that are not causal (adapt Tulip list; e.g. maternal asthma)
    - Additional categories as follows, in order to ensure alignment with the ICD-PM which requires recording a “maternal condition” for each death, and allows this to be stated as “no maternal condition” if relevant:
        - “No maternal condition”
        - “Maternal condition status unknown”
        - “No other associated conditions”
        - “Associated condition status unknown”
- Decide whether one of the AC can be called a “secondary COD” (as per Codac)

3.4 Type of death

Background:

- "A global system must incorporate both stillbirths and neonatal deaths" (Delphi, 86%)
- "A global system must require neonatal deaths to be clearly distinguished from stillbirths" (Delphi, 94%)
- "A global system must distinguish between antepartum and intrapartum conditions" (Delphi, 90% consensus)
- All Delphi systems include both SB and NND, as does ICD-PM; INCODE includes only SB
- Only Codac distinguishes fully between IP and AP, by including a flag for "IP, AP, NND, unknown, termination"; PSANZ-PDC and Kotecha distinguish partially; neither Tulip nor Cole 1986 distinguish at all; this is due to the lack of a flag for timing of death, together with a set of causes of death that are not clearly either IP or AP
- Reflecting the reality that SB and NND share many causes, as well as the lack of a flag for SB vs NND, systems generally do not fully distinguish between SB and NND
- ICD PM requires identification of timing of death as AP, IP or neonatal; a recent revision makes a provision for unknown timing of stillbirth

Proposal:

- Include SB and NND.
- Include a Timing Marker to require identification of each death as antepartum, intrapartum, neonatal, or unknown timing. (Termination, as a cause of death, should not be a Timing option.)
- ICD-10 codes do not indicate timing of death; consider input to ICD-11 process to address this issue.

3.5 ICD-10 codes

Background:

- Requiring the use of ICD-10 codes did not receive >80% consensus from Delphi, but is nevertheless a requirement for an effective global system, since ICD-10 is the only global approach for classification of deaths. Would be interesting to understand better why this characteristic did not receive higher consensus rating.
    - Of Delphi systems, only Codac uses ICD-10 codes
    - PSANZ-PDC recommends mapping to ICD-PM and ICD-10 but does not provide the actual codes for each cause
- ICD-PM, released in 2016, is crucial step forward in aligning classification approaches especially in LMIC. Any system for data-rich settings must be fully aligned with ICD-PM. ICD-PM lists all allowed ICD codes. "Codes that are not considered to be a cause of perinatal death in these sections have been excluded from the ICD-PM groupings… The information provided about the cause of death and the maternal condition should meet the ICD-10 coding rules for assigning a specific code before any tabulation can be undertaken".
    - Hence, ICD-PM requires that ICD-10 code be assigned first, which is then mapped to the relevant ICD-PM category for cause of death

Proposal:

- Cause of death should be assigned first, followed by identification of the relevant ICD-10 code(s) and mapping to the appropriate ICD-PM category.
- Within the hybrid system, each cause of death at each level should be accompanied by a comprehensive list of ICD-10 codes which might be used, adapted from the Codac system spreadsheet and ICD-PM. Providing such a list should help address the challenges of using ICD-10 codes (which we assume is one reason virtually no systems use them, and also why this requirement did not receive >80% consensus in the Delphi process).

4. STRUCTURE OF THE SYSTEM

4.1 Hierarchical approach

Background:

- "Hierarchy" (a set of rules forcing causes to be selected or rejected in a pre-determined order) is meant to assist in consistent assignment of cause of death when multiple conditions are present. This feature was contentious, with the Delphi panel evenly split on whether a system should have this feature
- Tulip, Kotecha, INCODE and ICD-PM are not hierarchical
- Codac and Cole 1986 are partly hierarchical:
    - Codac: "only offer[s] a hierarchical system for situations in which the actual narrative has been lost" (eg population-based surveillance) or if multiple conditions, all of equal importance
    - Cole 1986: causes are listed in hierarchical order but "Such an approach should not be used, however, if it leads to a conclusion which clearly infringes the cardinal rule that death should always be ascribed to the initial factor that set the baby's death in train."
- PSANZ-PDC states that it "no longer uses a hierarchical approach for any particular category but rather employs rules around common scenarios when multiple factors may be involved"
- Essentially, these systems all advise a hierarchy only if there is no other means of choosing between causes. But they differ in their hierarchical listings.
    - Only "congenital" appears among the first 5 causes in all three systems
    - The top 5 causes in order are:

	1	2	3	4	5
Codac	infection	neonatal	intrapartum	congenital	fetal
Cole 1986	congenital	iso-immun	pre-eclampsia	APH	mechanical
PSANZ-PDC	congenital	infection	hypertension	APH	maternal

Proposal:

- Adapt the practical approach of Codac, Cole 1986 and PSANZ-PDC to reject a hierarchical approach, instead including clear rules for how to assign underlying cause in cases where it is unclear how to select from among several possibilities.
- Identify all of the most likely situations when this might occur and provide an example and rule for assigning cause of death in each situation.

4.2 Number of levels

Background:

- "A global system must have multiple levels of causes of death, with a small number of main categories" (Delphi, 82%)
- PSANZ-PDC and INCODE have 4 levels, Codac and Tulip have 3, Cole 1986 has 2, Kotecha has 1
- PSANZ-PDC example:
    - Congenital anomaly
        - Structural anomaly
            - Other specified congenital anomaly
                - Idiopathic hydrops fetalis
- Codac example:
    - Infection
        - Viral-other
            - Poliovirus
- Tulip example:
    - Placenta
        - Placental pathology
            - Parenchyma
- ICD-PM has at least 3, if all ICD-10 levels are included
- ICD-PM example:
    - Infection
        - P35: Congenital viral diseases
            - P35.0: Congenital rubella syndrome

Proposal:

- To align with ICD-PM and the reality that ICD-10 codes will be used, provide 3 levels
- Provide ICD-10 codes for each level, adapted from ICD-PM and Codac lists

5. CAUSES TO INCLUDE IN THE SYSTEM

5.1 Number of causes

Background:

- "A global system must include a sufficiently comprehensive list of categories to result in a low proportion of deaths classified as 'other'" (Delphi, 80% consensus)
- However, it is not just comprehensiveness of categories, but also the stringency of rules for assigning cause of death, and how easily they are applied, that affect the % of deaths classified as 'other' or 'unknown': Codac is used in the UK for classification of perinatal deaths, and stillbirths with "unknown or missing" causes of death were 49.4% in 2014 and 42.2% in 2015 (for neonatal deaths, percentages were much lower: 8.9% and 7.5%, respectively)
- Delphi systems: PSANZ-PDC has 12 causes at top level, Codac & Cole 1986 have 10, Kotecha has 9, Tulip has 6; INCODE has 7
- ICD-PM has 6 in the AP group, 7 in the IP group, and 11 in the NN group

Proposal:

- Top level to include a small yet comprehensive number of underlying cause categories.
- Following INCODE, consider allowing a flag for certainty of diagnosis
- Provide definitions for all causes at all levels, and rules for assigning causes, that are brief & clear

5.2 Major cause groups

Background:

- An upcoming review of globally reported causes of perinatal death found 15 causal categories used for 500,000 stillbirths, but stated that not all of these conditions described likely truly causal:
    1. antepartum haemorrhage
    2. congenital anomalies
    3. hypertension
    4. hypoxic peripartum death
    5. infection
    6. intrauterine growth restriction
    7. maternal condition
    8. other unspecified condition
    9. placental conditions
    10. spontaneous preterm
    11. specific fetal/placental condition
    12. termination of pregnancy, unspecified
    13. umbilical cord
    14. unable to classify
    15. Unexplained
- Major cause groups for selected systems (see Sections 9-10 for details):
    - Cole 1986
        - Congenital Anomaly
        - Isoimmunization
        - Pre-eclampsia
        - Antepartum Haemorrhage (APH)
        - Mechanical
        - Maternal Disorder
        - Miscellaneous
        - Unexplained
    - Codac:
        - Infectious causes of death (abbrev: Infection)
        - Conditions, diseases and events specific to neonatal life (abbrev: Neonatal)
        - Mechanics and events of parturition or its complications (abbrev: Intrapartum)
        - Congenital anomalies, chromosomal anomalies and structural malformations (abbrev: Congenital anomaly)
        - Fetal conditions, diseases and events (abbrev: Fetal)
        - Cord conditions, diseases and events (abbrev: Cord)
        - Conditions, diseases and events of the placenta and membranes (abbrev: Placenta)
        - Maternal conditions, diseases and events (abbrev: Maternal).
        - Unknown, unexplained and unclassifiable causes of death (abbrev: Unknown)
        - Terminations of pregnancy (abbrev: Termination).
    - Tulip:
        - Congenital anomaly
        - Placenta
        - Prematurity/immaturity
        - Infection

        - Other
        - Unknown
    - PSANZ-PDC:
        - Congenital anomaly
        - Perinatal infection
        - Hypertension
        - Antepartum haemorrhage (APH)
        - Maternal Conditions
        - Complications of multiple pregnancy
        - Specific perinatal conditions
        - Hypoxic peripartum death
        - Placental dysfunction or placental pathology
        - Spontaneous preterm labour or rupture of membranes (ROM (<37 weeks gestation)
        - Unexplained antepartum fetal death
        - Neonatal death without obstetric antecedent
    - Kotecha:
        - Congenital anomaly
        - Intrapartum events
        - Conditions consequent upon preterm birth
        - Infection
        - Specific conditions
        - Accidental death
        - Sudden unexpected death
        - Unclassifiable
    - INCODE:
        - Maternal medical conditions
        - Obstetric complications
        - Maternal or fetal hematologic conditions
        - Fetal genetic, structural, and karyotypic abnormalities
        - Placental infection, fetal infection, or both
        - Placental pathologic findings
        - Other pertinent condition not yet specified
    - ICD-PM:
        - Antepartum causes:
            - A1: Congenital malformations, deformations and chromosomal abnormalities
            - A2: Infection
            - A3: Antepartum hypoxia
            - A4: Other specified antepartum disorder
            - A5: Disorders related to fetal growth
            - A6: Fetal death of unspecified cause
        - Intrapartum causes:
            - I1: Congenital malformations, deformations and chromosomal abnormalities
            - I2: Birth trauma
            - I3: Acute intrapartum event

        - I4: Infection
        - I5: Other specified intrapartum disorder
        - I6: Disorders related to fetal growth
        - I7: Intrapartum death of unspecified cause
    - Neonatal causes:
        - N1: Congenital malformations, deformations and chromosomal abnormalities
        - N2: Disorders related to fetal growth
        - N3: Birth trauma
        - N4: Complications of intrapartum events
        - N5: Convulsions and disorders of cerebral status
        - N6: Infection
        - N7: Respiratory and cardiovascular disorders
        - N8: Other neonatal conditions
        - N9: Low birth weight and prematurity
        - N10: Miscellaneous
        - N11: Neonatal death of unspecified cause
    - Maternal conditions:
        - M1: Complications of placenta, cord and Membranes
        - M2: Maternal complications of pregnancy
        - M3: Other complications of labour and Delivery
        - M4: Maternal medical and surgical conditions
        - M5: No maternal condition
- These major causes can be grouped roughly, for the purposes of discussion, as follows:
    1. Congenital anomalies
    2. Infection
    3. Placental and cord conditions
    4. Other specific neonatal & fetal conditions
    5. Other specific maternal conditions
    6. Intrapartum-related conditions
    7. Prematurity-related conditions
    8. Other categories (accidents, terminations, unexplained and unclassifiable deaths)

Proposal:

- Agree to a small yet comprehensive number of underlying cause categories.
- Ensure each top-level cause has an “Other” sub-category to facilitate classification even in low-data settings (see Karnataka et al. use of Codac)

5.3 Congenital anomaly

Background:

- All Delphi systems, INCODE and ICD-PM include this category
- It is called "congenital anomaly" except by
    - Codac: "Congenital anomalies, chromosomal anomalies and structural malformations"
    - ICD-PM: "Congenital malformations, deformations and chromosomal abnormalities"
    - INCODE: "Fetal genetic, structural, and karyotypic abnormalities"
- Listed as first category in the partially hierarchical systems Cole, and fourth in Codac
- Divided by:
    - System affected (eg CNS, CVS) with chromosomal and syndrome as additional sub-categories—eg Structural, chromosomal, or genetic (Tulip, Codac, PSANZ-PDC)
    - Timing (AP, IP, NN) (ICD-PM)
    - Other type of division (INCODE, Cole 1986)

Proposal:

- Include "Congenital anomaly" as an underlying causal category.
- Divide into sub-categories for lower-level causes following PSANZ-PDC & Tulip:
    - Chromosomal
    - Structural (by system affected):
        - Central nervous
        - Cardiovascular
        - Urogenital
        - Gastrointestinal
        - Musculoskeletal
        - Respiratory
        - Haematological
        - Endocrine/metabolic system
        - Neoplasm
        - Other
    - Genetic
    - Other specified congenital abnormality (including multiple—or if multiple, list as AC? Or secondary cause?)
    - Unspecified congenital abnormality
- Identify all ICD-10 codes that apply to each sub-category

5.4 Infection

Background:

- All Delphi systems, INCODE, and ICD-PM include this category
- These systems divide infection in different ways:
    - Focus (maternal vs fetal/neonatal, Cole 1986, and placental vs fetal, INCODE)
    - Cause (bacterial, viral, protozoal, fungal) (PSANZ-PDC)
    - Cause & some main types (bacterial, viral, protozoal, fungal; HIV, syphilis, malaria, group B strep, …) (Codac)
    - Timing and cause (AP, IP, NN; viral, other causes) (ICD-PM)
    - Mechanism (transplacental, ascending, neonatal, NOS) (Tulip)

Proposal:

- Include "Infection" as an underlying causal category.
- Divide into sub-categories for lower-level causes following PSANZ-PDC, by cause, with key infections as level 2 options for ease in use and comparison:
    - Bacterial (including Group B strep, syphilis)
    - Viral (including HIV, herpes)
    - Protozoal (including malaria)
    - Fungal
    - Unspecified or unknown infection
- Identify all ICD-10 codes that apply to each sub-category

5.5 Placental & cord conditions

Background:

