



ELSEVIER

Contents lists available at ScienceDirect

Best Practice & Research Clinical Obstetrics and Gynaecology

journal homepage: www.elsevier.com/locate/bpobgyn

9

Neonatal near miss: a measure of the quality of obstetric care

Theunis Avenant, MBChB, MMed(Paed), Senior Consultant *

Department of Paediatrics, University of Pretoria and Kalafong Hospital, Private Bag X396, Pretoria 0001, South Africa

Keywords:

pregnancy
neonatal morbidity
severe acute maternal morbidity
perinatal mortality

Thirty-seven percent of under-five deaths occur in the neonatal period. Identifying and correcting factors that contribute to neonatal and maternal care are of the utmost importance. Evaluation of severe acute maternal morbidity, also known as “near miss”, is used to improve obstetric practice. Neonatal near miss in conjunction with neonatal mortality can be used in a similar fashion to identify deficiencies in care. No accepted definition of neonatal near miss currently exists. None of the neonatal morbidity scoring systems is applicable or appropriate for this purpose. Organ system based criteria are objective and allow for identifying severe morbidities and identifying primary causes. This system can be of use in a variety of settings to identify health system problems and to institute remedial action where necessary.

© 2009 Elsevier Ltd. All rights reserved.

The fourth millennium development goal of reducing by two-thirds, between 1990 and 2015, the under-five mortality rate is largely dependent on reducing the infant mortality rate. As thirty-seven percent of under-five deaths occur in the neonatal period, identifying and correcting factors that contribute to neonatal and maternal care are of the utmost importance.¹

More than deaths should, however, be examined. By identifying those neonates that escaped being captured as a death statistic, deficiencies in the services rendered to pregnant women may be addressed and this may lead to further improvement in care.

Severe acute maternal morbidity (SAMM), also known as neonatal “near miss”, is by now a well-known term used in the obstetric literature. It is defined as “a very ill pregnant or recently delivered woman who would have died had it not been that luck and good care was on her side”. It describes a patient with an acute organ system dysfunction, which if not treated appropriately, could result in death.^{2,3} There is, however, still a need to standardise criteria to classify patients as SAMM.^{4,5} Near-miss reviews are used as a tool for monitoring the quality of maternity services.

* Tel./Fax: +27 12 373 1009.

E-mail address: theunis.avenant@up.ac.za

The term near miss (close call) in paediatrics and neonatology is mostly used in the context of almost adverse events and potential adverse events in the intensive care unit.^{6,7} Another frequent paediatric use of “near miss” is in the context of sudden infant death syndrome (SIDS).⁸

Used differently the definition of neonatal near miss (NNM) can, however, aid in assessing and improving obstetric practice in diverse settings. No accepted definition of NNM in this context currently exists.

Will defining NNM make a difference?

The “Saving Babies 2003–2005: Fifth Perinatal Care Survey of South Africa” is a report based on a Perinatal Problem Identification Program (PPIP).⁹ Approximately 20% of births in South Africa have been entered into the program for this period. The primary obstetric causes of early neonatal deaths are listed in Table 1.

These conditions, together with stillbirths, represent the focus areas for improvement of obstetric care in all other developing countries. These conditions, however, are also present in neonates surviving the neonatal period. Statistics on the surviving babies are not necessarily collected when assessing health care in pregnancy. This may give a false sense of complacency that everything is well. It may, however, be that these babies are surviving despite deficiencies that still exist in the obstetric service.

Including the near miss cases will have several advantages compared with looking at the mortality only. As the number of ill survivors identified most likely will be approximately four times the number of deaths, conclusions and reporting on maternal care issues will be more rapid. This is true especially where the number of neonatal deaths is low.¹⁰

Other advantages of identifying neonatal near misses are: lessons learnt from near misses will reinforce the lessons learnt from assessing deaths, it may provide relevant controls for neonatal deaths, since many babies who die pass through a phase of organ dysfunction before dying, and comparative ratios/indices can be calculated.¹¹ An example of this is the Mortality Index.

