

Validation of a Scoring System for Near-Miss (life-threatening) Maternal Morbidity



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Abstract

Introduction: The ability to study near-miss maternal morbidity (NM) allows researchers to better understand ways to prevent deaths and decrease morbidity during pregnancy. The objective of this work was to validate a published scoring system designed to identify women with NM at delivery by comparing its results to those produced from scoring a different dataset.

Methods: The authors used a clinical database including all 1990-2004 deliveries at a tertiary care center in Washington DC. Experienced clinicians made morbidity determinations by review of case information for 443 deliveries that included all those with moderate or greater morbidity. The previously published scoring system was applied to these cases and the sensitivity and specificity of each of the 7 options was compared to previously published values.

Abstract (cont.)

Results: Each of the 7 options had sensitivity similar to those previously published in the ability to distinguish NM cases from those with severe or moderate morbidity. Five options (those with ≥ 2 factors) achieved 100% sensitivity. The option that included all 5 factors had the best performance: 100% sensitivity and 80% specificity. Specificities ranged from 66-83%, and for 6 options were significantly lower than published values.

Conclusions: The authors concluded that the published scoring system developed to identify NM was valid in a large delivery population, accepting that sensitivity is more important than specificity for identifying NM. This scoring system may be useful for quality assurance purposes, monitoring trends in maternal morbidity, epidemiologic study, resource planning, and health services research.

Background

- The continuum of maternal morbidity begins with a normal healthy pregnancy and ends with death. Maternal deaths are rare events.
- Near-miss maternal morbidity (NM) is defined as complications of pregnancy so severe as to be imminently life-threatening (i.e. the patient nearly died).
- A conceptual framework and scoring system was developed at University of Illinois-Chicago to identify cases of NM in their patient population, and to thereby differentiate these cases from those with less severe maternal morbidity.
- Our study objective: To validate the UIC scoring system, designed to identify women with NM, by using a different patient population—that of George Washington University Medical Center in Washington DC.

The Studies

- 1) The published scoring system was developed and optimized by investigators at the University of Illinois at Chicago.¹⁻² This will be referred to as the *Chicago* study.
- 2) The current validation analysis utilized delivery data from a perinatal database maintained at the George Washington University Medical Center in Washington DC, which will be referred to as the *DC* study.

Methods I.

- Figure 1 illustrates the conceptual framework that supports the validation study design.
- The DC perinatal database included a patient record for every delivery at George Washington University Medical Center between 1990 – 2004.

Methods II.

- The validation sample (DC sample) was selected from the database using an *Organ System Failure in Obstetrics Score* based on severity of the mother's condition at delivery. This index includes organ system failures plus other modifiers such as:
 - obesity
 - diabetes
 - pregnancy-induced hypertension.
- All cases with scores ≥ 1.5 (out of 5) were included.
- Stratified random sampling was used to select cases with lesser scores.

Methods III.

A. Clinician case review

1. The DC sample (n=443 deliveries) was subjected to case review by clinicians.
2. Each case was classified by morbidity as either: near-miss (NM), severe (SM), moderate (MM), or other (OM).

Methods IV.