- All Delphi systems and ICD-PM include some elements of placental and cord causes except for Kotecha
- Each system handles it differently:
    - PSANZ-PDC
        - has an APH main category
        - includes pre-eclampsia in "hypertension"
        - includes cord complications in "specific perinatal conditions"
        - includes cord prolapse in labour under "hypoxic peripartum death"
        - also has a "Placental dysfunction or placental pathology" top-level category
    - Cole 1986
        - has an APH main category
        - has a pre-eclampsia main category
        - includes cord prolapse and compression in "mechanical" (intrapartum)
    - Tulip
        - has a main category "Placenta" which includes placental bed pathology, placental pathology, umbilical cord complication, and NOS;
        - also includes "placental insufficiency" as a "mechanism" with an unspecified number of sub-categories
    - Codac
        - Has separate main categories for Placenta ("Conditions, diseases and events of the placenta and membranes") and Cord ("Cord conditions, diseases and events")
            - Cord prolapse appears under "Cord-Mechanical compromise" as a sub-category at level 3
            - Placenta previa appears under "Placenta-Abnormal implantation, migration, or shape" at level 3
        - But also includes "cord and placenta complications" under the main category "intrapartum"—and this also includes cord prolapse, placenta previa, and placental abruption at level 3
        - Also includes "hypertensive disorder" under "Maternal" main category
        - Does not include pre-eclampsia as a COD, I think
    - ICD-PM:
        - includes "Complications of placenta, cord and membranes" as a "maternal condition" rather than a fetal cause of death, including placenta previa, prolapsed cord and haemorrhage
        - includes pre-eclampsia and hypertension as maternal conditions under "Maternal medical and surgical conditions"
        - also has the fetal cause categories "Other specified antepartum disorder" and "Other specified intrapartum disorder" which include "codes specific to the antepartum period from haemorrhagic and haematological disorders of fetus and newborn"
    - INCODE has:
        - Hypertensive disorder of pregnancy under "Maternal medical conditions"
        - Fetal maternal haemorrhage, Abruptio placentae, and Uteroplacental insufficiency under "Obstetric complications"

        - Placental infection under “Placental infection, fetal infection, or both”
        - And a whole top-level category called “Placental pathologic findings” which includes sub-categories such as Placental disc, Placental membranes, and Umbilical cord
- Codac provides multiple sub-categories (within overarching “placenta” and “cord” categories)
    - “placenta” includes 9 sub-categories:
        1. Abnormal implantation, migration or shape
        2. Villous/vascular maldevelopment
        3. Abruption or retroplacental hematoma
        4. Infarctions and thrombi
        5. Circulatory disorder-other non-abruptions
        6. Neoplastic disorder
        7. Transfusion and feto-maternal haemorrhage
        8. Small for gestation placenta
        9. Unspecified or other
    - “cord” includes 8 sub-categories:
        1. Knots
        2. Loops
        3. Abnormal insertion
        4. Focal anomaly
        5. Generalized anomaly
        6. Other mechanical compromise
        7. Thrombosis of the cord
        8. Unspecified or other
    - Each of these has its own sub-categories (level 3)
- PSANZ-PDC provides multiple placental sub-categories:
    - Maternal vascular malperfusion
    - Fetal vascular malperfusion
    - High grade villitis of unknown etiology (VUE)
    - Massive perivillous fibrin deposition/maternal floor infarction
    - Severe chronic intervillositis (Histiocytic intervillositis)
    - No causal placental pathology demonstrated, with antenatal evidence of poor placental function was identified (such as abnormal fetal umbilical artery Doppler)
    - Placental pathological examination was not performed, with antenatal evidence of poor placental function was identified (such as abnormal fetal umbilical artery Doppler)
    - Other placental pathology
    - Unspecified
- 2014 literature review of placental pathology in association with SB (Ptacek et al) found that
    - **Placental causes are important**: “The proportion of stillbirths diagnosed with a placental cause of death ranged from 11.2% to 64.9%” depending on the classification system used
    - **There is much variation in placental causes across systems**: “no consensus on lesions included in classification systems”; this may partly reflect the lack of data on causality
    - **There is much variation in terminology and diagnostic criteria for placental causes**: “Most diagnoses were based on subjective, qualitative descriptions”
    - **Knowledge of extent and severity of lesions may be important** since many types of placental lesions are present in both SB and live births (eg focal vs widespread)

    - **Histopathological exam of the placenta is useful but dependent on the classification system used**; the more placental categories, the higher the % of causes attributed to them (but no inverse relationship between % of unknown and % of placental cases or # of placental categories)
    - **Diagnosis of placental causes is affected by tissue storage after death,** so details of exam should be recorded
- 2016 report on Placental Workshop Consensus Statement on placental lesions (Khong et al) (so excluding eg placenta previa and other placental causes) provided recommendations for:
    - Sampling protocol for the placenta
    - Diagnostic criteria for the following placental lesions:
        - maternal vascular malperfusion
        - fetal vascular malperfusion
        - delayed villous maturation
        - villitis of unknown etiology

Proposal:

- Include placental and cord conditions as separate underlying causal categories to facilitate separate tracking and reflect their status as biological entities separate from one another and from fetus and mother.
- Adapt the Codac and PSANZ lists of placental and (for Codac) cord sub-categories, ensuring alignment with recent consensus on terminology for placental lesions.
- Specifically, clarify which causal categories the following causes should fall under—Placental, Cord, Maternal, Intrapartum, or some other category:
    - cord prolapse
    - placenta previa
    - placental abruption
    - APH
    - hypertension
    - pre-eclampsia
- Ensure clinical audit recommendations align with consensus on placental histopathology, and ensure there is space to record details of exams performed ("basis of diagnosis") (see Section 6 below).
- Identify all ICD-10 codes that apply to each sub-category

5.6 Other neonatal & fetal conditions

Background:

- Of Delphi systems, Cole 1986, Kotecha and Tulip do not have a category for either Neonatal or Fetal conditions
- Codac has 2 separate main categories:
    - Fetal conditions, diseases and events:
        - Brain injury
        - Cardiac
        - Alloimmunization
        - Hematological-other
        - Metabolic
        - Neoplasia
        - Hydrops of unknown origin
        - Unspecified or other
    - Conditions, diseases and events specific to neonatal life:
        - Extreme prematurity
        - Neurological
        - Cardio-respiratory
        - Gastrointestinal
        - Multi-organ failure
        - Trauma or suffocation
        - Inadequate care
        - Unspecified or other
- PSANZ-PDC has “specific perinatal conditions” that include fetal and neonatal both:
    - Fetomaternal haemorrhage
    - Antepartum cord or fetal vessel complications
    - Uterine/cervical abnormalities
    - Alloimmune disease
    - Idiopathic hydrops
    - Fetal antenatal intracranial injury
    - Other specific perinatal conditions
    - Unspecified
- In addition, PSANZ-NDC is the NND-only companion system to the PSANZ-PDC. Its top-level categories are:
    - Congenital anomaly
    - Extreme prematurity
    - Cardio-respiratory disorders
    - Neonatal infection
    - Neurological
    - Gastrointestinal
    - Other
- For comparison, Black CHERG is a global system for NND only. Its categories (the system only has 1 level) are:
    - Preterm birth complications
    - Birth asphyxia
    - Sepsis
    - Other

    - Pneumonia
    - Congenital abnormalities
    - Diarrhoea
    - Tetanus
- INCODE does not have a separate fetal conditions category, but does have "Maternal or fetal hematologic conditions" including:
    - Heritable thrombophilias
    - Antiphospholipid syndrome
    - Red cell isoimmunization
    - Platelet alloimunization
    - Other maternal or fetal hematologic conditions
- ICD-PM has 3 relevant main categories:
    - "other neonatal conditions":
        - Fetal blood loss
        - Umbilical haemorrhage of newborn
        - Intracranial nontraumatic haemorrhage of fetus and newborn
        - Haemorrhagic disease of fetus and newborn
        - Other neonatal haemorrhages
        - Haemolytic disease of fetus and newborn
        - Hydrops fetalis due to haemolytic disease
        - Kernicterus
        - Neonatal jaundice due to other excessive haemolysis
        - Neonatal jaundice from other and unspecified causes
        - Disseminated intravascular coagulation of fetus and newborn
        - Other perinatal haematological disorders
        - Meconium ileus in cystic fibrosis
        - Other intestinal obstruction of newborn
        - Necrotizing enterocolitis of fetus and newborn
        - Other perinatal digestive system disorders
        - Hypothermia of newborn
        - Other disturbances of temperature regulation of newborn
        - Other conditions of integument specific to fetus and newborn
        - Feeding problems of newborn
        - Reactions and intoxications due to drugs administered to fetus and Newborn
        - Disorders of muscle tone of newborn
    - "other specified AP disorder"
        - Fetal blood loss
        - Intracranial nontraumatic haemorrhage of fetus and newborn
        - Haemolytic disease of fetus and newborn
        - Hydrops fetalis due to haemolytic disease
        - Disseminated intravascular coagulation of fetus and newborn
        - Other perinatal haematological disorders
        - Meconium ileus in cystic fibrosis
        - Necrotizing enterocolitis of fetus and newborn
        - Other conditions of integument specific to fetus and newborn
        - Other conditions originating in the perinatal period (including TOP)
    - "other specified IP disorder"
        - Fetal blood loss

- Intracranial nontraumatic haemorrhage of fetus and newborn
- Haemolytic disease of fetus and newborn
- Hydrops fetalis due to haemolytic disease
- Disseminated intravascular coagulation of fetus and newborn
- Other perinatal haematological disorders
- Other conditions originating in the perinatal period (including TOP)

Proposal:

- Include “Other neonatal conditions” and “Other fetal conditions” as underlying causal categories.
- List them, along with “Other maternal conditions”, just prior to the final category (“Unexplained/unclassifiable”). All other categories coming before them will indicate either specific conditions (e.g. infection) or other biological entities (e.g. placental conditions) that merit stand-alone categories (for when a hierarchical assignment of cause of death is required).
- Divide Fetal and Neonatal into sub-categories AFTER sub-categories for all other main causes have been identified. What remains from the Delphi systems and ICD-PM should be placed into these Other Fetal and Neonatal Conditions categories (take the same approach for Other maternal conditions).
- Ensure that Neonatal causal category includes sufficient list of causes, as all NND will select the underlying cause from this category. Include a rule requiring that all neonatal deaths select underlying cause from this category, with obstetric antecedents included as associated conditions.
- Identify all ICD-10 codes that apply to each sub-category

5.7 Other maternal conditions

Background:

- Tulip and Kotecha do not have this category; all other Delphi systems do.
    - PSANZ-PDC "maternal conditions":
        - Termination of pregnancy for maternal psychosocial indications
        - Diabetes
        - Maternal injury
        - Maternal sepsis
        - Antiphospholipid syndrome
        - Obstetric cholestasis
        - Other specified maternal conditions
    - Codac "Maternal conditions, diseases and events":
        - Unspecified or other
        - Hypertensive disorder
        - Uterus and cervix
        - Diabetes
        - Endocrine-other
        - Anemia
        - Hematology-other
        - Autoimmune-other
        - Malnutrition
        - Trauma
    - Cole 1986 "maternal disorder"
        - Maternal hypertensive disease
        - Other maternal disease
        - Maternal infection
- INCODE has two relevant main categories:
    - "Maternal medical conditions":
        - Hypertensive disorder of pregnancy
        - Diabetes during pregnancy
        - Systemic lupus erythematosus
        - Intrahepatic cholestasis of pregnancy
        - Thyroid disorders during pregnancy
        - Renal disease during pregnancy
        - Severe maternal infection
        - Shock during pregnancy
        - Asthma during pregnancy
        - Seizure disorders during pregnancy
        - Maternal substance abuse
        - Other maternal condition
    - Maternal or fetal hematologic conditions
        - Heritable thrombophilias
        - Antiphospholipid syndrome
        - Red cell isoimmunization
        - Platelet alloimunization
        - Other maternal or fetal hematologic conditions
- ICD-PM does not have "maternal conditions" as an underlying cause; rather, every death is to be given both an underlying fetal cause and a "maternal condition" as follows:

- Complications of placenta, cord and membranes:
  - placenta praevia
  - other forms of placental separation and haemorrhage
  - placental dysfunction, infarction, insufficiency
  - fetal-placental transfusion syndromes
  - prolapsed cord, other compression of umbilical cord
  - chorioamnionitis
  - other complications of membranes
- Maternal complications of pregnancy:
  - incompetent cervix
  - preterm rupture of membranes
  - oligohydramnios/polyhydramnios
  - ectopic pregnancy
  - multiple pregnancy
  - maternal death
  - malpresentation before labour
  - other complications of pregnancy
- Other complications of labour and delivery
  - breech delivery and extraction
  - other malpresentation, malposition and disproportion during labour and delivery
  - forceps delivery/vacuum extraction
  - caesarean delivery
  - precipitate delivery
  - preterm labour and delivery
  - other complications of labour and delivery, including termination of pregnancy
- Maternal medical and surgical conditions
  - pre-eclampsia, eclampsia
  - gestational hypertension
  - other hypertensive disorders
  - renal and urinary tract diseases
  - infectious and parasitic disease
  - circulatory and respiratory disease
  - nutritional disorders
  - injury
  - surgical procedure
  - other medical procedures
  - maternal diabetes, including gestational diabetes
  - maternal anaesthesia and analgesia
  - maternal medication
  - tobacco/alcohol/drugs of addiction
  - nutritional chemical substances
  - environmental chemical substances
  - unspecified maternal condition
- No maternal condition

Proposal:

- Include “Other maternal conditions” as a main causal category. The reason for the word “Other” is that maternal infection should be included under main category “Infection” above.
- As with “Other fetal” and “Other neonatal”, sub-categories of all other main causes should be determined first, before sub-categories for “Maternal”, so that there is no redundancy and Maternal receives only those sub-categories which are still remaining to be allocated (other than to the final “Other” category). In addition, any sub-categories that are in fact associated conditions rather than possible underlying causes should be moved to the AC list. For example, from the ICD-PM list above:
    - “tobacco/alcohol/drugs of addiction” and “multiple pregnancy” should be added to the AC list
    - “termination of pregnancy” should be included in “Other-TOP”
    - “Complications of placenta, cord and membranes” should be included in “Placental conditions” (placenta and membrane-related causes) and “Cord conditions” (cord-related causes)
    - “Other complications of labor and delivery” category should be included in “Intrapartum”
    - “infectious and parasitic disease” should be included in “Infection”
    - “injury” should be included in “Other-Accidents”
- Consider the following sub-categories for “Other maternal conditions”:
    - Maternal conditions related to pregnancy (eg gestational diabetes)
    - Other maternal medical conditions (eg chronic anemia)
    - Other specified maternal conditions
    - Other unspecified maternal conditions
    - No maternal condition found (despite sufficient data)
    - No maternal condition known (including if no data is known)
- Of note, to ensure alignment with ICD-PM, the sub-category “no maternal condition known or found” is required
- Identify all ICD-10 codes that apply to each sub-category

5.8 Intrapartum-related conditions

Background:

- Of Delphi systems, Cole 1986, Codac, Kotecha and INCODE have relevant categories.
- Tulip does not have this category
- PSANZ-PDC has the category "Hypoxic peripartum death" including:
    - With intrapartum complications
    - Evidence of significant fetal compromise (excluding other complications)
    - No intrapartum complications and no evidence of significant fetal compromise identified
    - Unspecified hypoxic peripartum death
- Cole 1986 has the category "Mechanical" including:
    - Cord prolapse or compression with vertex of face presentation
    - Other vertex or face presentation
    - Breech presentation
    - Oblique or compound presentation uterine rupture
- Codac has the category "Mechanics and events of parturition or its complications (abbrev: Intrapartum)" including:
    - Unspecified or other
    - Uterine rupture
    - Cord and placenta complications
    - Malpresentation
    - Disproportion
    - Prolonged labor
    - Extreme prematurity
    - Excessive contractions/hypertonic labor
    - Unknown (fetal respiratory failure/asphyxia)
- Kotecha has "Intrapartum events" category
- INCODE has "Obstetric complications" category
    - Fetal maternal hemorrhage
    - Cervical insufficiency
    - Preterm labor
    - Preterm premature rupture of membranes
    - Clinical chorioamnionitis
    - Intrapartum fetal death with labor – associated asphyxia (≤ 26 weeks)
    - Hypoxic intrapartum fetal death (> 26 weeks)
    - Abruptio placentae
    - Complications of multiple gestation
    - Uterine rupture
    - Multiple trauma during pregnancy
    - Uteroplacental insufficiency
    - Other obstetric condition
- ICD-PM causes of death are grouped into antepartum, intrapartum and neonatal causes (plus maternal conditions). Four of the 7 causes within the Intrapartum group are relevant here:
    - Birth trauma (eg Other birth injuries to central nervous system)
    - Acute intrapartum event (eg Intrauterine hypoxia)
    - Other specified intrapartum disorder (eg Fetal blood loss)
    - Intrapartum death of unspecified cause

- In addition, within the Neonatal group, there are two relevant sub-categories:
    - Birth trauma
    - Complications of intrapartum events (eg Intrauterine hypoxia, birth asphyxia)

Proposal:

- Include “Other intrapartum-related conditions” as a main causal category.
- Many causes included under this heading in the Delphi systems and ICD-PM likely belong elsewhere. For instance:
    - Hypoxia and asphyxia under “Unexplained”
    - Complications of multiple gestation included as an AC?
    - Abrupted placenta under “Other placental conditions”
    - Cord prolapse under “Other cord conditions”
    - Extreme prematurity under “Prematurity-related conditions”
- Sub-categories of “Other intrapartum-related conditions” should likely include:
    - Birth trauma
    - Uterine rupture
    - Malpresentation??
    - Other intrapartum complications (breech, prolonged labor)
    - Other
- Identify all ICD-10 codes that apply to each sub-category

5.9 Prematurity-associated conditions

Background:

- Delphi systems that include this as a main cause are
    - Tulip "Prematurity/immaturity" including:
        - PPROM
        - Preterm labour
        - Cervical dysfunction
        - Iatrogenous
        - NOS
    - PSANZ-PDC "Spontaneous preterm labour or rupture of membranes (ROM) (<37 weeks gestation)"
    - Kotecha "Conditions consequent upon preterm birth"
- Cole 1986, Codac and INCODE do not have this category
    - Codac includes "extreme prematurity" under the main "Intrapartum" category
- ICD-PM has a Neonatal category "Low birth weight and prematurity" as well as "Disorders related to length of gestation and fetal growth" within the AP group and "Disorders related to fetal growth" within the IP group

Proposal:

- Decide whether this should be a separate main category, or whether relevant causes should be incorporated within other causal categories.

5.10 Additional categories

Background:

- All Delphi systems have some version of categories for unknown or unexplained, as well as for "other" causes
- Cole 1986 has 3 relevant main categories:
    - Miscellaneous
        - Neonatal Infection
        - Other neonatal disease
        - Specific lethal condition
    - Unexplained
        - Mature: ≥2.5 kg
        - Premature: <2.5 kg
    - Unclassifiable
- Codac has 2 relevant categories:
    - Unknown, unexplained and unclassifiable causes of death (abbrev: Unknown)
    - Terminations of pregnancy
- Tulip has 2 relevant categories:
    - Other
        - Fetal hydrops of unknown origin
        - Maternal disease
        - Trauma
    - Unknown
        - Despite thorough investigation
        - Important information missing
- PSANZ-PDC has two relevant categories:
    - Unexplained antepartum fetal death
        - Unexplained antepartum fetal death despite full investigation
        - Unclassifiable antepartum fetal death with incomplete investigation
        - Unclassifiable antepartum fetal death due to unknown level of investigation
    - Neonatal death without obstetric antecedent
        - Neonatal death with no obstetric antecedent factors despite full investigation
        - Neonatal death unclassifiable as to obstetric antecedent with incomplete investigation
        - Neonatal death unclassifiable as to obstetric antecedent due to unknown level of investigation
- Kotecha has three relevant categories:
    - Accidental death
    - Sudden unexpected death
    - Unclassifiable
- INCODE has 1:
    - Other pertinent condition not yet specified
- And ICD-PM has
    - AP death of unspecified cause
    - IP death of unspecified cause
    - Within the neonatal group:
        - Neonatal death of unspecified cause
        - Miscellaneous

Proposal:

- Include the following as main cause groups:
    - Terminations of pregnancy for any reason
    - Unexplained (including deaths associated with FGR, IUGR: FGR and IUGR should be considered as associated conditions, with an underlying cause that is “Unexplained”, so placed into this causal category)
    - Unknown (no information available about cause)
- Decide how to handle deaths associated with hypoxia, asphyxia. These may be associated conditions, with an underlying cause that is “unexplained”, or they may be included as “intrapartum-related conditions”
- Decide where to put SIDS-associated deaths—under the main “Unexplained” category or within “Neonatal”?
- Decide whether deaths caused by accident, violence and injury should have their own category, be subsumed within other categories, or considered as associated conditions.
- “Other” causes should be included as “other” options within each of the other main causal categories, eg “Placental conditions” should have a sub-category of “Other placental conditions not otherwise specified”.
- Additional information about each death should be retained separately from cause of death, rather than included as part of a cause (eg fetal weight, type of exam):
    - A flag for time of death (IP, AP, NN, unknown)
    - Up to two AC (with details of risk factors etc)
    - Details of Minimum Dataset (MDS) status (eg exams performed, fetal weight, etc)
- Ensure there is an “Other” sub-category for every main causal category to assist those with minimal data
- Identify all ICD-10 codes that apply to each category

5.11 Definitions of causes

Background:

- "A global system must have clear guidelines for use and definitions for all terms used" (Delphi, 100%)
- Delphi systems: Cole 1986, PSANZ-PDC and Kotecha give definitions for all causes at top level; Codac, Tulip and INCODE give definitions for some causes
- ICD-PM uses ICD-10 definitions

Proposal:

- All causes at all levels should have brief, clear definitions. Consider starting with PSANZ-PDC definitions.
- Simultaneously with the selection of main categories and sub-categories, existing definitions should be reviewed, compared, and adapted to the extent possible, rather than creating new definitions. Sources for each definition should be recorded.

6. FEATURES TO ENSURE HIGH-QUALITY PERFORMANCE OF THE SYSTEM

6.1 Rules for assigning causes

Background:

- "A global system must use rules to ensure valid assignment of cause of death categories" (Delphi, 98%)
- "A global system must have clear guidelines for use and definitions for all terms used" (Delphi, 100%)
- All Delphi systems and INCODE provide rules for the assigning of causes of death, however the quality of the rules (eg, how easy to understand and apply) was not assessed. It is possible to have detailed rules that are still unclear or difficult to implement:
    - MBRACE has reported causes of perinatal mortality in the UK using Codac, a system with very detailed rules, for several years, but has reported some challenges in using the system as reflected in eg the following quote:
        - "There has been a halving in the number of deaths attributed to intrapartum causes since the last report: 2.8% of stillbirths and 2.5% of neonatal deaths compared with 5.8% and 4.8%, respectively in 2014. This reduction in deaths due to intrapartum events partly reflects a continued improvement in both the expertise and quality of the coding using the CODAC system, with additional guidance being provided to reporters for this type of death during 2015, but may also show an improvement in perinatal care provision." (May 2017 report on 2015 data)
    - ICD-PM refers to ICD 10 rules and provides case examples, but the latter do not explain how to select the primary if there is more than 1 cause or maternal condition

Proposal:

- As each element of the hybrid system is reviewed and agreed, a brief, clear rule should be drafted to capture the decision about that element. For example, a possible rule related to AC might be:
    - "Up to 2 associated conditions (AC) may be recorded for each death. AC should be taken from either (a) the list of causes of death or (b) the list of risk factors. AC are not considered to be either underlying causes or secondary causes."

6.2 Accessibility

Background:

- "A global system must be available in different formats including inexpensive ehealth and mhealth options, and in multiple languages" (Delphi, 92%)
- "A global system must allow easy access to the data by the end-users" (Delphi, 92%)
- Almost no systems meet these criteria. There are only three systems of 81 that are in e-format: Codac, INCODE, and PPIP. Codac is the only one that is not only available in e-format but also provides some guidelines for how to access data that is classified under the system.
- Kotecha also provides some guidelines on data access.
- Much effort is spent on system development, but systems can only be effective if they are used widely and properly. Over 90% of experts consulted for the Delphi process agree that a truly global system must be truly globally accessible, but virtually no system meets this requirement.

Proposal:

- Publish the system in an open-access journal
- Funding should be identified to place draft and final versions of a hybrid system online, including testing and debugging
- Consider funding design, testing and roll-out of an app for mobile devices that would allow easy recording and uploading of data for single cases.
- Sponsor parental review of all e- and m-systems to address issues of sensitivity
- Identify key languages for translation—eg French, Spanish, Russian and Chinese—and fund translation (including management and testing of translation)
- Plan, fund, and implement a process to raise awareness and uptake of the system
- Plan and fund an approach for training in system use
- Discuss and agree on how to ensure easy access to data by end-users, while ensuring confidentiality

6.3 Minimum dataset (MDS)

Background:

- "A global system must be able to work with all levels of data (from both low-income and high-income countries), including minimal levels" (Delphi, 98%)
    - Our focus is data-rich settings, but country profiles change rapidly, and what is now generally a data-poor setting (for example India) is likely to become more data-rich as income levels rise in the coming decades. Moreover, within countries that are overall data-poor, there are still data-rich settings, such as hospitals in capital cities, specialist clinics, and health posts affiliated with well-funded health research projects. Hence it is ideal to ensure that even a system for data-rich settings is functional across the board.
- "A global system should record the level of data available to assign the cause of death (e.g. verbal autopsy only, placental histology, autopsy, etc.)" (Delphi, 86%)
    - For example: From MBRACE report 2017: "data collected separately about placental histology and consent for postmortem examination on the MBRRACE-UK system provides evidence that users are limiting their coding of primary cause of death to level 1 of CODAC, and failing to take into account tests that have been carried out. This is demonstrated by the fact that only 111 stillbirths had a reported primary CODAC code of 'Unknown despite post-mortem and placenta histology', whereas the full MBRRACE-UK records show that both postmortem examination and placental histology were actually undertaken for 497 stillbirths with an unknown cause of death. It is important to be able to determine whether the allocation of an unknown cause of death for a stillbirth has been concluded following appropriate testing by accurate use of all three CODAC levels".
    - This quote not only reflects the need for training in system use (see above) but also the importance of recording what data was available and unavailable as practitioners assigned a cause of death.
- Cole 1986, Kotecha, INCODE and Tulip do not specify an MDS
- Codac specifies a "Minimal dataset for perinatal deaths" which includes:
    - Gestational items:
        - Gender
        - Plurality
        - Sequence of multiples
        - Gestation group (gestational age/birthweight combinations)
        - Gestation at birth (weeks and days)
        - Method of validation of gestational age
        - Birthweight
        - Time from birth to death (NND)
        - Time from death to birth (SB)
    - Maternal items:
        - Age
        - Height
        - Pre-pregnancy weight
        - Weight at delivery
        - Gravidity
        - Parity
        - # spontaneous abortions
        - # terminations

        - # perinatal deaths
        - Smoking status
        - Cigarette consumption
        - Alcohol status
        - Alcohol consumption
        - ethnicity
    - Delivery items
        - Method of delivery
        - Birth attendance type
        - Care level
    - Codac also records the basis for diagnosis, with options for clinical history and exam, autopsy or MRI, placenta or cord PAD, screening for infections, chromosomal/genetic testing, routinely collected birth notification, and other tests
- PSANZ:
    - Specifies core examinations:
        - Maternal history, maternal exam, Kleihauer-Betke or flow cytometry
        - Baby: clinical exam at birth, full autopsy
        - Placenta: macroscopic exam, histopathology studies, cytogenetic analysis
    - In addition, there is a very detailed Australian Perinatal Mortality Audit Tool (APMAT) with accompanying guidelines as well as a checklist for clinical examination of the baby and guidelines for placental examination
- ICD-PM (via the WHO's Perinatal Audit Tool 2017)
    - minimum data for all births includes maternal age, place of delivery, mode of delivery, birth weight, gestational age, and birth outcome.
    - the "Minimum set of perinatal indicators to collect for all births and perinatal deaths" includes sections on identification, pregnancy progress and care, labor and birth, and details of the death.
    - The "Stillbirth and Neonatal Death Case Review Form" includes the same sections as the Minimum set above, as well as one on critical delays and modifiable factors
    - In addition, a list of "Background and contextual information relevant to stillbirths and neonatal deaths for review of cases" is provided, including sociodemographic status and health status and care received

Proposal:

- Classification of each death should be accompanied by:
    - An agreed minimum dataset that does not require any testing or special equipment (based on Codac and ICD-PM) (hence "minimum")
    - Recording of the basis for diagnosis (based on Codac list)
- Agree on clinical audit recommendations (based on APMAT and ICD-PM) (each recommended test or procedure should be a separate option under the basis for diagnosis)

7. TESTING & ROLLOUT OF THE SYSTEM

7.1 Criteria for assessing success

Background:

- "A global system must produce data that can be used to inform strategies to prevent perinatal deaths" (Delphi, 96%)
- "A global system must have high inter- and intra-rater reliability" (Delphi, 94% consensus)
- "A global system must be easy to use, and produce data that are easily understood and valued by users" (Delphi, 100%)
- "A global system must ensure cause of death categories are relevant in all settings" (Delphi, 96%)
- "A global system must include a sufficiently comprehensive list of categories to result in a low proportion of deaths classified as 'other'" (Delphi, 80%)
    - Maximum % recorded as "unexplained" for Delphi systems was Codac, 53%; Tulip, 23%, Cole 1986, 55%, PSANZ-PDC (unrevised) is 54%, Kotecha is 6%. For INCODE no data for this category was available.
    - Maximum % recorded as "other" for Delphi systems was 1% (Codac), 5% (Tulip), 17% (Kotecha), 56% (Cole 1986). PSANZ-PDC and INCODE do not have this category.