The Maternal Mortality Index is defined as the ratio of the maternal deaths to the sum of maternal deaths and maternal near misses and represents the proportion of women who present with near miss criteria and subsequently die. This index is used to assess the standard of care in specific maternal conditions.^{11,12} In the same manner, a neonatal mortality index can be calculated.

Where should the focus for investigating morbidity and deaths lie? Clearly, spontaneous preterm delivery is the leading cause of neonatal mortality and morbidity and deserves all the attention possible.

Intrapartum asphyxia and trauma constitutes a major group of survivors where further investigation into the circumstances surrounding the pregnancy and birth may be necessary. The majority of these babies will not die, but the presence of asphyxia and its sequelae may point to serious deficiencies in the obstetric care.

Looking at surviving mothers with hypertensive disorders and abruptio placenta, the focus should be on correct action by personnel in dealing with hypertension, poor fundal growth and poor obstetric history with timely referral to appropriate levels of care.⁹

Table 1

Primary causes of pre-discharge early neonatal deaths (ENND) in the PPIP database in South Africa (≥ 500 g).

Primary causes	N	% ENND	Rate/1000
Spontaneous preterm birth	2720	50.8	6.92
Intrapartum asphyxia and birth trauma	1223	22.8	3.11
Foetal abnormality	296	5.5	0.75
Infections	275	5.1	0.70
Hypertension	249	4.7	0.63
Antepartum haemorrhage	214	4	0.54
Idiopathic intrauterine growth restriction	53	1	0.13
Pre-existing maternal disease	37	0.7	0.09
Other	284	5.4	0.72

Saving Babies 2003–2005: Fifth Perinatal Care Survey of South Africa.

Maternal infection, sometimes difficult to diagnose, is often an unexpected finding and one of the conditions easily overlooked in the management of pregnancy and the delivery. Many cases of idiopathic preterm labour are likely due to infections. Identifying perinatal infections in babies and subsequently investigating maternal illness may sensitise clinicians to diagnose and treat infection in time.

A substantial amount of babies are born with congenital abnormalities. They survive in most instances. Unexpected finding of these abnormalities must lead health care workers to focus on aspects such as maternal age, family history, amniotic fluid volume, and ultrasound findings if available.

Identifying IUGR cases will focus attention on foetal growth monitoring and good antenatal care.

Maternal diseases such as diabetes mellitus are an often overlooked cause of perinatal mortality. Babies of these mothers often present with pathology in more than one organ system, e.g. hypoglycaemia, cardiac disease, and respiratory distress. Screening mothers for and treating gestational diabetes will lead to a reduction in perinatal deaths.¹³

Defining neonatal near miss (NNM)

Many systems that score neonatal morbidity exist. The question is whether we can use any of these existing assessments of morbidity to define NNM. Neonatal scoring systems were developed for a variety of uses and some are fairly complicated and cumbersome to use. In the setting of health services in developing countries where improvement in obstetric services are of the utmost importance, they are in most instances neither suitable nor applicable.

Reasons for developing these scoring systems include adjusting mortality in a particular hospital or population for morbidity of their infants in order to allow comparisons. High-risk infants who need specific interventions may be identified. It can also be used to give prognostic information to parents about their baby, but this practice is fraught with difficulty and the use of scoring systems in this scenario has been limited.¹⁴

The ideal neonatal scoring system should have the following properties: ease of use, applicability early in the course of hospitalisation, ability to reproducibly predict mortality, specific morbidities, or cost for various categories of neonates and usefulness for all groups of neonates to be described.¹⁵

The choice of variables to be included in these scores is extremely important. A balance need to be found between complex scoring systems containing many variables and/or special investigations and a simpler model that is easy to use but not as accurate.

The scoring systems generally available will be summarised briefly.

National Therapeutic Intervention Scoring System (NTISS)

The National Therapeutic Intervention Scoring System (NTISS) is a modification of an adult intensive care score and is a severity of illness index.¹⁶ It is based on interventions/management of the child and not on physiological variables. Many of these interventions are not standard amongst units and many are not available across the board.