B. Scoring system

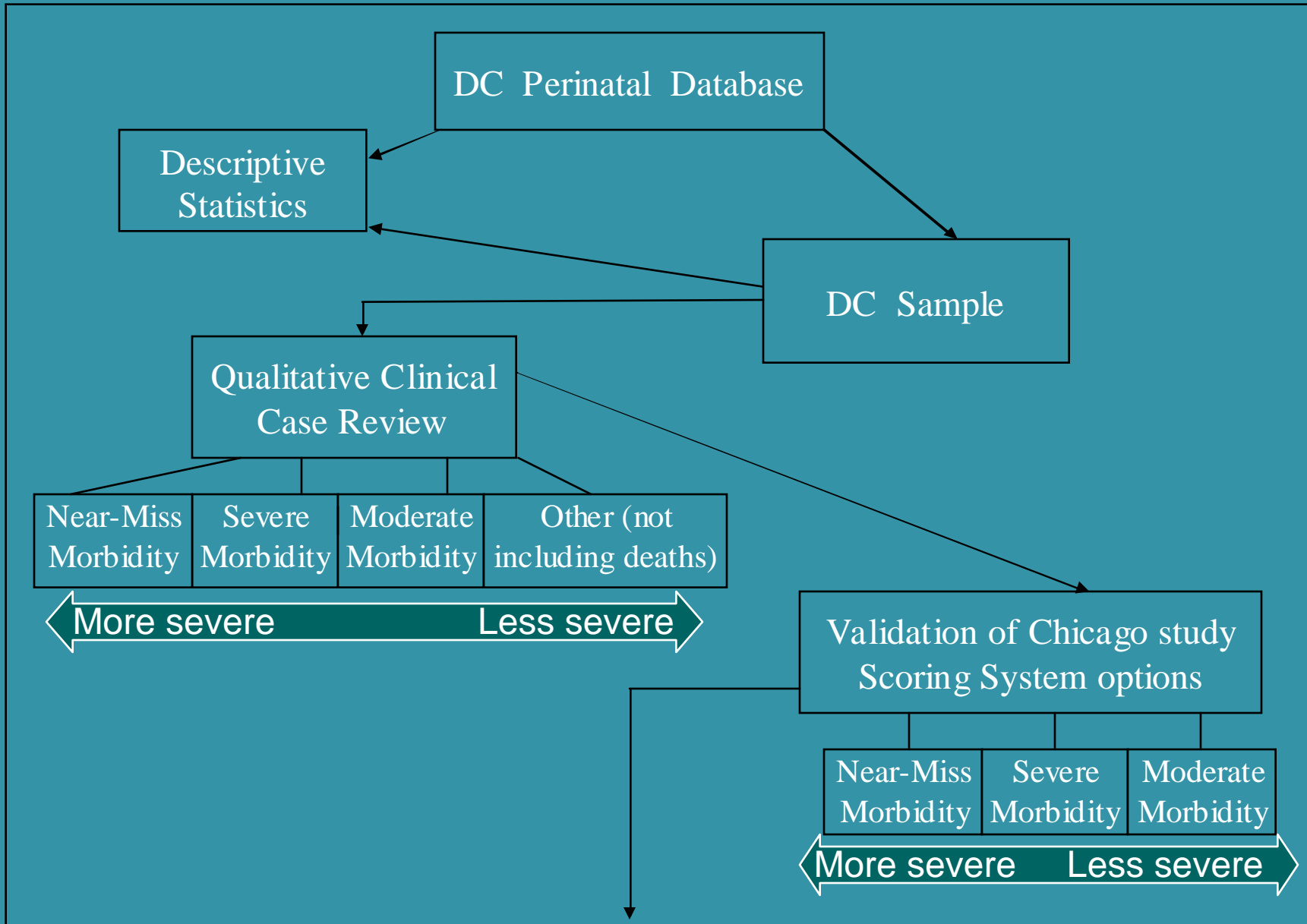
1. The Chicago study's scoring system was applied to each case.
2. For each case, the total score for each of the 7 different scoring options was calculated as the weighted sum of the clinical factors present*. Clinical factors in Chicago scoring system include:
 - multiple organ system failure
 - ICU admission
 - blood transfusion
 - extended intubation
 - surgical intervention
3. The score determined whether the system identified a case as NM. This was compared with the clinician's determination for each scoring option.