Proposal:

- Consider adoption of the following "measures of success" of a hybrid system, which are all adapted from the variables used to assess alignment with the Delphi characteristics listed above:
    - % classified as "unexplained" and "unclassified" (added together) is less than 20%
    - % classified as "other" within the level 2 causes of each main category is, together, less than 20%
    - % with a flag of "unknown timing" is low
    - Reliability testing conducted in diverse settings
    - Kappa scores for individual main causal categories and overall underlying cause of death both at least 0.60
    - There are definitions provided within the system for all causes at all levels
    - There are rules provided for assigning cause of death
    - A substantial proportion of high-income settings (including (a) countries, (b) well-funded research projects, and (c) data-rich care settings such as specialist hospitals) uses the system
    - Each year, the system is used in at least two high-income countries and on at least 500 deaths
    - The system is gradually adopted by countries that are becoming high-income
- Clarify, finalize and publicize measures of success PRIOR to system use, to increase accountability

7.2 Dissemination

Background:

- The 2016 systematic review of classification systems for causes of SB and NND found that a tiny proportion of these deaths were being classified using any system at all, and most systems were used only in the countries where they were developed. For "Delphi systems", the numbers at the time of publication were:
    - Cole 1986: 345 deaths; used in Nigeria, Netherlands
    - INCODE: 1,075; used in Canada, US
    - PSANZ-PDC: 13,416: used in Australia, New Zealand, Vietnam, Madagascar
    - Codac: 872, used in Norway, Italy, Wales; also now used in UK as a national system and tested in India
    - Tulip: 3,603; used in the Netherlands
    - Kotecha: 296; used in Wales
- For most if not all these systems, the numbers of deaths classified since then has of course increased, but the point is that the numbers are low compared to the volume of actual deaths (with possible exception of PSANZ-PDC which is used nationally in Australia and New Zealand and hence on most of those deaths).
- In some countries multiple systems have been used (in the period 2009-2014), for instance:
    - In the UK: 8
    - In the Netherlands: 7
    - In Brazil, India, Pakistan: 6
    - In Canada: 5
    - In Australia, Italy, Scotland, Tanzania and the US: 4
    - In Ireland, Nepal, New Zealand, Vietnam and Wales: 3
- This suggests a demand in these countries, whether at national, researcher, or practitioner or hospital level, for using some system of classification
- Yet as seen earlier, virtually no system is available in multiple languages or electronically for easy access, and training, while sometimes available for system use, is not always effective, while many systems lack definitions for all causes and even rules for use.
- The conclusion is that dissemination—ie, penetration of the system into the settings for which it would be designed—will be a real challenge

Proposal:

- Articulate who we expect to use this system and by when (set goals for dissemination)
- Identify roadblocks to successful dissemination and how to overcome these
- Identify funding sources and management resources for dissemination

7.3 Evaluation and revision

Background:

- No hard data was collected on this important facet of system creation
- Yet it is evident that some systems do undergo revision, eg
    - Codac training has been revised in light of UK experience with its use
    - PSANZ-PDC has been revised several times, most recently substantially revised, partially in line with results of Delphi process, and through a consultative process in Australia and New Zealand
    - ICD-PM has been simplified after testing in several countries (though the simplified version apparently does not replace the original, merely an alternative for settings where the original is challenging to use)
- The 2016 systematic review of systems found that just 10 systems out of 81 identified had ever been tested for reliability, including several of the "Delphi" systems (no accident since reliability testing results were a component of Delphi alignment assessment):
    - Cole 1986: overall Kappa found to be 0.35, 0.85 and 0.92 depending on who did the testing, with cause-specific agreement ranging 0.58-0.98
    - PSANZ-PDC: overall Kappa 0.63; 0.92 for "unexplained" only
    - Codac: overall Kappa 0.51-0.82 for each pair of raters, 0.65 when tested by another group
    - Tulip: .074, 0.81, 0.93 overall Kappa depending on who did the testing; 0.46-0.92 or 0.74-0.96 for cause-specific Kappa depending on who did the testing
- Resources have clearly been found for reliability testing in the past but possibly some results are not comparable due to different groups doing the testing

Proposal:

- Agree on a time frame, location, and method for evaluating the system with the first year of use, including reliability testing and ease of use.
- Identify funding and management resources for operationalizing this plan.

8. BASIC DATA ON OTHER NATIONAL SYSTEMS

8.1 Introduction

A system that is useful in data-rich settings must meet the needs of the largest current users in those settings, which include governments that fund regular data collection on causes of stillbirth and neonatal death. A window into those needs is provided by the systems currently used by such countries, including Canada, the UK, Scotland, Wales and Ireland, as well as middle-income settings such as Brazil and South Africa, and large countries with high perinatal death burdens and a growing middle class, such as Bangladesh

8.2 Canada's Public Health Agency 2008

- Canada uses a simple system to classify causes of stillbirth as one component of tracking the "fetal mortality rate" which is one of its 29 perinatal health indicators. There are 1000-1500 stillbirths a year, approximately.
- Causes in the system (just 1 level):
    - Congenital anomalies
    - Maternal complications of pregnancy
    - Complications of placenta/cord/membranes
    - Intrauterine hypoxia and birth asphyxia
    - Unspecified
- ICD-9 and ICD-10 codes provided for each category
- Causes determined by data from "stillbirth registration forms"
- Does not distinguish timing. Not hierarchical. Requires 1 COD. No AC included. No definitions or rules.
- 48% "other", 4% "unexplained"

8.3 Brazilian List of Avoidable Deaths

- Brazil uses its own system to assess causes of neonatal death (stillbirth not included)
- It uses ICD codes
- Just 1 COD is allowed. Not hierarchical. No AC.
- Just 3 causes are included in the top level, though there are 3 levels:
    - avoidable by adequate attention to women during pregnancy
    - avoidable by adequate attention to women in delivery
    - other causes
- 12% "other"
- No definitions or rules provided.
- In our source document, just 50 deaths were classified.

8.4 Bangladesh NIPORT 2004

- Like several other national systems, this Bangladesh system uses ICD codes.
- It is only for neonatal deaths.
- The system is hierarchical and allows more than 1 COD.
- Associated factors are not allowed.

- There are 2 levels. The top level has 16 causes:
    - Neonatal tetanus
    - Congenital abnormality
    - Injury
    - birth asphyxia
    - birth injury
    - measles
    - measles followed by ARI or diarrhea
    - diarrhea
    - ARI
    - ARI and diarrhea
    - Possible serious infection
    - Premature birth/LBW
    - Malnutrition
    - Other causes
    - Unspecified
    - Undetermined
- 14% “other”, 21% “unexplained”
- Both definitions for all causes, and rules, are provided.
- 326 neonatal deaths were classified using this system in our source document.

8.5 National Services Scotland 2013-obstetric

- This Scottish system does not use ICD codes.
- Includes both SB and NND but does not fully distinguish timing of death
- Requires 1 COD. Not hierarchical. Associated factors are allowed but not fully distinguished from causes.
- There are 2 levels. The top level has 12 causes as follows:
    - Major congenital anomaly
    - Hypertensive disorders of pregnancy
    - Antepartum or intrapartum haemorrhage
    - Mechanical
    - Maternal disorder
    - Infection
    - Specific fetal conditions
    - Specific placental conditions
    - Intra-uterine growth restriction
    - Associated obstetric factors
    - No antecedent or associated obstetric factors
    - Unable to classify
- 24% “unexplained”
- The system allows recording the type of data used for classification and degree of certainty. Also, guidance is provided on accessing data from the system.
- However, no causes are defined and no rules are provided.
- In our source document, 880 deaths had been classified by this system.

8.6 UK: CMACE 2010-maternal & fetal

- ICD codes not used in this UK system. Both SB and NND are included. Unusually, timing of death is specified, although not all categories are separated between SB and NND.
- One COD is not required (up to 2 may be recorded).
- System is not hierarchical. Associated factors are allowed, but not distinguished clearly from causes.
- There are 2 levels, with 13 causes in the top level:
    - Major congenital anomaly
    - Iso-immunisation
    - Pre-eclamptic toxemia
    - Antepartum or intrapartum haemorrhage
    - Mechanical
    - Maternal disorder
    - Infection
    - Specific fetal conditions
    - Specific placental conditions
    - Intra-uterine growth restrictions
    - Associated obstetric factors
    - No antecedent or associated obstetric factors
    - Unclassified
- For neonates, a neonatal condition is also recorded:
    - Major congenital anomaly
    - Extreme prematurity
    - Respiratory disorders
    - Gastrointestinal disease
    - Neurological disorder
    - Infection
    - Injury/trauma
    - Other specific causes
    - Sudden unexpected deaths
    - unclassified
- 39% “unexplained”
- As with Scottish system above, certainty of the data and type of data used for diagnosis are both recorded. Rules are provided but definitions only for some causes.
- Nearly 7,000 deaths had been classified by this system in our source document.

8.7 UK, Wales: CMACE 2011-maternal & fetal

- As with the CMACE 2010 system, this one used in the UK and Wales does not use ICD codes and includes both SB and NND. It records timing of death and requires a single COD. It is not hierarchical and allows associated factors but does not distinguish them fully from causes.
- The system has 3 levels with 12 causes in the top level:
    - Major congenital anomaly
    - Hypertensive disorders of pregnancy
    - Antepartum or intrapartum haemorrhage
    - Mechanical
    - Maternal disorder

    - Infection
    - Specific fetal conditions
    - Specific placental conditions
    - Intrauterine growth restriction
    - Associated obstetric factors
    - No antecedent or associated obstetric factors
    - Unclassified
- For neonates, a neonatal condition is also recorded, exactly as in CMACE 2010 above
- 51% "unexplained"
- The system allows the type of data and certainty of the diagnosis to be recorded. No definitions and no rules are provided.
- Nearly 10,000 deaths had been classified by this system in our source document.

8.8 Ireland: Manning 2013-maternal & fetal

- System does not use ICD codes. Includes both SB and NND. Records timing of death. Does not fully distinguish between SB and NND due to some overlapping causes. Requires a single COD. Not hierarchical. Allows associated factors but does not fully distinguish them from causes.
- The system has 3 levels with 12 causes in the top level:
    1. Major congenital anomaly
    2. Hypertensive disorders of pregnancy
    3. Antepartum or intrapartum haemorrhage
    4. Mechanical
    5. Maternal disorder
    6. Infection
    7. Specific fetal conditions
    8. Specific placental conditions
    9. Intra-uterine growth restriction
    10. Associated obstetric factors
    11. No antecedent or associated obstetric factors
    12. Unclassified
- A separate section for NND causes lists the following:
    1. Major congenital anomy
    2. Pre-viable
    3. Respiratory discorder
    4. Gastrointestinal disease
    5. Neurological disorder
    6. Infection
    7. Injury/trauma
    8. Other specific causes
    9. Sudden unexpected deaths
    10. unclassified
- 22% unexplained
- Allows certainty of the diagnosis and type of data used to be recorded.
- Provides guidance on accessing data from the system. Only gives definitions for some causes; provides rules.
- About 800 deaths had been classified by this system in our source document.

8.9 South Africa: MRC 2002-PPIP

- ICD codes not used. Both SB and NND included. Timing of death is not fully captured.
- Stillbirths are allowed 1 COD while neonatal deaths have 1 primary obstetric and 1 final neonatal cause.
- The system is not hierarchical.
- Associated factors are allowed and fully distinguished from causes.
- The system has just 1 level with 12 obstetric and 7 neonatal causes as follows:
    - Primary causes
        - Unexplained IUD
        - Spontaneous preterm lab.
        - Hypertensive disorders
        - Antepartum haemorrhage
        - IUGR
        - Intrapartum asphyxia
        - Trauma
        - Infections
        - Fetal abnormalities
        - Maternal disease
        - Other
    - Final causes
        - Immaturity related
        - Hypoxia
        - Trauma
        - Infection
        - Congenital abnormalities
        - Other
        - Unknown
- 4% “other” and 35% “unexplained”
- Only some causes have definitions and no rules are provided. The system gives guidance on accessing the data and is available in e-format
- Over 47,000 deaths have been classified by this system in the source document

8.10 Lithuania: Basys 2014

- Does not use ICD codes. Includes both SB and NND. Records timing of death but does not fully distinguish between SB and NND.
- It appears that more than 1 COD is allowed. Not hierarchical; no associated factors allowed.
- 3 levels with 4 causes in the top level:
    - Fetus malformation
    - Antenatal death
    - Intrapartum death
    - Early neonatal death
- 81% “unexplained”
- No definitions or rules. The system is provided in Lithuanian. About 200 deaths were classified using it.

9.ICD-PM

Note that we have referred to the original document released 2016 rather than the different structure described in the more recent WHO perinatal audit guide since the latter is just a simplification of the former.

Causes

Antepartum causes:

A1: Congenital malformations, deformations and chromosomal abnormalities
A2: Infection
A3: Antepartum hypoxia
A4: Other specified antepartum disorder
A5: Disorders related to fetal growth
A6: Fetal death of unspecified cause

Intrapartum causes:

I1: Congenital malformations, deformations and chromosomal abnormalities
I2: Birth trauma
I3: Acute intrapartum event
I4: Infection
I5: Other specified intrapartum disorder
I6: Disorders related to fetal growth
I7: Intrapartum death of unspecified cause

Neonatal causes:

N1: Congenital malformations, deformations and chromosomal abnormalities
N2: Disorders related to fetal growth
N3: Birth trauma
N4: Complications of intrapartum events
N5: Convulsions and disorders of cerebral status
N6: Infection
N7: Respiratory and cardiovascular disorders
N8: Other neonatal conditions
N9: Low birth weight and prematurity
N10: Miscellaneous
N11: Neonatal death of unspecified cause

Maternal conditions:
M1: Complications of placenta, cord and Membranes, ncluding
1. placenta praevia
2. other forms of placental separation and haemorrhage
3. placental dysfunction, infarction, insufficiency

4. fetal-placental transfusion syndromes
5. prolapsed cord, other compression of umbilical cord
6. chorioamnionitis
7. other complications of membranes

M2: Maternal complications of pregnancy, including
1. incompetent cervix
2. preterm rupture of membranes
3. oligohydramnios/polyhydramnios
4. ectopic pregnancy
5. multiple pregnancy
6. maternal death
7. malpresentation before labour
8. other complications of pregnancy

M3: Other complications of labour and Delivery, including
1. breech delivery and extraction
2. other malpresentation, malposition and disproportion during labour and delivery
3. forceps delivery/vacuum extraction
4. caesarean delivery
5. precipitate delivery
6. preterm labour and delivery
7. other complications of labour and delivery, including termination of pregnancy

M4: Maternal medical and surgical conditions, including
1. pre-eclampsia, eclampsia
2. gestational hypertension
3. other hypertensive disorders
4. renal and urinary tract diseases
5. infectious and parasitic disease
6. circulatory and respiratory disease
7. nutritional disorders
8. injury
9. surgical procedure
10. other medical procedures
11. maternal diabetes, including gestational diabetes
12. maternal anaesthesia and analgesia
13. maternal medication
14. tobacco/alcohol/drugs of addiction
15. nutritional chemical substances
16. environmental chemical substances
17. unspecified maternal condition

M5: No maternal condition (1. no maternal condition identified (healthy mother))

Rules

Every death must have both a fetal/neonatal condition and a maternal condition.