NICHHD (National Institute of Child Health and Human Development)

This score was developed in order to predict mortality risk for infants weighing 500–1500 grams at birth.¹⁷ Factors identified on admission were used to develop this score. They include birth weight, SGA, race sex, and Apgar score at one minute.

CRIB (Clinical Risk Index for Babies)

The CRIB score was developed to predict mortality for infants born at less than 32 weeks of gestation. Logistic regression was used to identify six variables most predictive of mortality.¹⁸

The CRIB II uses the birth weight by gestation and sex together with the maximum base deficit in the first 12 hours and the admission temperature to predict mortality. This score needs to be validated and may be influenced by factors affecting the admission temperature of the neonate.¹⁹

SNAP (Score for Neonatal Acute Physiology)

This severity index is based on 28 items collected during the first 24 hours of life.²⁰ Results of special investigations, as well as physiological measurements, are included in this score. It assesses many body systems but the information is often difficult to collect.

The SNAP-PE (Score for Neonatal Acute Physiology – Perinatal Extension) adds birth weight, SGA and low Apgar score at 5 minutes to the SNAP score.²¹

SNAP II and SNAP-PE II

The SNAP and SNAP-PE scores were modified to make it easier to use and validated on cohorts of 10,819 and 14,610 patients.²² Variables were decreased to the following six: mean blood pressure, lowest temperature, PO₂/FIO₂ ratio, serum pH, multiple seizures and urine output. By adding the perinatal extension factors as above, the SNAP-PE II was produced. These scores predict mortality.

The Berlin Score is a score for comparing mortality risk in very low birth weight infants. Factors included are birth weight, grade of RDS, Apgar score at 5 minutes, artificial ventilation and base excess at admission.²³

NMPI (Neonatal Mortality Prognosis Index)

This index selects prognostic factors up to 12 hours after admission.²⁴ Included are gestational age, birth weight, cardiac arrest, PO₂/FIO₂ ratio, major congenital malformations, sepsis and base excess.

The NBRS (Nursery Neurobiologic Risk Score) predicts neurological outcome in VLBW infants.²⁵

It is clear that none of these systems are ideal for use in defining the neonatal near miss. Which factors should we then look at when trying to identify a near miss?

Organ system based criteria, similar to those used in the definition of maternal near miss, are objective and allow for identifying severe morbidities and primary causes.⁴ Defining a neonatal near miss (NNM) in this context has been looked at by Mukwevo.¹⁰ It included treating abnormalities in any organ system or supporting these systems within three days of delivery. Markers included in the definition were:

- Respiratory failure/dysfunction
- Cardiac failure/dysfunction
- CNS failure/dysfunction
- Hypovolaemia
- Haematological failure/dysfunction
- Endocrine failure/dysfunction
- Renal failure/dysfunction
- Immune system: response to infection/dysfunction, e.g. neutropaenia
- Musculoskeletal morbidity
- GIT/Hepatic failure/dysfunction

In each of these groups, primary obstetric causes of the morbidity were subsequently identified.

The rate for NNM defined by using these markers was calculated as 24.7/1000 live births and was approximately 4 times that of the neonatal death rate (6.3/1000). Unpublished data from the same unit showed a similar NNM rate (25.8/1000) for the year 2007. A Neonatal Mortality Index of 20.5% was calculated as described above.

Most cases of NNM came from abnormalities in the respiratory failure/dysfunction group (63%), then the immunological group, which includes infections (21.2%), followed by dysfunction or failure in the central nervous system (5.0%).

When comparing primary causes of death or morbidity, the real value of defining NNM becomes evident, as can be seen in [Table 2](#).

Many more cases of intrapartum asphyxia, trauma and antepartum haemorrhage were identified. If only deaths had been used to evaluate care, many cases with definite modifiable factors would have

Table 2

Comparison of neonatal near miss (NNM) and neonatal deaths.