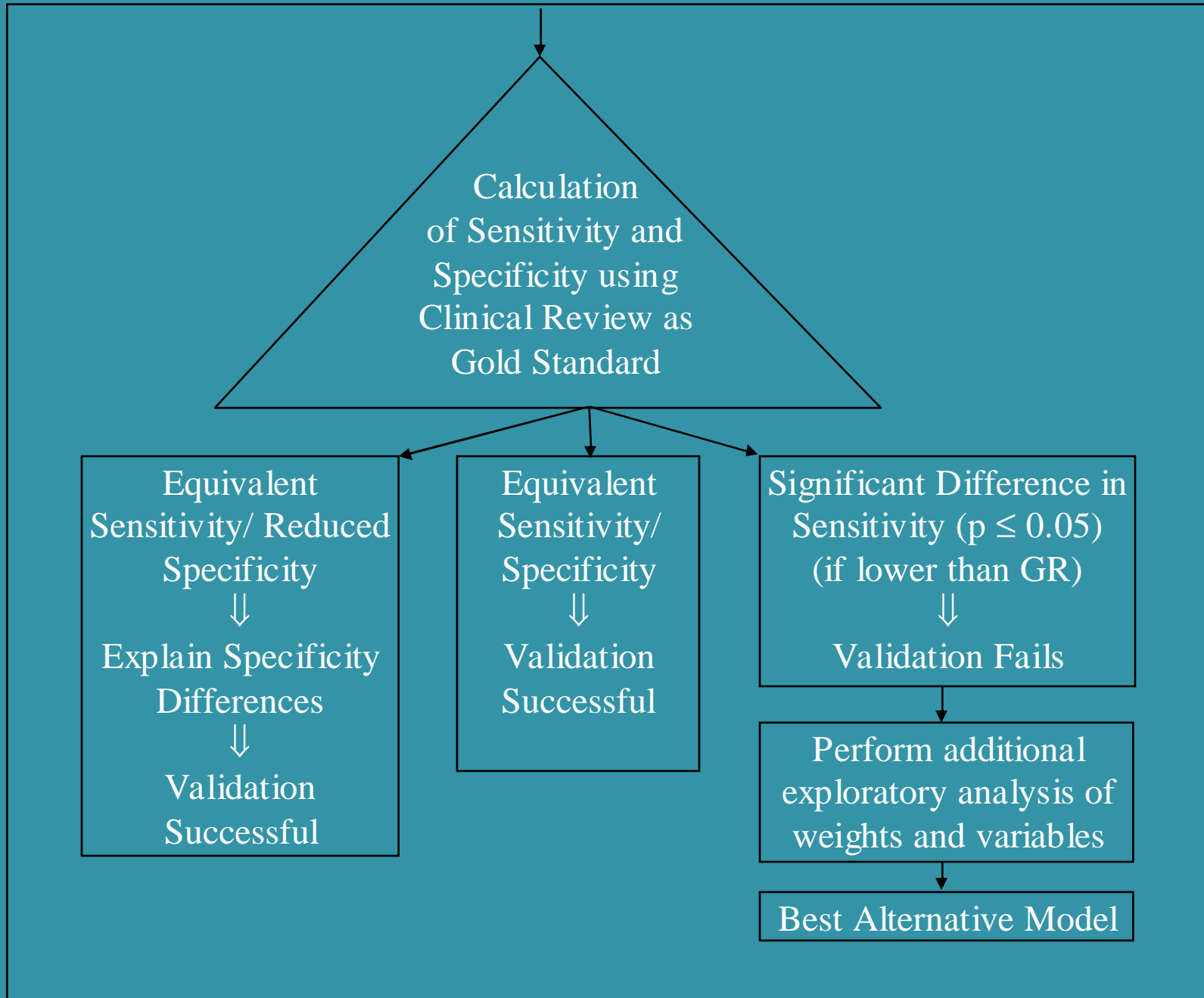
* Refer to table: *Factors and weights for each of the scoring system options.*

Methods V.

- Sensitivity = $\frac{\text{scoring system NM}}{\text{true NM}} \times 100\%$.
- Specificity = $\frac{\text{scoring system NM}}{\text{non-NM}} \times 100\%$.
- Fisher's Exact Test was used to compare the sensitivity/specificity of the 7 scoring options in the DC sample with those of the Chicago sample.

Fig 1. Conceptual Framework Supporting Specific Aims of Validation Study





1990-2004 DC study deliveries: Descriptive statistics for selected demographic and health indicator variables

| Age at Delivery | DC Perinatal Database | | DC Sample | |
|-----------------------|-----------------------|---------|-----------|---------|
| | Frequency | Percent | Frequency | Percent |
| 19 or Younger | 784 | 3.9 | 16 | 3.6 |
| 20-34 | 12,900 | 64.5 | 287 | 64.2 |
| 35-44 | 6,216 | 31.1 | 138 | 30.9 |
| 45 or Older | 98 | 0.5 | 6 | 1.3 |
| Race/Ethnicity | | | | |
| White Non-Hispanic | 9,682 | 48.4 | 161 | 36.2 |
| Black Non-Hispanic | 8,388 | 41.9 | 244 | 54.6 |
| White Hispanic | 831 | 4.2 | 20 | 4.5 |
| Black Hispanic | 27 | 0.1 | 1 | 0.2 |
| Asian | 972 | 4.9 | 17 | 3.8 |
| Other* | 97 | 0.5 | 4 | 0.9 |
| Missing | 1 | 0.01 | 0 | 0.0 |
| GWU-OSF | | | | |
| 0 | 9958 | 49.8 | 72 | 16.1 |
| 0.5 | 8856 | 44.3 | 87 | 19.5 |
| 1.0 | 971 | 4.9 | 75 | 16.8 |
| 1.5 – 5.0 | 213 | 1.0 | 213 | 47.6 |