From the WHO audit guide, Table 2.2, the advice on filling out cause of death in a perinatal death certificate:

Sections of causes of death on a standard perinatal death certificate

(a) Main disease or condition in fetus or infant
(b) Other diseases or conditions in fetus or infant
(c) Main maternal disease or condition affecting fetus or infant
(d) Other maternal diseases or conditions affecting fetus or infant

10. DELPHI SYSTEMS

From Classification systems library except Kotecha, abstracted by hand, and PSANZ-PDC, from revised version still in draft form

Cole 1986

Cole SK, Hey EN, Thomson AM: Classifying perinatal death: an obstetric approach. Br J Obstet Gynaecol 1986, 93(12):1204-121

Classification categories

- Congenital Anomaly
  - Neural-tube defects
  - Other anomalies
- Isoimmunization
  - Due to the Rhesus (D) antigen
  - Due to other antigens
- Pre-eclampsia
  - Without APH
  - Complicated with APH
- Antepartum Haemorrhage (APH)
  - With placental previa
  - With placental abruption
  - APH of uncertain origin
- Mechanical
  - Cord prolapse or compression with vertex of face presentation
  - Other vertex or face presentation
  - Breech presentation
  - Oblique or compound presentation uterine rupture
- Maternal Disorder
  - Maternal hypertensive disease
  - Other maternal disease
  - Maternal infection
- Miscellaneous
  - Neonatal Infection
  - Other neonatal disease
  - Specific lethal condition
- Unexplained
  - Mature: ≥2.5 kg
  - Premature: <2.5 kg
- Unclassifiable

Definitions

Congenital Anomaly

- Any genetic or structural defect arising at conception or during embryogenesis incompatible with life or potentially treatable but causing death.

Isoimmunization

- Death ascribable to blood group incompatibility

Pre-eclampsia

- Diastolic blood pressure of 90 mmHg or more on two separate days after 20 weeks gestation (140 days) with significant proteinuria in the absence of existing hypertensive disease before pregnancy. Full definition as per the International Federation of Gynaecology and Obstetrics to the terms pre-eclampsia and eclampsia in the 9th Editions of *International Classification of Disease*
- Used for pregnancy-associated hypertension which appears for the first time after the 20th week associated with more than a trace of proteinuria or symptoms commonly found in the clinical syndrome of pre-eclampsia (headache, epigastric pain, visual disturbance, extensive generalized oedema)

Antepartum Haemorrhage (APH)

- Vaginal bleeding after 20 weeks gestation (140 days) whether revealed or not, excluding antepartum haemorrhage secondary to pre-eclampsia (which is classified under pre-eclampsia)

Mechanical

- Any death from uterine rupture and those deaths from birth trauma, or intrapartum asphyxia that are associated with problems in labor such as disproportion, malpresentation, cord prolapse, cord compression, or breech or delivery in babies of 1000 g or more.

Maternal Disorder

- Include maternal trauma (such as road traffic accident), diabetes, appendicitis, and cardiac disease, etc, if severe enough to jeopardize the baby.

Miscellaneous

- Specific fetal and neonatal conditions only.

Unexplained

- Deaths with no obstetric explanation, including unexplained antepartum stillbirths, deaths resulting from unexplained preterm delivery (including hyaline membrane disease, intraventricular haemorrhage etc.) and cases of intrapartum asphyxia or trauma if the baby weighed less than 1000 g at birth or delivery was unassociated with any obvious mechanical problem.

Unclassifiable

- Cases where little or nothing is known about pregnancy or delivery only.

Rules

The various causes of death appear in a hierarchical order. Such an approach should not be used, however, if it leads to a conclusion which clearly infringes the cardinal rule that death should always be ascribed to the initial factor that set the baby's death in train.

Pre-eclampsia

- Only significant pre-eclampsia, a diastolic blood pressure of 90 mmHg or more on two separate days after 20 weeks gestation (140 days) with significant proteinuria in the absence of existing hypertesnsive disease before pregnancy
- Hypertension present before pregnancy or hypertension developing as a consequence of known renal disease before pregnancy is classified as a 'Maternal disorder'

Antepartum Haemorrhage

- Minor degrees of haemorrhage at the start of labor, and haemorrhage due to a cervical erosion or polyp should be ignored, but significant or recurrent bleeding of uncertain origin that is fairly closely followed by preterm labor should not be ignored.

Mechanical

- If there is no evidence of difficult in labor, deaths from asphyxia or trauma should be classified as 'Unexplained'. Antepartum deaths associated with cord entanglement in the absence of strong circumstantial evidence that cord compression caused death should also be classified as 'Unexplained'.

Maternal Disorder

- Include significant renal disease or essential hypertension known to be present before pregnancy. Also include symptomatic and asymptomatic maternal infection when this results in the death of the baby.

Miscellaneous

- Do not include conditions directly ascribable to prematurity or asphyxia before birth, because these deaths are attributable to the relevant underlying obstetric disorder.
- Include specific fetal conditions, (e.g. twin-to-twin transfusion) or neonatal conditions (e.g. inhalation of milk) where these are not directly ascribable to intrapartum anoxia or preterm delivery.
- Include postnatally acquired infection, except in babies of less than 1000g; here the reason for the low birthweight is the codable factor.

Unexplained

- Cases should be subclassified into those babies weighing 2500 g or more and those of less than 2500 g at birth.

Unclassifiable

- Use this category as sparingly as possible.

CODAC

J F Frøen et al. Causes of death and associated conditions (Codac): A utilitarian approach to the classification of perinatal deaths. BMC Pregnancy and Childbirth 2009;9:22.

Classification categories

0. Infectious causes of death (abbrev: Infection)
   Deaths caused by infections affecting the mother, neonate or intrauterine structures and compartments directly are coded here by the causative agents as the primary COD. This includes lethal effects of infection by leading to congenital anomalies, by causing direct failure of the placenta or vital fetal/neonatal/maternal organs, or by initiating pre-viable preterm labor. The locus of the infection may be coded in subsequent positions.
1. Conditions, diseases and events specific to neonatal life (abbrev: Neonatal)
   Neonatal deaths caused by conditions or events specific to neonatal life are coded in this category as primary COD. Other COD and AC for neonatal deaths may be coded in any other relevant category.
2. Mechanics and events of parturition or its complications (abbrev: Intrapartum)
   Deaths occurring after onset of labor (intrapartum or neonatal) and where the most significant causal mechanisms were initiated by the onset, progress or complication of labor, are coded in this category as primary COD. Cases in which pre-existing conditions had reduced fetal survival potential to such an extent that mortality in normal and otherwise uncomplicated labor is significant (proportion > 0.05) if undelivered, should be coded with that condition as the primary COD with Intrapartum in a subsequent position.
3. Congenital anomalies, chromosomal anomalies and structural malformations (abbrev: Congenital anomaly)
   Deaths caused by congenital and chromosomal anomalies and structural fetal malformations, including effects of amniotic banding, are coded here as primary COD. Malformations of the placenta and cord are coded in those categories, with the exception of amniotic banding which are all coded here, irrespective of structures affected. Disruptions/deformations due to maternal uterine malformations are coded in Maternal. Congenital neoplasia is coded in Fetal.
4. Fetal conditions, diseases and events (abbrev: Fetal)
   Deaths caused by any fetal condition, disease or event (except Congenital anomaly) are coded here as primary COD. This includes those caused by placental transfer of toxins, or maternal antibodies against fetal tissues (as in alloimmunization) that does not constitute a maternal disease. The effects of maternal antibodies against her own tissues (as in anti-cardiolipin syndrome causing placental thrombosis or SS-A/SS-B antibodies causing fetal arrhythmias), should however be coded in Maternal.
5. Cord conditions, diseases and events (abbrev: Cord)
   Deaths caused by any condition, disease or event affecting the umbilical cord and its insertion are coded here as primary COD. If the same process has been shown to be present and equally significant in the fetal compartment, the primary COD should be coded there, if applicable.
6. Conditions, diseases and events of the placenta and membranes (abbrev: Placenta)
   Deaths caused by any condition, disease or event affecting the placenta and membranes are coded here as main COD. If the same process has been shown to be present and equally significant in the fetal or cord compartment, the primary COD should be coded there, if applicable.
7. Maternal conditions, diseases and events (abbrev: Maternal)
   Deaths caused by any maternal condition, disease or event, of a sufficient degree to significantly increase the risk of perinatal death are coded here as primary COD. If the same process has

been shown to be present and equally significant in the fetal, cord or placental compartment, the primary COD should be coded there, if applicable.
This category includes conditions that was unrelated to of pregnancy (as in maternal cancer), was incompatible with a viable pregnancy (as in Ehler-Danlos syndrome), was exacerbated by the normal physiology of pregnancy (as in anti-phospholipid syndrome), or was caused by uncertain mechanisms of pregnancy, and yet poses serious threats to maternal and fetal health (as in acute fatty liver of pregnancy). In exceptional cases, the category may include maternal pathology provoked by non-lethal pathophysiology of pregnancy (as in acute onset pregnancy-induced hypertensive crisis with apparently minimal placental pathology). Symptoms (as hypertension) caused by intrauterine pathologies (as placental insufficiencies) should not be coded as a COD, but may be coded in subsequent positions.

8. Unknown, unexplained and unclassifiable causes of death (abbrev: Unknown)
   Neonatal, antepartum, and deaths with unknown timing, in which no definite or probable COD has been found are coded in this category as the primary COD. Otherwise unclassifiable cases are also coded here. This category only exists for causes of death, and is replaced by Associated perinatal for AC.
9. Terminations of pregnancy (abbrev: Termination).
   All deaths caused by termination of pregnancy are coded in this category as the primary COD. This is irrespective of the indication, timing of death, or whether termination was performed by health professionals or not. It includes augmentations of labor in cases of expected unavoidable death, and also cases in which death did not occur before the completion of delivery. This category only exists for causes of death, and is replaced by Associated maternal for AC.

Categories specific to associated conditions

10. Associated conditions and complications in the perinatal period (abbrev: Associated perinatal)
    AC and complications of pregnancy are coded here in the secondary or third position.
11. Associated maternal conditions and identified risk (abbrev: Associated maternal)
    AC and identified risk of the mother are coded here in the secondary or third position.

Definitions

Perinatal period

The perinatal period commences as the birth weight passes 500 grams, or 22 completed weeks of gestation if weight is unknown, or 25 cm crown-heel length if weight and age is unknown, and it ends with the early neonatal period at 7 postnatal days.

Fetal death

Fetal death is death prior to the complete expulsion or extraction from its mother of a fetus, irrespective of the duration of pregnancy; the death is indicated by the fact that after such separation the fetus does not breathe or show any other evidence of life, such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles.

Stillbirth

A stillbirth is the birth after fetal death in the perinatal period.

Perinatal death

A perinatal death is death during the perinatal period, and includes stillbirths and early neonatal deaths.

Cause of death
A cause of death in stillbirth is an event, disease or condition of sufficient severity, magnitude and duration for death to be expected in a significant proportion of such cases in a continued pregnancy in the clinical situation it was observed.
COD in the neonate is defined likewise by deleting the insert "... in a continued pregnancy ..."

Associated condition
An associated condition of stillbirth is an event, disease or condition of sufficient severity, magnitude and duration to contribute in explaining the circumstances of death in a significant proportion of such cases in a continued pregnancy in the clinical situation it was observed.
AC in the neonate is defined likewise by deleting the insert "... in a continued pregnancy ..."

Mechanism of death
Mechanisms are biological pathways or chains of events that are initiated by an underlying cause, and consistently and irreversibly result in the same ultimate outcome when triggered by the same event.

Rules

1. To be a COD, the condition(s combined) should have significant lethality (≥ 0.05) in the clinical setting it was observed.
2. If no COD was found, code antepartum stillbirths and neonatal deaths as 8xx and intrapartum deaths as 29x.
3. If two (or more) conditions could be COD, select the most significant contributor to death.
4. If two equally significant conditions could be COD, code the first to occur if this can cause the latter (related conditions)
5. If two equally significant conditions could be COD, code the last to occur if this cannot cause the first (unrelated conditions)
6. If two equally significant conditions of unknown timing could be COD, code the first among codes 0 to 7 (hierarchically).
7. If COD was infectious, code as 0xx (000 if unknown agent) and report the locus as AC in 19x, 49x, 59x, 69x or 79x.
8. If any act to advance death was performed (termination), code as 9xx, and conditions leading to termination as AC.
9. To be an AC, the condition(s combined) should contribute significantly in explaining the circumstances of death.
10. Do not code any condition(s) unrelated to the causes or circumstances of death.

Tulip

Korteweg, F.J., et al., The Tulip classification of perinatal mortality: introduction and multidisciplinary inter-rater agreement. BJOG, 2006. 113(4): p. 393-401.

Classification categories

Congenital anomaly

- Chromosomal defect
- Syndrome
- Central Nervous System
- Heart and circulatory system
- Respiratory system
- Digestive system
- Urogenital system
- Musculoskeletal system
- Endocrine/metabolic system
- Neoplasm
- Other

Placenta

- Placental bed pathology
- Placental pathology
- Umbilical cord complication
- NOS

Prematurity/immaturity

- PPROM
- Preterm labour
- Cervical dysfunction
- Iatrogenous
- NOS

Infection

- Transplacental
- Ascending
- Neonatal
- NOS

Other

- Fetal hydrops of unknown origin
- Maternal disease
- Trauma

Unknown

- Despite thorough investigation
- Important information missing

Definitions

Congenital anomaly

- The cause of death is explained by a genetic or a structural defect incompatible with life or potentially treatable but causing death. Assignment to this group is justified if the congenital anomaly is the actual cause of death and no other major category of causes of death has initiated the causal pathway leading to death. Termination of pregnancy because of a congenital anomaly is also classified in this group; subclassification is dependent on the defect.

Placenta

- The cause of death is explained by a placental pathological abnormality supported by the clinical findings.

Prematurity/immaturity

- The cause of death is explained by the initiation of preterm delivery only and in the case of neonatal death also, with the associated problems of prematurity/immaturity.

Infection

- The cause of death is explained by an infection resulting in sepsis and stillbirth or neonatal death. There is a clear microbiological evidence of infection with matching clinical and pathological findings.

Other

- The cause of death is explained by another specific cause not mentioned in the previous groups of cause of death.

Unknown

- Despite thorough investigation
- Important information missing

Rules

Congenital anomaly

- Sub classifications defined by definition.

Placenta

- Placental bed pathology - inadequate spiral artery remodelling and/or spiral artery pathology leading to uteroplacental vascular insufficiency such as placental infarction.
- Placental pathology - pathology originated during development of the placenta itself, abnormalities in the parenchyma or localisation of the placenta.
- Development - morphologic abnormalities that arise because of abnormal developmental processes such as placenta circumvallata, villus immaturity and placenta hypoplasia.
- Parenchyma - acquired placenta parenchyma disorders of the villi or intervillous space. Examples are villitis of unknown origin, massive perivillous fibrin deposition and fetomaternal haemorrhage without obvious cause.
- Abnormal localization – example is praevia.
- Umbilical cord complication - acquired umbilical cord complications supported by clinical findings. Example is umbilical cord prolapse, with occlusion of the vessels.

- NOS - the cause of death falls into the group placenta, but because of the existence of different placenta subclassifications, a choice cannot be made as to what was first in the chain of events leading to death.