Primary cause of morbidity or death	NNM (%)	NND (%)	Total (%)
Intrapartum asphyxia	12.9	4.2	11.1
Birth trauma	10.8	0	8.5
Antepartum haemorrhage	14	4.2	12
Hypertension	8.6	12.5	9.4
Spontaneous preterm birth, PPROM, multiple births	40	62.5	44.4
Congenital abnormality	0	8.3	1.7
Maternal infection	1.1	4.2	1.7
Unknown	12.9	4.2	11.1

Adapted from Mukwevo.¹⁰

been missed. An even larger proportion (33.0%) of surviving asphyxiated babies was seen in 2007. Due to the larger numbers contained in the combined NNM and NND group, conclusions on aspects which need attention could also be reached earlier.

Conclusion

It is necessary to develop and validate an easy-to-use simple definition of the neonatal near miss in order to help improve the obstetric care in institutions, especially those with few neonatal deaths. This will be used with neonatal mortality data to assess and improve the quality of their obstetric care. An organ system dysfunction/failure approach similar to that used in the classification of SAMM is an objective method, which can be of use in a variety of settings to identify health system problems and to institute remedial action where necessary.

Summary

The fourth millennium development goal of reducing by two-thirds, between 1990 and 2015, the under-five mortality rate is largely dependent on reducing the infant mortality rate. Identifying and correcting factors that contribute to neonatal and maternal care are thus of the utmost importance. Maternal near-miss reviews are used as a tool for monitoring the quality of maternity services. The term near miss (close call) in paediatrics and neonatology is mostly used in the context of sudden infant death syndrome (SIDS) or almost adverse events and potential adverse events in the intensive care unit. Used differently, the definition of neonatal near miss (NNM) can, however, aid in assessing and improving obstetric practice in diverse settings. Including the near miss cases will have several advantages compared with looking at the mortality only. As the number of ill survivors identified will exceed the deaths by far, conclusions and reporting on maternal care issues will be more rapid. This is true especially where the number of neonatal deaths is low.

No accepted definition of NNM in this context currently exists. None of the neonatal morbidity scoring systems is applicable or appropriate for this purpose. Organ system based criteria are objective and allow for identifying severe morbidities and identifying primary causes. This system can be of use in a variety of settings to identify health system problems and to institute remedial action where necessary.

Conflict of interest

No conflict of interest to declare.

Practice points

- Information on neonatal morbidity should be looked at in conjunction with neonatal mortality when identifying aspects that may improve care in pregnancy.
- Assessment of neonatal morbidity with the view of identifying disease in the mother should be routine practice.

Research agenda

- Criteria to define the neonatal near miss (NNM) should be standardised.
- Near miss data should be used together with neonatal mortality data as a tool in the assessment of obstetric care.