*Other race includes Arabic, Indian, Native American, Native Alaskans, and Pacific Islanders

1990-2004 DC deliveries: Descriptive statistics for selected demographic and health indicator variables (cont.)

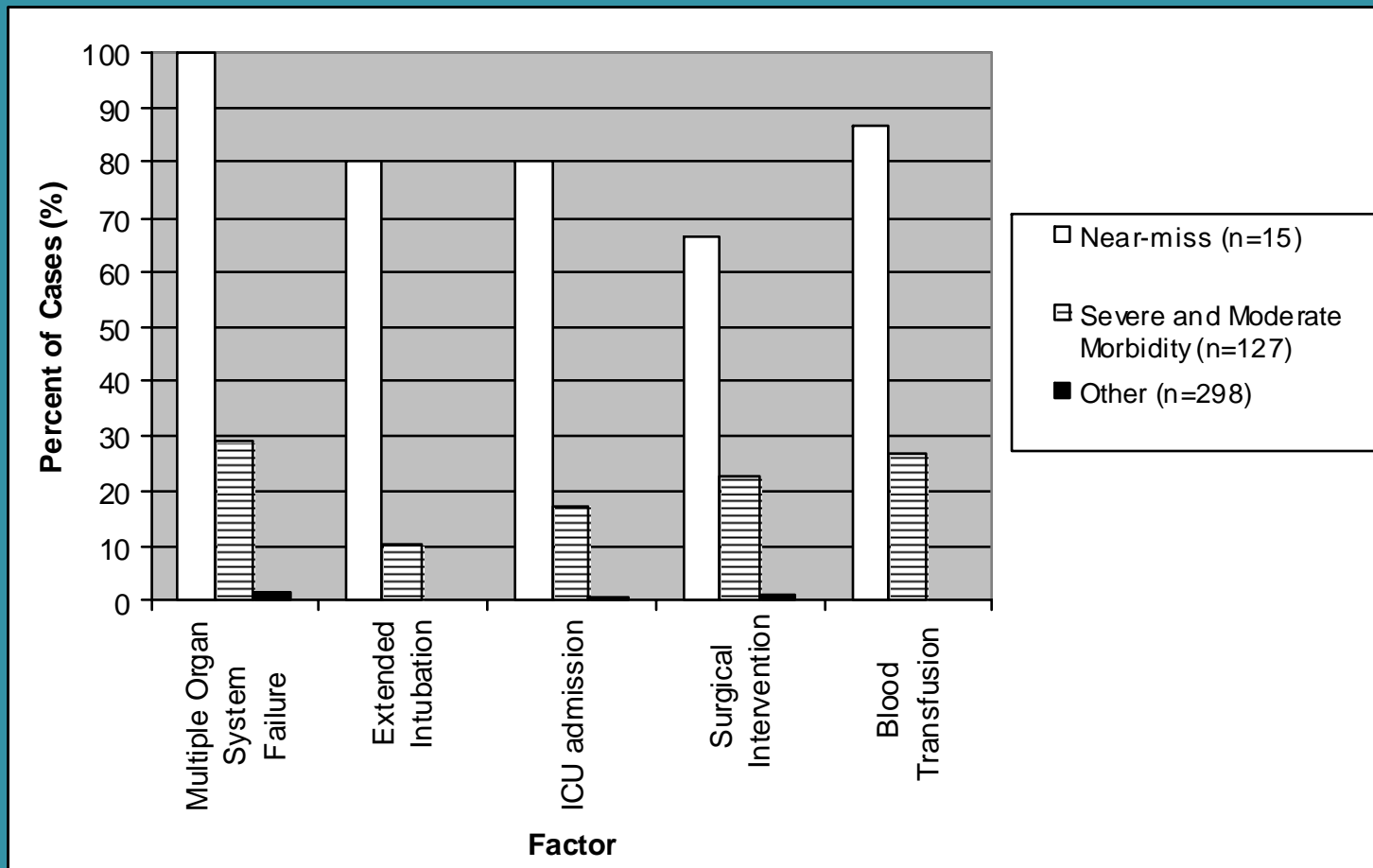
| | DC Perinatal Database | | DC Sample | |
|---------------------------------------|-----------------------|---------|-----------|---------|
| | Frequency | Percent | Frequency | Percent |
| Diabetes | | | | |
| Yes | 612 | 3.1 | 44 | 9.8 |
| No | 19,381 | 96.9 | 403 | 90.2 |
| Pregnancy Induced Hypertension | | | | |
| Yes | 82 | 0.4 | 10 | 2.2 |
| No | 19,916 | 99.6 | 437 | 97.8 |
| Hemorrhage | | | | |
| Yes | 40 | 0.2 | 39 | 8.7 |
| No | 19,958 | 99.8 | 408 | 91.3 |
| C-Section Delivery | | | | |
| Yes | 5,644 | 28.2 | 210 | 47.0 |
| No | 14,354 | 71.8 | 237 | 53.0 |
| Maternal Deaths | | | | |
| Yes | 7 | 0.04 | 7 | 1.6 |
| No | 19,991 | 99.96 | 440 | 98.4 |
| Health Status of Newborn | | | | |
| Healthy | 17,706 | 88.5 | 321 | 71.8 |
| Sick | 1,682 | 8.4 | 101 | 22.6 |
| Stillbirths | 337 | 1.7 | 16 | 3.6 |
| Fetal Death | 118 | 0.6 | 6 | 1.3 |
| Missing | 155 | 0.8 | 3 | 0.7 |