Prematurity/immaturity

- PPROM - Preterm prelabour rupture of membranes (PPROM) initiates preterm delivery.
- Preterm labour - where uterus contractions initiate preterm delivery.
- Cervical dysfunction - initiates preterm delivery.
- Iatrogenous - procedure initiates preterm delivery on maternal non- obstetrical indication only, for example caesarean section on maternal indication for carcinoma.
- NOS - where prematurity/immaturity is the cause of death but it is not clear how preterm delivery was initiated.

Infection

- Transplacental - where there is a haematogenous infection through the spiral arteries, the placenta and the umbilical cord to the fetus such as Parvovirus infection.
- Ascending - where there is an ascending infection from colonisation of the birth canal such as Streptococci group B infection.
- Neonatal - where there is infection acquired after birth such as Escherichia coli sepsis–meningitis.
- NOS - where there is infection, but it cannot be discerned whether the infection was transplacental, ascending or acquired after birth

Other

- Fetal hydrops of unknown origin.
- Maternal disease - is severe enough to jeopardise the fetus or the neonate, initiating death. Examples might be severe maternal sepsis or alloimmunisation. For most maternal medical conditions, this classification.
- Medical Conditions - will only apply when the disease leads directly to perinatal death, as in diabetic ketoacidosis. Other- wise, the condition is a risk factor.
- Trauma - such as severe road traffic accidents.
- Fetal – such as birth trauma
- Out of the ordinary - a specific event or condition initiating the causal pathway to fetal or neonatal death such as rupture of the uterus.

Unknown

- Despite thorough investigation

To register more information about each case of perinatally related mortality, it is also possible to describe contributing factors, defined as other known factors on the causal pathway to death, e.g. risk factors such as obesity and smoking, and comorbidity, defined as an event or a condition relevant for the clinical situation or the care given but not part of the causal pathway to death.

PSANZ-PDC

Congenital anomaly

1.1 Structural anomaly
- 1.11 Nervous system
- 1.12 Cardiovascular system
- 1.13 Genitourinary system
- 1.14 Gastrointestinal system
- 1.15 Musculoskeletal
  - 1.151 Congenital diaphragmatic hernia
  - 1.152 Gastroschisis/omphalocele
- 1.16 Respiratory system
- 1.17 Congenital malformation affecting multiple systems (no chromosomal/genetic cause)
- 1.18 Other specified congenital anomaly
  - 1.182 Idiopathic hydrops fetalis
  - 1.183 Fetal tumour (include sacro-coccygeal teratoma)
  - 1.184 Other specified
  - 1.19 Congenital anomaly, unspecified

1.2 Chromosomal anomaly
- 1.21 Down syndrome (trisomy 21)
- 1.22 Edward syndrome and Patau syndrome (trisomy 18, trisomy 13)
- 1.23 Other trisomies and partial trisomies of the autosomes, not elsewhere classified (includes pathogenic duplications, unbalanced translocations and insertions)
- 1.24 Monosomies and deletions from the autosomes, not elsewhere classified (includes pathogenic deletions e.g. 22q11.2 deletion syndrome (diGeorge syndrome), Wolff-Hirschorn syndrome, Cri-du-chat syndrome
- 1.25 Turner syndrome (monosomy X)
- 1.26 Other sex chromosome abnormalities (e.g. Klinefelter syndrome)
- 1.28 Other chromosomal abnormalities, not elsewhere specified (includes Fragile X syndrome, imprinting syndromes, triploidy)
- 1.19 Unspecified

1.3 Genetic condition
- 1.31 Genetic condition, specified (e.g. Tay-Sachs disease; includes inborn errors of metabolism)
- 1.39 Genetic condition, unspecified

Definitions and Rules:

This category includes deaths in which a major congenital anomaly, whether structural, functional or chromosomal, is considered to have been the reason for the death. All categories correspond to the ICD10 numbering in Chapter XVII Congenital malformations, deformations and chromosomal abnormalities (Q00-Q99) as presented in ICD-PM [1]

If termination of pregnancy was undertaken as a result of the anomaly include the digit "9" at the end the numerical classification e.g. Termination of Trisomy 21 (Down Syndrome) 1.2109. All terminations of pregnancy for congenital anomalies regardless of the causal link to perinatal death are also classified here. With mapping to ICD coding, non-lethal abnormalities may be identified.

Chromosomal and genetic testing are categorised separately, in recognition of advances in prenatal screening and testing. The scope of genetic testing is widening to include some conditions that may not manifest with structural anomalies in the prenatal period (e.g. Fragile X syndrome). If there is both a chromosomal/genetic and structural abnormality, code for the chromosome or genetic condition with

the structural condition as an associated condition. Results of genetic testing of unknown significance are captured under associated conditions.
The chromosomal abnormality category excludes deaths where molecular karyotyping identifies an anomaly which is not thought to be causal. Findings of genetic testing of unknown significance (variations of uncertain or unknown significance, VUS)) are classified as associated conditions. Where there is both a chromosomal and a structural abnormality, classify according to the chromosome abnormality with the structural abnormality as an associated condition.

Specific examples:

Down syndrome (Trisomy 21) is classified as a Chromosome abnormality (Down syndrome 1.21). If a cardiac anomaly is also present, this would be an associated condition (1.12 cardiovascular system).

VATER association with no known genetic abnormality is classified as 1.17 Congenital malformations affecting multiple systems.

Hydrops Fetalis*:* Antibody related hydrops (Immune Hydrops) e.g. Rhesus or Kell incompatibility is coded under 6.6 (Specific perinatal conditions).

Hydrops fetalis due to known genetic disorder e.g. Bart's haemoglobinopathy (alpha thalassemia), code under 1.3 genetic condition, specified.

Non immune hydrops if due to chromosomal/genetic anomalies, classify under 1.2 and appropriate sub-classification, e.g. 1.25 Turner syndrome.

Non chromosomal, non-immune immune hydrops fetalis without structural or underlying genetic/ metabolic abnormality classify as 1.18 Other specific congenital anomaly, hydrops fetalis, idiopathic.

If the hydrops is secondary to underlying structural pathology e.g. congenital heart abnormality, neuromuscular disorders, skeletal dysplasia (achondrogenesis) or infection – classify in appropriate systems.

Hydrops associated with monochorionic twins classify under 6.1 category.

Multiple anomalies: Where the multiple anomalies are a part of a chromosomal anomaly found in the decedent, e.g. cleft lip and palate with heart defect as in velocardiofacial syndrome associated with 22q11 deletion, they should be classified under Category 1.2 but only if chromosome testing confirms deletion.

VATER and **VACTERL** are 1.17 Congenital malformations affecting multiple systems, specified. For syndromes where DNA testing is available and has been confirmed in the case (e.g. CHARGE syndrome) classify as genetic condition 1.31, specified.

Anterior wall defects

Omphalocoele, gastroschisis, and congenital diaphragmatic hernia are now classified under musculoskeletal anomalies (Category 1.15), in line with ICD10-PM.

Omphalocoele (synonymous with exomphalos), is a midline anterior wall defect that may be seen as an isolated condition or in association with chromosome abnormalities, syndromes and associations/sequences. If it is an isolated anomaly classify 1.15; if associated with multiple structural anomalies classify as 1.17; if associated with aneuploidy e.g. trisomy 18, classify as 1.22.

Acquired CNS anomalies

Infection-related abnormalities should be classified under Category 2, e.g. microcephaly/hydrocephaly secondary to CMV or toxoplasma infections should be classified as Category 2.21 and 2.3 respectively.

Congenital intracranial haemorrhage/injury may be classified as Category 7.6 *Fetal antenatal intracranial injury*

Disruptions due to amniotic band disruption sequence may cause extensive asymmetric injury to the cranium and brain. It may also present as anencephaly or encephalocele. Classify under Category 7.6 *Fetal antenatal intracranial injury.*

Neuromuscular disorders

These are a complex group that may include primary muscle anomalies, CNS anomalies – both acquired and primary - and metabolic abnormalities. Some are syndromic with recognised recurrence risk. Associated anomalies may include pulmonary hypoplasia, hydrops and cleft palate. The cause of death may have been respiratory failure but the death should be classified as the underlying abnormality.
If the underlying aetiology is unknown classify as 1.19. If the underlying aetiology is known classify accordingly – e.g. *Fetal antenatal intracranial injury* Category 7.6.

Unspecified Congenital Abnormalities

Category 1.19 *Congenital anomaly, unspecified* covers those cases where an abnormality was stated as the cause but where insufficient information was available to classify under other categories.

Perinatal infection

2.1 Bacterial
- 2.11 Group B Streptococcus
- 2.12 E coli
- 2.13 Listeria monocytogenes
- 2.14 Spirochaetal e.g. Syphilis
- 2.18 Other bacterial
- 2.19 Unspecified bacterial

2.2 Viral
- 2.21 Cytomegalovirus
- 2.22 Parvovirus
- 2.23 Herpes simplex virus
- 2.24 Rubella virus
- 2.25 Zika virus
- 2.28 Other viral
- 2.29 Unspecified viral

2.3 Protozoal e.g. Toxoplasma

2.5 Fungal

2.8 Other specified organism

2.9 Other unspecified organism

Definition

In order to qualify for this category, there must be evidence of fetal or neonatal infection as in Table 1. Determination of perinatal infection.

Rules

This category aims to identify all perinatal deaths due to infection as the primary cause including perinatal deaths with infection following spontaneous preterm labour or rupture of the membranes. Deaths in preterm infants following spontaneous rupture of the membranes or labour not fulfilling the definition of infection should be classified under Category 9 *Spontaneous Preterm*.
Category 2.8 *Other specified organism* includes deaths due to other identified organisms other than those in Categories 2.1 to 2.5. Category 2.9 *Other unspecified organism* includes cases where there is an obvious infection however the organism was either not identified or not specified.

Examples:

Classify here: Prelabour rupture of the membranes at term, with birth following 24 hours of membrane rupture, neonatal pneumonia identified within 48 hours of birth, subsequent neonatal death, group B Streptococcus identified on vaginal and placental cultures. Classify as subcategory 2.11 Group B Streptococcus and PSANZ-NDC subcategory 4.1.

Classify here: Spontaneous rupture of membranes preterm followed by spontaneous labour at 26 weeks and stillbirth. Membranes were ruptured for 12 hours prior to birth. Fetal pneumonia was detected at autopsy and growth of E Coli from the lungs. Placental pathology showed chorioamnionitis and funisitis. Classify 2.12 with an associated condition as Category 10.11 *Spontaneous preterm, with chorioamnionitis on placental histopathology*.

Classify here: Spontaneous rupture of the membranes at 24 weeks gestation. Clinical chorioamnionitis ensued after 6 days of membrane rupture. Induction of labour was undertaken resulting in birth of a liveborn infant. Birthweight was 650gms. Active resuscitation was unsuccessful. No autopsy or placental pathology was undertaken. Cord blood cultures grew E coli. Classify as Category 2.11 with an associated category of Spontaneous preterm Category 10.13 and PSANZ-NDC Congenital bacterial 4.1 with an associated classification of NDC 2.2 *Extreme prematurity – Unsuccessful resuscitation.*

Classify here: Spontaneous rupture of membranes at 14 weeks, with severe chorioamnionitis at 22 weeks. Labour was induced and baby born without signs of life with a birthweight was 350gms. Autopsy findings of E.coli growth from lung fluid. Placental histopathology showed chorioamnionitis and funisitis. Classify as Category 2.1209.

Do not classify here: Spontaneous rupture of membranes at 21 weeks, with spontaneous onset of labour and birth at 22 weeks gestation. Baby was born without signs of life with a birthweight was 450gms No autopsy was undertaken. Placental histopathology showed chorioamnionitis (no funisitis), no organism was grown. Classify as Category 10.11

Do not classify here: Neonatal death from late onset (≥48 hrs of age) Group B Streptococcal disease in a term infant. Classify under Category 12. *Neonatal death with no obstetric antecedent factor* and PSANZ-NDC as 4.4.

Death type	Criteria for Perinatal Infection category
Fetal	1. Histological confirmation of inflammation in cord (funisitis) or fetus (pneumonitis or pneumonia) with or without microbiological evidence of infection or 2a. Convincing clinical evidence of primary maternal infection and 2b. Positive culture of a pathogen from mother or placenta
Neonatal	**A. Congenital** Early onset infection (within 48 hours of birth), defined as: 1. Clinical signs in neonate consistent with sepsis and 2. Haematological changes consistent with sepsis and one or more of the following: 3a. Positive culture of a pathogen (bacterial or viral) from the neonate or 3b. Pathological evidence at autopsy or 3c. Positive serology or 3d. Positive culture of a pathogen from the mother or the placenta. or 3e. Pneumonia without specified bacterial or viral pathogens

	NB: Some congenital viral infections may have onset later than 48 hours after birth. **B. Acquired** Onset of infection at 48 hours or later, with criteria as above, but excluding 3d.

Table 1. Determination of perinatal infection

Hypertension

3.1 Chronic hypertension: essential
3.2 Chronic hypertension: secondary, e.g. renal disease
3.3 Chronic hypertension: unspecified
3.4 Gestational hypertension
3.5 Pre-eclampsia
3.6 Pre-eclampsia superimposed on chronic hypertension
3.9 Unspecified hypertension

Definition

The classification of *Hypertension* follows that of the Society of Obstetric Medicine of Australia and New Zealand[2] with the exceptions that unspecified subcategories have been included. The definitions are as follows:

Hypertension is diagnosed when the systolic blood pressure is ≥140 mm Hg and /or diastolic blood pressure (Korotkoff V) is ≥90 mm Hg. These blood pressures should be confirmed by repeated readings over several hours in a clinic or day assessment unit or after rest in hospital.

Gestational hypertension is defined as hypertension arising in pregnancy after 20 weeks gestation without any other feature of the multisystem disorder pre-eclampsia and which resolves within 3 months postpartum.

Pre-eclampsia may be defined as hypertension arising after 20 weeks gestation and the onset after 20 weeks gestation of one or more of: proteinuria, renal insufficiency, liver disease, neurological problems, haematological disturbances, fetal growth restriction. The hypertension will have returned to normal within 3 months postpartum.

Rules

This category includes deaths where the hypertensive disorder is considered the factor initiating the chain of events leading to the death. If placental abruption complicates a hypertensive disorder, the death is classified here, as the abruption is attributed to the hypertensive disorder. Specific placental pathology can be coded as associated conditions (see PSANZ-SB&ND Associated conditions list page 34)

This category excludes the circumstance when the hypertension is secondary to an underlying systemic disorder, e.g. Diabetes, where this is severe and uncontrolled (in which case, classify as subcategory 5.2 *Diabetes*, under *Maternal Conditions*). However, if the systemic disorder such as diabetes or gestational diabetes is mild or well controlled, and the death appeared to be due to hypertension or its complications, classify in this category. This category also includes hypertension secondary to renal disease as this often presents first with hypertension.

Antepartum haemorrhage (APH)

4.1 Placental abruption
4.2 Placenta praevia
4.3 Vasa praevia

4.9 Unspecified APH

Definitions

Placental abruption: The diagnosis of placental abruption is made clinically. Confirmation by evaluation of the placenta after delivery is not essential for assigning the death to abruption. Clinically features are classically with vaginal bleeding (although the bleeding may be concealed), abdominal pain, uterine contractions and tenderness[3].