References

- *1. United Nations Millennium Development Goals. Fact Sheet for Goal Four. Available from: <http://www.un.org/millenniumgoals/2008highlevel/pdf/newsroom/Goal%204%20FINAL.pdf> [accessed 30.09.08].
- *2. Mantel GD, Buchmann E, Rees H et al. Severe acute maternal morbidity: a pilot study of a definition for a near-miss. *Br J Obstet Gynaecol* 1998; **105**: 985–990.
3. Prual A, Bouvier-Colle M-H, De Bernis L et al. Severe maternal morbidity from direct obstetric causes in West Africa: incidence and case fatality rates. *Bull World Health Organ* 2000; **78**: 593–602.
- *4. Say L, Pattinson RC & Gülmezoglu AM. WHO systematic review of maternal morbidity and mortality: the prevalence of severe acute maternal morbidity (near miss). *Reprod Health* 2004; **1**: 3. doi:10.1186/1742-4755-1-3.
5. Souza JP, Cecatti JG, Parpinelli MA et al. Appropriate criteria for identification of near miss maternal morbidity in tertiary care facilities: A cross sectional study. *BMC Pregnancy Childbirth* 2007; **7**: 20. doi:10.1186/1471-2393-7-20.
6. Suresh G, Horbar JD, Plsek P et al. Voluntary anonymous reporting of medical errors for neonatal intensive care. *Pediatrics* 2004; **113**: 1609–1618.
7. Tourgeman-Bashkin O, Shinar D & Zmora E. Causes of near misses in critical care of neonates and children. *Acta Paediatr*. 2008 Mar; **97**(3): 299–303.
8. Kahn A, Mantauk L & Blum D. Diagnostic categories in infants referred for an acute event suggesting near miss SIDS. *Eur J Pediatr* 1987; **146**: 458–460.
- *9. Saving Babies 2003–2005: Fifth Perinatal Care Survey of South Africa. MRC Research Unit for Maternal and Infant Health Care Strategies. PPIP Users and Saving Babies Technical Task Team. Available from: <http://www.ppip.co.za/Downloads/Saving%20babies%202003-5.pdf> [accessed 20.09.08].
- *10. Mukwevo MTP, Avenant T, Pattinson RC. Developing a practical clinical definition of severe acute neonatal morbidity to evaluate obstetric care: a pilot study. Presentation at the 27th Conference on Priorities in Perinatal Care in Southern Africa. Hartenbos; March 2007.
- *11. Pattinson RC & Hall MH. Near misses: a useful adjunct to maternal death enquiries. *Br Med Bull* 2003; **67**: 231–243.
- *12. Vandecruys HI, Pattinson RC, Macdonald AP et al. Severe acute maternal morbidity and mortality in the Pretoria Academic Complex: changing patterns over 4 years. *Eur J Obstet Gynecol Reprod Biol* 2002; **102**: 6–10.
- *13. Crowther CA, Hillier JE, Moss JR et al. Australian Carbohydrate Intolerance Study in Pregnant Women (ACHOIS) Trial Group. Effect of treatment of gestational diabetes on pregnancy outcomes. *N Engl J Med* 2005; **352**(24): 2477–2486.
- *14. Dorling JS, Field DJ & Manktelow B. Neonatal disease severity scoring systems. *Arch Dis Child Fetal Neonatal Ed* 2005; **90**: F11–F16.
- *15. Fleisher BE, Murthy L, Lee S et al. Neonatal severity of illness scoring systems: a comparison. *Clin Pediatr* 1997; **36**: 223–227.
16. Gray JE, Richardson DK, McCormick MC et al. Neonatal Therapeutic Intervention Scoring System; a therapy-based severity-of illness index. *Pediatrics* 1992; **90**: 561–567.
17. Horbar JD, Onstad L, Wright E et al. Predicting mortality risk for infants weighing 501 to 1500 grams at birth: a National Institutes of Health Research Network Report. *Crit Care Med* 1993; **21**: 12–18.
18. International Neonatal Network. The CRIB (Clinical Risk Index for Babies) Score: a tool for assessing initial neonatal risk and comparing performance of neonatal intensive-care units. *Lancet* 1993; **342**: 193–198.
19. Parry G, Tucker J & Tarnow-Mordt W. CRIB II an update of the Clinical Risk Index for Babies score. *Lancet* 2003; **361**: 1789–1791.
20. Richardson DK, Gray JE, McCormick MC et al. Score for Neonatal Acute Physiology: a physiological severity index for neonatal intensive-care. *Pediatrics* 1993; **91**: 617–623.
21. Richardson DK, Phibbs CS, Gray JE et al. Birth-weight and illness severity: independent predictors of neonatal mortality. *Pediatrics* 1993; **91**: 969–975.
22. Richardson DK, Corcoran JD, Escobar GJ et al. SNAP-II and SNAPPE II: simplified newborn illness severity and mortality risk scores. *J Pediatr* 2001; **138**: 92–100.
23. Maier RF, Caspar-Karweck UE, Grauel EL et al. A comparison of two mortality risk scores for very low birthweight infants: Clinical Risk Index for Babies and Berlin Score. *Intensive Care Med* 2002; **28**: 1332–1335.
24. Garcia H, Villegas-Silva R, Villanueva-Garcia D et al. Validation of a prognostic index in the critically ill newborn. *Rev Invest Clin* 2000; **52**: 406–414.
25. Brazy JE, Eckerman CO, Oeler JM et al. Nursery Neurobiological Risk Score: important factors in predicting outcome in very-low-birth-weight infants. *J Pediatr* 1991; **118**: 783–792.