Factors and weights for each of the scoring system options

| Scoring options* | Factors (weights) |
|------------------|--|
| 5-factor [8] | Multiple organ system failure (5), ICU admission (4), blood transfusion greater than three units (3), extended intubation greater than or equal to twelve hours (2), surgical intervention (1) |
| 4-factor [3] | ICU admission (4), blood transfusion greater than three units (3), extended intubation greater than or equal to twelve hours (2), surgical intervention (1) |
| 3-factor [3] | Multiple organ system failure (3), ICU admission (2), blood transfusion greater than three units (1) |
| 2-factor A [1] | ICU admission (2), blood transfusion greater than three units (1) |
| 2-factor B [1] | Multiple organ system failure (2), ICU admission (1) |
| 1-factor A [1] | Multiple organ system failure (1) |
| 1-factor B [1] | ICU admission (1) |

*System scores are a weighted sum of the factors present/absent. Optimal cutoff score for near-miss is shown in [].

Distribution of the five factors by morbidity in the DC sample



Frequency of the five factors in the Chicago and DC samples across morbidity categories

| Factors | Near-miss (Chicago) versus Near-miss (DC) | | | | | Severe Morbidity (Chicago) versus Severe Morbidity (DC) | | | | | Severe Morbidity (Chicago) versus Severe and Moderate Morbidity combined (DC) | | | | |
|---------------------------------|---|------|------|-------|----------|---|------|------|------|----------|---|------|------|------|----------|
| | Chicago | | DC | | <i>p</i> | Chicago | | DC | | <i>p</i> | Chicago | | DC | | <i>p</i> |
| | Freq | % | Freq | % | | Freq | % | Freq | % | | Freq | % | Freq | % | |
| Multiple organ system failure | 21 | 95.5 | 15 | 100.0 | 1.000 | 20 | 12.2 | 22 | 50.0 | <.001 | 20 | 12.2 | 37 | 29.1 | 0.001 |
| ICU admission | 19 | 86.4 | 12 | 80.0 | 0.670 | 20 | 12.2 | 21 | 47.7 | <.001 | 20 | 12.2 | 22 | 17.3 | 0.241 |
| Blood transfusion (>3 units) | 18 | 81.8 | 13 | 86.7 | 1.000 | 19 | 11.6 | 23 | 52.3 | <.001 | 19 | 11.6 | 34 | 26.8 | 0.001 |
| Extended intubation (≥12 hours) | 16 | 72.7 | 12 | 80.0 | 0.711 | 2 | 1.2 | 13 | 29.6 | <.001 | 2 | 1.2 | 13 | 10.2 | 0.001 |
| Surgical intervention | 16 | 72.7 | 10 | 66.7 | 0.728 | 28 | 17.1 | 22 | 50.0 | <.001 | 28 | 17.1 | 29 | 22.8 | 0.236 |
| Total | 22 | | 15 | | --- | 164 | | 44 | | --- | 164 | | 127 | | --- |