Placenta praevia: Placenta praevia is defined as a placenta that lies wholly or partly within the lower uterine segment diagnosed on ultrasound[3]. With improved diagnosis and management stillbirth as a result of bleeding for placental praevia is now rare.

Vasa praevia: Vasa praevia is the presence of unsupported fetal vessels below the fetal presenting part, where the cord insertion is velamentous[3]. Classically, vaginal bleeding following amniotomy with subsequent fetal bradycardia suggests vasa praevia. The diagnosis of vasa praevia can be confirmed by Doppler and endovaginal ultrasound studies if aberrant vessels over the internal cervical os are suspected[3].

APH of undetermined origin: This category is used where insufficient information is available on the reason for the bleeding. However, there is convincing clinical evidence that the stillbirth was as a result of the bleeding[3].

Rules

This category includes all perinatal deaths where the primary factor leading to the death was an APH. Convincing clinical signs of abruption alone is sufficient to assign the category of 4.1 Abruption. If abruption occurs as a complication of a hypertensive disorder, the death is attributed to the hypertensive disorder (Category 3) with Category 4.1 Placental abruption as an associated condition. Other placental pathology thought to be contributory may also be classified under associated conditions Category 9.

Examples:

Classify here: A women presents at 38 weeks' gestation with abdominal pain, tense abdomen and uterine contractions and a fetal death diagnosed. Placental macroscopic examination showed a large adhesive clot however placental histopathology was inconclusive. Classify as 4.1 Placental abruption.

Maternal Conditions

5.1 Termination of pregnancy for maternal psychosocial indications
5.2 Diabetes
- 5.21 Gestational diabetes
- 5.22 Pre-existing diabetes

5.3 Maternal injury
- 5.31 Accidental
- 5.32 Non-accidental

5.4 Maternal sepsis
5.5 Antiphospholipid syndrome
5.6 Obstetric cholestasis
5.8 Other specified maternal conditions
- 5.81 Maternal suicide
- 5.88 Other specified maternal medical or surgical conditions

Definitions and Rules

Category 5 includes perinatal deaths attributed to any medical or surgical condition in the mother, or to its complications or treatment, excluding conditions elsewhere classified i.e. APH, hypertension. The subcategory 5.1 excludes terminations of pregnancy undertaken for medical indication including congenital and other complications (e.g. prolonged preterm rupture of membranes (PPROM) with severe infection) where a pregnancy is terminated and the fetus is not expected to survive. In this scenario the death is classified under the specific condition including termination of pregnancy due to a congenital anomaly (classified under *Congenital Anomaly*, Category 1) and other conditions such as severe chorioamnionitis following preterm rupture of the membranes at 20 weeks (classify 10.1009 Spontaneous preterm)

Renal disease is not included as a separate subcategory here, but under *Hypertension*, subcategory 3.2, as it usually presents first as hypertension. Maternal conditions should only be attributed here if there is a high probability that they were the cause of death, e.g. a well-documented history of lupus obstetric syndrome with a previous stillbirth. Maternal substance use or smoking may be classified as an associated condition if there is a significant history (including alcohol, cocaine, marijuana) and where it is reasonable to assume that the fetal or neonatal death may be linked.

Example:

Classify here: Fetal death as a result of severe uncontrolled Type I Diabetes with mild pre-eclampsia classify as subcategory 5.22 with an associated condition of Hypertension, Category 3.5.

Complications of multiple pregnancy

6.1 Monochorionic twins or triplets
- 6.11 Twin to twin transfusion syndrome (TTTS)
- 6.12 Selective fetal growth restriction (FGR) (i.e affecting only one twin)
- 6.13 Monoamniotic twins (including cord entanglement)
- 6.14 Other
- 6.15 Unknown or unspecified

6.2 Dichorionic twins or trichorionic triplets
- 6. 21 Early fetal death in a multiple pregnancy (<20 weeks gestation)
- 6. 22 Selective FGR
- 6. 23 Other
- 6.24Unknown or unspecified

6. 3 Complications of higher order multiples

6. 4 Complications where chorionicity is unknown

6.8 Other

6.9 Unspecified

Rules

Where one of the twins (or multiples) is growth restricted as a result of twin to twin transfusion syndrome, classify as 6.11 and not 6.12. Where one or more of the twins (or multiples) is growth restricted from a known underlying cause, classify elsewhere as appropriate, eg classify under Category 9 if there is placental disease in one of dichorionic twins.

Specific perinatal conditions

7.1 Fetomaternal haemorrhage

7.2 Antepartum cord or fetal vessel complications (excludes monochorionic twins or triplets)
- 7.21 Cord vessel haemorrhage

7.22 Cord occlusion (True knot with evidence of occlusion or other)
7.23 Other cord complications
7.29 Unspecified cord complications

7.3 Uterine/cervical abnormalities
7.31 Developmental anatomical abnormalities (e.g. bicornuate uterus)
7.38 Other
7.39 Unspecified

7.4 Alloimmune disease
7.41 Rhesus isoimmunisation
7.42 Other red cell antibody
7.43 Alloimmune thrombocytopenia
7.48 Other
7.49 Unspecified

7.5 Idiopathic hydrops

7.6 Fetal antenatal intracranial injury
7.61 Subdural haematoma
7.62 Fetal antenatal ischaemic brain injury
7.63 Fetal antenatal haemorrhagic brain injury

7.8 Other specific perinatal conditions
7.71 Rupture of membranes after amniocentesis
7.72 Termination of pregnancy for suspected but unconfirmed congenital anomaly.
7.73 Amniotic band
7.78 Other

7. 9 Unspecified

Definitions

Category 7.22 Cord occlusion: A cord knot is where the cord becomes tangled with itself (or another cord in a multiple pregnancy) such that the vessels of the cord may be compromised. To be considered significant there should be evidence of congestion or haemorrhage in the cord, and/or changes in the placenta such as fetal vessel thrombosis or villous oedema to suggest vascular compromise. A knot could cause death without these changes but not every knot causes fetal compromise and therefore should not be accepted as a cause of death without further evidence as above, or strong clinical suspicion by the delivering clinician based on CTG or other changes during delivery. Cord accidents usually only account for a few percent of perinatal deaths.

Other cord compression: For stillbirths, and also neonatal deaths as a result of hypoxic ischaemic encephalopathy (HIE), where the cord is found to be tightly around neck or body with skin blanching (indicating significant cord compression) classify as 7.28.

Category 7.21 includes cord haemorrhage following cordocentesis, umbilical cord ulceration leading to cord haemorrhage, and torn velamentous vessels

Rules

This category includes deaths in which the specific perinatal condition present was thought to be the cause of death. The category excludes perinatal deaths with a major congenital anomaly. Cord complications during labour and other complications of twins eg head entrapment in labour should be categorised under *Hypoxic Peripartum Death*, subcategory 8.18.

Example:

Do not classify here: Spontaneous prelabour rupture of membranes (ROM) at 33 weeks, with immediate cord prolapse and fetal death. Categorise as Spontaneous Preterm Category 10 as the cord complication occurred as a result of the preterm ROM. Cord prolapse is classified as an associated condition.

Hypoxic peripartum death

8.1 With intrapartum complications
- 8.11 Uterine rupture
- 8.12 Cord prolapse
- 8.13 Shoulder dystocia
- 8.14 Complications of breech presentation
- 8.15 Birth trauma
- 8.18 Other

8.2 Evidence of significant fetal compromise (excluding other complications)

8.3 No intrapartum complications and no evidence of significant fetal compromise identified.

8.9 Unspecified hypoxic peripartum death

Definitions and rules

This category includes both intrapartum fetal deaths and neonatal deaths as a result of acute or chronic hypoxia in babies without major congenital anomalies or other major conditions such as antepartum haemorrhage at a gestation in which survival in the context of the birth would be expected (typically of >28 weeks gestation or >1000g birthweight). If placental pathology is identified which resulted in fetal compromise and death then classify under the relevant category i.e. Category 9 Placental pathology or Category 4 Antepartum haemorrhage.

Where intrapartum fetal death or neonatal death occurs following preterm spontaneous onset of labour or rupture of membranes which fulfils the definition of Infection then classify under Category 2. If not fulfilling the criteria for infection and less than 24 weeks then classify under Category 10 *Spontaneous preterm.*

Neonatal deaths as a result of hypoxic ischaemic encephalopathy and otherwise unexplained severe cardiorespiratory depression at birth are included here. Where possible, evidence for intrapartum hypoxia should include fetal, umbilical artery or early neonatal (within one hour) blood gases showing evidence of a severe metabolic acidosis. Otherwise peripartum death might also be due to non-hypoxic causes, e.g. infection or chronic ischaemia but wrongly assumed to be due to acute hypoxia.

There may have been intrapartum complications (subcategory 8.1), or no intrapartum complications but with evidence of non-reassuring fetal status (subcategory 8.2), or no intrapartum complications or evidence of non-reassuring fetal status (subcategory 8.3). A specific major intrapartum complication, such as uterine rupture, cord prolapse or shoulder dystocia, is required for inclusion as subcategory 8.1. However, if there were no apparent intrapartum complications (as defined in category 8.1) but there was evidence of placental insufficiency antenatally, then the death should be attributed to Category 9. In this case Category 8 is captured as an associated condition.

If there is insufficient information about fetal wellbeing or intrapartum complications, classify as subcategory 8.9 *Unspecified hypoxic peripartum death.*

Evidence of non-reassuring fetal status is defined as abnormal fetal heart rate, fetal scalp pH/lactate, fetal pulse oximetry without intrapartum complications.

The term ‘non-reassuring fetal status’ has been used in preference to the term ‘fetal distress’ as ‘clinical signs often poorly predict a compromised fetus and continued use of this latter term may encourage wrong assumptions or inappropriate management’[4, 5].

Examples:

Classify here: No known problems prior to labour at gestation 38 weeks. Severe fetal heart rate decelerations in second stage of labour, without other major complication. Baby is born with no signs of

life with a birthweight of 3500gm, placental histopathology did not identify any significant pathology and no autopsy was performed. Classify as subcategory 8.2.
Classify here: No known problems prior to labour at 36 weeks. No evidence of intrapartum fetal distress. At birth, the baby shows signs of severe respiratory depression and hypoxia. Subsequently develops encephalopathy and multiorgan failure and dies on Day 10 of life. Placental histopathology did not identify any significant pathology and no autopsy was performed. Classify as subcategory 8.3 and PSANZ NDC as 5.1.
Do not classify here: Spontaneous membrane rupture at 22 weeks' gestation, severe oligo hydramnios with positional deformities shown on ultrasound at 26 weeks. Labour and birth at 26 weeks gestation of a baby boy weighing 700gms and was not able to be resuscitated. Placental pathology showed chorioamnionitis but no organisms identified on placental culture or baby blood cultures. Classify as 10.11 *Spontaneous preterm* and PSANZ NDC as Category 2.2 *Not resuscitated.*
Do not classify here: No complications during pregnancy. Spontaneous preterm labour and birth at 38 weeks gestation. Intrapartum fetal distress in second stage and delivered by forceps. Baby boy weighing 2200gms, Apgars 1 and 4, mechanically ventilated and admitted to NICU. Seizures commenced at 2 hrs and active management ceased at 24 hrs due to poor prognosis. Placental pathology showed fetal vascular malperfusion and mild chorioamnionitis however no organisms were identified on culture of the placental or baby. Classify as 9.2 *Placental dysfunction* and PSANZ NDC 5.1 *Hypoxic ischaemic encephalopathy / Perinatal asphyxia*

Placental dysfunction or placental pathology

9.1 Maternal vascular malperfusion
9.2 Fetal vascular malperfusion
9.3 High grade villitis of unknown etiology (VUE)
9.4 Massive perivillous fibrin deposition/maternal floor infarction
9.5 Severe chronic intervillositis (Histiocytic intervillositis)
9.6 No causal placental pathology demonstrated, with antenatal evidence of poor placental function was identified (such as abnormal fetal umbilical artery Doppler)
9.7 Placental pathological examination was not performed, with antenatal evidence of poor placental function was identified (such as abnormal fetal umbilical artery Doppler)
9.8 Other placental pathology
9.9 Unspecified

Rules
This category includes perinatal deaths where placental dysfunction is considered the underlying cause of the death. It excludes perinatal deaths as a result of an identified maternal or fetal condition where the death is classified according to the condition (e.g. Pre-Eclampsia, Pre-existing hypertension). It should exclude pathology which is not thought to be causal, and also amniotic fluid infection/acute chorioamnionitis. Placental pathology which is thought to be contributory rather than causal should be classified as an associated condition (See Associated conditions page 34)

It is acknowledged that multiple pathologies may exist. In these circumstances a dominate pathology needs to be identified and classified as the main cause and others as associated conditions.

This categorise overrides deaths following intrapartum related events as defined in Category 8 Hypoxic peripartum deaths.

Definitions:
This category is based on the Amsterdam Placental Workshop Group Consensus Statement[6].
Category 9.1 *Maternal vascular malperfusion (MVM).* Placental features considered to be indicative of MVM include both gross and microscopic findings. Gross findings include placental hypoplasia, infarction, and retroplacental haemorrhage. Placental hypoplasia is reflected by a placental weight that is low for the stated gestational age and context (weight <10th centile) and/or a thin cord (<10th centile or <8-mm diameter at term). Any infarction seen in a preterm placenta and, at term, anything more than 5% of non-peripheral infarction should be classified as a cause. Although marginal infarcts in a term placenta may have less meaning than in a preterm placenta, they should be classified as an associated condition. *Microscopic findings* include abnormalities of villous development, which can be separated into distal villous hypoplasia, and accelerated villous maturation (vide infra), and infarcts. It should be recognized that many of these histologic findings will coexist in some placentas.
Category 9.6 and 9.7 includes stillbirths or neonatal deaths where clinical evidence of poor placental function sufficient to explain the death was identified however significant causal pathology of the placental was not demonstrated or placental histopathology was not performed. Clinical evidence of poor placental function is defined as evidence of placental disease either on antenatal ultrasound studies or biochemistry. This former can include evidence of reduced maternal (uterine artery) or fetal (umbilical artery, ductus venosus, middle cerebral artery Doppler) vascular perfusion on Doppler studies. The latter can include angiogenesis-related factors such as s-Flt-1/PLGF; further clinical evaluations may clarify which biochemical markers robustly identify placental dysfunction.

Examples:

Classify here: Normal pregnancy. Spontaneous preterm labour and birth at 40 weeks gestation. Non-reassuring fetal status in second stage ensued and birth was by emergency caesarean section. Baby boy weighing 2600gms, Apgars 2 and 4, mechanically ventilated and admitted to NICU with subsequent diagnoses of meconium aspiration and persistent pulmonary hypertension of the newborn. Despite intensive care the baby died at 12 hrs of age. Placental pathology showed massive perivillous fibrin deposition/maternal floor infarction and mild chorioamnionitis, no organisms were identified on placental culture or baby blood cultures. Classify as 9.4 *Placental dysfunction* and PSANZ NDC 3.3 *Primary persistent pulmonary hypertension,* with an Associated condition of *Fetal growth restriction.*
Do not classify here: Normal pregnancy until maternal presentation at 40 weeks' gestation with decreased fetal movements and abdominal pain. Antepartum fetal death was diagnosed and spontaneous labour ensued shortly after. A baby girl was born, mildly macerated, weighing 3400gms. Placental pathology showed massive abruption. Maternal investigations were normal. No organisms were identified on placental culture or baby blood cultures. Classify as APH Abruption 4.1.

Spontaneous preterm labour or rupture of membranes (ROM (<37 weeks gestation)

10.1 Spontaneous preterm with intact membranes, or membrane rupture
- 10.11 With histological chorioamnionitis
- 10.12 Without histological chorioamnionitis
- 10.13 With clinical evidence of chorioamnionitis, no examination of placenta
- 10.17 No clinical signs of chorioamnionitis, no examination of placenta
- 10.19 Unspecified or not known whether placenta examined

10.2 Spontaneous preterm with intact membranes, or membrane rupture preceded by suspected premature cervical shortening
10.21 With histological chorioamnionitis
10.22 Without histological chorioamnionitis
10.23 With clinical evidence of chorioamnionitis, no examination of placenta
10.27 No clinical signs of chorioamnionitis, no examination of placenta
10.29 Unspecified or not known whether placenta examined

Definitions

Clinical evidence of chorioamnionitis is defined as maternal fever (≥38°C) associated with one or more of the following symptoms or signs: maternal or fetal tachycardia, uterine tenderness, malodorous amniotic fluid, and maternal leukocytosis or raised C-reactive protein[7-9].

The diagnosis of histological chorioamnionitis should only be made when there is histological evidence of inflammation or microbiological evidence of infection of the placenta and membranes.

The subcategory of cervical incompetence should be reserved for those circumstances where the primary event appears to be cervical change. This may occur as consequence of pre-existing damage to the cervix from a surgical procedure, due to a congenital structural cervical anomaly (with or without uterine anomaly) or clinically determined from previous obstetric history and/or clinical factors in the current pregnancy.

Rules

Deaths of normally formed, appropriately grown preterm babies following spontaneous onset of preterm labour or spontaneous rupture of membranes, irrespective of induction of labour or mode of delivery (e.g. elective caesarean section). There should be no evidence of fetal or neonatal infection (see Table 1 Determination of perinatal infection), otherwise classify under Category 2 *Perinatal Infection*. Careful examination of the placenta macroscopically and microscopically is recommended.

In cases where there is histological evidence of chorioamnionitis with or without evidence of clinical chorioamnionitis, classify as subcategory 10.11. In cases of clinical chorioamnionitis where placental pathological examination was not performed or it is not known whether the placenta was examined, classify as subcategory 10.13.

Where cervical incompetence is followed by spontaneous preterm labour or ROM classify as 10.2 as opposed to 10.1. There may be some bleeding at the time of onset of labour, or earlier in pregnancy, but not in amounts to warrant the antecedent cause being attributed to *Antepartum Haemorrhage* Category 4. Early bleeding, which is often associated with preterm premature rupture of the membranes may be classified as an associated condition (see page 34).

Examples:

Classify here: Spontaneous labour at 26 weeks, no apparent explanation, and membranes intact. Vaginal delivery after 6 hours of membrane rupture, no evidence of intrapartum hypoxia or chorioamnionitis; subsequent early neonatal death from respiratory distress syndrome. Classify here as subcategory 10.12 *Spontaneous preterm with intact membranes, or membrane rupture, without chorioamnionitis on placental histopathology* and NDC: Category 3.1

Do not classify here: Spontaneous onset of labour at 28 weeks with intact membranes. No cause identified for preterm labour. Delivery following 24 hours of membrane rupture. Maternal intrapartum pyrexia. Chorioamnionitis and funisitis on placental histology, no organism identified. Classify as Category 2.9 Infection, Other unspecified organism

Do not classify here: Alive at the onset of spontaneous labour at 31 weeks, no apparent explanation, and membranes intact. After 12 hrs, continuous intrapartum fetal monitoring showed deep decelerations and emergency caesarean section undertaken. Baby girl weighing 1700 gms was stillborn and could not be resuscitated. Placental pathology showed chorioamnionitis (no funisitis) no organisms

were identified, and no other pathology was demonstrated. No autopsy was performed. Macroscopic examination of the baby was normal, no maceration. Classify as Category 8.2 *Hypoxic peripartum death Evidence of significant fetal compromise (excluding other complications).*

Unexplained antepartum fetal death

11.1 Unexplained antepartum fetal death despite full investigation
11.2 Unclassifiable antepartum fetal death with incomplete investigation
11.3 Unclassifiable antepartum fetal death due to unknown level of investigation

Rules
This category applies to fetal death prior to the onset of labour where no cause for the death was identified. Antepartum fetal death with associated placental pathology (ie not thought to be causative) are coded as associated conditions.

Category 11.1 Unknown antepartum fetal death despite full investigation.
An antepartum fetal death where no cause of death was identified following (as a minimum): comprehensive maternal and pregnancy history; histopathology of the placenta and cord; full autopsy; karyotype/cytogenetics; and testing for Feto-Maternal Haemorrhage (Kleihauer or flow cytometry).

Category 11.2 is used where none or some of the above investigations were performed and Category 11.3 is used where it is unknown/unclear if these investigations were performed or the results were unavailable.

Examples:
Classify here: Intrauterine Fetal Death (IUFD) at 37 weeks, with no maternal conditions, no antepartum haemorrhage, with membranes intact, before onset of labour, where no cause of death was identified following full investigation (*comprehensive maternal and pregnancy history; histopathology of the placenta and cord; full autopsy; karyotype/cytogenetics; and Kleihauer*) Classify as Unexplained Antepartum Fetal Death, subcategory 11.1**.**
Intrauterine Fetal Death (IUFD) at 40 weeks, with no maternal conditions, no antepartum haemorrhage, with membranes intact, before onset of labour, where no cause of death was identified and perinatal death investigations were incomplete (e.g. *No karyotype/cytogenetics*) Classify as Unexplained Antepartum Fetal Death, subcategory 11.2**.**
Do not classify here: Spontaneous ROM at 27 weeks, no significant maternal conditions present, subsequent IUFD prior to onset of labour. No chorioamnionitis on examination of the placenta. Classify as subcategory 10.12 Spontaneous preterm labour or ROM (<37 weeks gestation).

Neonatal death without obstetric antecedent

12.1 Neonatal death with no obstetric antecedent factors despite full investigation
12.2 Neonatal death unclassifiable as to obstetric antecedent with incomplete investigation
12.3 Neonatal death unclassifiable as to obstetric antecedent due to unknown level of investigation

Rules
This category includes neonates where no obstetric antecedent factors (according to the PDC list) were identified as contributing to the death.

Category 12.1 applies to a neonatal death where not obstetric antecedent factor was identified following negative findings for the following (as a minimum): comprehensive maternal and pregnancy history and full autopsy.

Category 12.2 is used where the full autopsy was not performed and Category 11.3 where it is unknown if they were performed or the results were unavailable.

NB: Whether a PDC code is assigned or not, all neonates require a neonatal cause of death according to the PSANZ NDC to be assigned. The NDC provides information on the causes and associated conditions present in the neonatal period.

Examples:
Classify here: Baby boy born at term weighing 3.5kg was discharged home well on Day 2 of life. On day 27, the baby was found dead in his cot by the parents and following full investigation was classified as SIDS. Please refer to the NDC to classify the neonatal cause of death.
Classify here: Baby boy born at 38 weeks weighing 3kg was discharged home well. On day 10, the baby became unwell and died. Blood cultures and CSF were positive for Group B Streptococcus. Please refer to the NDC to classify the neonatal cause of death and classify as 4.1.
Do not classify here: Neonatal death on Day 7 of a 29 week baby girl with severe fetal growth restriction and reverse end diastolic flow delivered by emergency caesarean section who developed fulminating necrotising enterocolitis. Placental pathology showed high grade villitis of unknown etiology (VUE). Classify as Category 9.3 with the PSANZ Associated condition of *Fetal growth restriction* and NDC Category 6.1 *Necrotising enterocolitis*

Kotecha

Kotecha S, Kotecha S, Rolfe K, Barton E, John N, Lloyd M, Watkins WJ (2014). **All Wales Perinatal Survey Annual Report 2013** Cardiff, Wales.
[not in Systems library; Zan extracted]

Classification categories:

- Congenital anomaly
- Intrapartum events
- Conditions consequent upon preterm birth
- Infection
- Specific conditions
- Accidental death
- Sudden unexpected death
- Unclassifiable

Notes: late terminations excluded

INCODE

Dudley, D.J., et al., A new system for determining the causes of stillbirth. Obstet Gynecol, 2010. 116(2 Pt 1): p. 254-60. (*Causes of death among stillbirths.* JAMA, 2011. **306**(22): p. 2459-68. Modification to be included)

Classification categories

1. Maternal medical conditions
    - Hypertensive disorder of pregnancy
    - Diabetes during pregnancy
    - Systemic lupus erythematosus
    - Intrahepatic cholestasis of pregnancy
    - Thyroid disorders during pregnancy
    - Renal disease during pregnancy
    - Severe maternal infection
    - Shock during pregnancy
    - Asthma during pregnancy
    - Seizure disorders during pregnancy
    - Maternal substance abuse
    - Other maternal condition
2. Obstetric complications
    - Fetal maternal hemorrhage
    - Cervical insufficiency
    - Preterm labor
    - Preterm premature rupture of membranes
    - Clinical chorioamnionitis
    - Intrapartum fetal death with labor – associated asphyxia (≤ 26 weeks)
    - Hypoxic intrapartum fetal death (> 26 weeks)
    - Abruptio placentae
    - Complications of multiple gestation
    - Uterine rupture
    - Multiple trauma during pregnancy
    - Uteroplacental insufficiency
    - Other obstetric condition
3. Maternal or fetal hematologic conditions
    - Heritable thrombophilias
    - Antiphospholipid syndrome
    - Red cell isoimmunization
    - Platelet alloimunization
    - Other maternal or fetal hematologic conditions
4. Fetal genetic, structural, and karyotypic abnormalities
    - Chromosomal anomalies
    - Autosomal recessive disorders
    - X-linked dominant disorder in males
    - Structural anomalies without chromosomal anomaly
    - Fetal metabolic disorders
    - Other chromosomal, genetic or structural abnormality
5. Placental infection, fetal infection, or both
    - Fetal infection involving vital organs: brain, heart, lung & liver
    - Fetal infection that causes congenital anomaly or other fetal condition

- Placental infection – organism likely to lead to decreased placental function
- Infection-related fetal death by other or unknown mechanisms

6. Placental pathologic findings
    - Placental disc
    - Placental membranes
    - Umbilical cord
    - Fetal membranes and placental inflammatory disorders
    - Circulatory disorders
    - Other placental abnormalities
7. Other pertinent condition not yet specified

Definitions

Obstetric complications

Many noninfectious obstetric conditions can be a direct cause of fetal death. These conditions are not associated with other medical conditions in the mother or fetus and have no other specific known placental or fetal cause.

Fetal-maternal hemorrhage

When considering fetal-maternal hemorrhage (FMH) as a cause of death, we made the following assumptions:

1. Fetoplacental blood volume =125 mL/kg fetal weight
2. FMH red cell volume = maternal blood volume × maternal hematocrit × % fetal red blood cells in maternal sample
3. FMH whole blood volume(FMH red cell volume)/(fetal hematocrit)

Conditional on these assumptions, we chose to define a FMH of greater than 40% of fetal blood volume before delivery as sufficient to cause fetal death.

Maternal or fetal hematologic conditions

We list specific hematologic conditions separate from the broader category of maternal medical conditions, because they are of contemporary interest as potential causes of fetal death. In addition, many of these conditions represent unique interactions between the mother and fetus via the maternal immune system.

Fetal genetic, structural, and karyotypic abnormalities

A variety of fetal conditions have been implicated as causes of fetal death. These conditions are intentionally general, as specific abnormalities may be part of a syndrome or sequence such that detailed listing of all associated anomalies would likely be incomplete.

Placental infection, fetal infection, or both

To better clarify the relationship between various infections and stillbirth, we defined three potential mechanisms by which infections are thought to cause stillbirth and provide criteria by which each of these mechanisms may be considered a present condition, or rise to be considered a possible or probable cause of stillbirth. We are aware that not all cases in which an infection causes stillbirth will fit exactly into one of these mechanistic categories. If an infection is considered a possible or probable cause of a specific stillbirth, yet the mechanism is not clear, the infection is classified as an infectious cause of death of other or unknown mechanisms.

Placental pathologic findings
Although placental pathologic findings are characteristically found in many of the conditions in Initial Causes of Fetal Death (eg, fibrosis or infarcts in association with antiphospholipid syndrome), placental conditions were included as an independent condition for those cases in which placental findings predominate and without a previously diagnosed maternal or fetal condition. When the placental findings occur in association with a maternal or fetal condition, then the condition itself is considered to be a possible or probable cause of death, rather than the placental anatomic abnormality.

Rules

Given the degree of uncertainty in the majority of cases regarding the event or condition that led directly to fetal death, we adopted a hierarchical system wherein a condition that was a potential cause of fetal death was graded as being a *present* condition, a *possible* cause of death, or a *probable* cause of death.

For a condition to be considered a possible cause of stillbirth, literature showing an association of the condition with stillbirth must be present and referenced. For a condition to be considered a probable cause of stillbirth, medical literature showing pathophysiology leading to fetal death must be referenced.

1. Probable Cause of Stillbirth.
The identified condition is, with high likelihood, the cause of the fetal death. For example, maternal diabetes would be the probable cause of fetal death for a case in which the mother has type 1 diabetes mellitus with a stillbirth that occurred during an episode of diabetic ketoacidosis.

2. Possible Cause of Stillbirth.
The identified condition cannot with high likelihood be considered the cause of death, but there is reasonable certainty that this condition may be involved in a pathophysiologic sequence that led to the fetal death. For example, a fetal death occurs in a woman with poorly controlled type 1 diabetes mellitus and an elevated hemoglobin A1C with normal fetal growth. A fetal death in this circumstance cannot be definitely considered caused by the diabetes, as there are many other potential conditions that may affect this outcome.

Isolated histologic chorioamnionitis
We have chosen to consider isolated histologic chorioamnionitis as a present condition, as there is insufficient evidence to include this pathologic diagnosis as a probable or possible cause of death.

Small for gestational age
Small for gestational age will not be treated as a cause of death but rather as a confirmatory finding that the maternal or placental condition adversely influenced fetal well-being. Although SGA is commonly associated with fetal death, it can only be considered as a consequence of other intrinsic conditions that are possible or probable causes of fetal death and cannot be considered to be a proximate cause of death. In this regard, SGA is a common modifier of other underlying maternal and fetal conditions, but not a specific condition itself. For the purpose of this algorithm SGA will be defined as a birth weight below the 10th percentile for gestational age based on population norms.

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