Scoring system results compared to case review determination for Chicago (near-miss versus severe morbidity) and DC (near-miss versus severe and moderate morbidity combined) samples

| Scoring System | Chicago Sample | | | | DC Sample | | | | | |
|----------------|-----------------|-----------------|--------------------------|---|-------------|----------|-------------|----------|------------------------|---|
| | Sensitivity (%) | Specificity (%) | True Near-miss* (n = 22) | False Near-miss (Severe Morbidity: n=164) | Sensitivity | | Specificity | | True Near-miss* (n=15) | False Near-miss (Severe and Moderate Morbidity combined: n=127) |
| | | | | | (%) | <i>p</i> | (%) | <i>p</i> | | |
| 5-factor | 100.0 | 93.3 | 22 | 11 | 100.0 | 1.000 | 80.3 | 0.001 | 15 | 25 |
| 4-factor | 100.0 | 78.1 | 22 | 36 | 100.0 | 1.000 | 66.1 | 0.025 | 15 | 43 |
| 3-factor | 100.0 | 86.6 | 22 | 22 | 100.0 | 1.000 | 68.5 | <0.001 | 15 | 40 |
| 2-factor A | 100.0 | 78.1 | 22 | 36 | 100.0 | 1.000 | 66.1 | 0.025 | 15 | 43 |
| 2-factor B | 100.0 | 80.5 | 22 | 32 | 100.0 | 1.000 | 67.7 | 0.014 | 15 | 41 |
| 1-factor A | 95.5 | 87.8 | 21 | 20 | 100.0 | 1.000 | 70.9 | <0.001 | 15 | 37 |
| 1-factor B | 86.4 | 87.8 | 19 | 20 | 80.0 | 0.670 | 82.7 | 0.241 | 12 | 22 |

*True Near-miss was determined by clinical case review.

Note: Differences in specificity were determined to be due to differing morbidity classification methods between the Chicago and DC studies.

Scoring System Cut-Off Points

- A Receiver Operating Characteristic (ROC) curve was plotted for the 5-factor scoring option results to determine the optimal cut-off point for identifying NM cases in this scoring option.
- The Chicago study cut-off point of 8 was confirmed.

Limitations

The ability of the scoring system to differentiate near-miss morbidity was not identical between the Chicago and DC sample populations, for reasons including:

- Methods of qualitative determination of morbidity differed due to lack of a gold standard.
- An overall difference in prenatal care and pre-pregnancy maternal health may have existed due to demographic differences between the two populations.
- Lack of information regarding the lower boundary of the D.C. study severe morbidity group.

Conclusions

- The authors concluded that the published scoring system developed to identify NM was valid in a large delivery population.
- Although the specificities were lower than the published values, the authors felt that sensitivity was of greater importance to this validation and to the potential applications of such a scoring system.
- Since NM is a rare event, and sensitivity is of greater importance, some of the scoring options requiring fewer clinical factors may be more easily implemented by some institutions.
- This scoring system may be useful for quality assurance purposes, monitoring trends in maternal morbidity, resource planning, epidemiologic study, and health services research.

References

1. Geller SE, Rosenberg D, Cox S, Brown M, Simonson L, Kilpatrick S. (2004) A scoring system identified near-miss maternal morbidity during pregnancy. *J Clin Epi* 57:716-720.
2. Geller SE, Rosenberg D, Cox S, Kilpatrick S. (2002) Defining a conceptual framework for near-miss maternal morbidity. *JAMWA* 57(3):135-139.