NOTICE: This document contains correspondence generated during peer review and subsequent revisions but before transmittal to production for composition and copyediting:

- Comments from the reviewers and editors (email to author requesting revisions)
- Response from the author (cover letter submitted with revised manuscript)*

**The corresponding author has opted to make this information publicly available.*

Personal or nonessential information may be redacted at the editor's discretion.

Questions about these materials may be directed to the *Obstetrics & Gynecology* editorial office: obgyn@greenjournal.org.

Date: 12/22/2023
To: "Johanna Quist-Nelson" [redacted]
From: "The Green Journal" em@greenjournal.org
Subject: Your Submission ONG-23-2067

RE: Manuscript Number ONG-23-2067

Hospital discharge codes may overestimate severe maternal morbidity

Dear Dr. Quist-Nelson:

Thank you for sending us your work for consideration for publication in Obstetrics & Gynecology. Your manuscript has been reviewed by the Editorial Board and by special expert referees. The Editors would like to invite you to submit a revised version for further consideration.

If you wish to revise your manuscript, please read the following comments submitted by the reviewers and Editors. Each point raised requires a response, by either revising your manuscript or making a clear argument as to why no revision is needed in the cover letter.

To facilitate our review, we prefer that the cover letter you submit with your revised manuscript include each reviewer and Editor comment below, followed by your response. That is, a point-by-point response is required to each of the EDITOR COMMENTS (if applicable), REVIEWER COMMENTS, and STATISTICAL EDITOR COMMENTS (if applicable) below. The revised manuscript should indicate the position of all changes made. Please use the "track changes" feature in your document (do not use strikethrough or underline formatting). Upload the tracked-changes version when you submit your revised manuscript.

Your submission will be maintained in active status for 21 days from the date of this letter. If we have not heard from you by 01/12/2024, we will assume you wish to withdraw the manuscript from further consideration.

EDITOR COMMENTS:

Please note the following:

* Help us reduce the number of queries we add to your manuscript after it is revised by reading the Revision Checklist at https://journals.lww.com/greenjournal/Documents/RevisionChecklist_Authors.pdf and making the applicable edits to your manuscript.

* As of January 2024, only certain article types will appear in the print version of the journal. All accepted articles will continue to publish online. All articles will be indexed in PubMed as an official article of Obstetrics & Gynecology. Additional information is available in the Instructions for Authors (https://journals.lww.com/greenjournal/Pages /InformationforAuthors.aspx#II).

REVIEWER COMMENTS:

Reviewer #1:
The authors' objective was to identify SMM diagnoses that were also coded during encounters prior to the birth hospitalization, and thus potentially falsely carried forward as de novo SMM events.

They conducted a retrospective study included pregnant patients with births between 2016-2020. The primary outcome was the rate of SMM diagnoses recorded during the birth hospitalization that were also coded on previous encounters. They found that certain SMM events may be prone to carry forward error and alone not signify a de novo event.

The following are my comments and questions:
1. The authors should clarify their restrictive use of SMM (birth hospitalization only) and why a postpartum SMM would be considered false case identification?

2. The paper refers to inclusion of any "encounter during the birth hospitalization, pre-pregnancy, antepartum, and postpartum" and then "as antenatal, prenatal, birth hospitalization or postpartum." The different terms are confusing.

3. Typically, small cell sizes are not published; several in Table 1 are n=1. The name of the State should be removed from Table 1. I also recommend a small cell size limit be used to guide what estimates are calculated; eg, aneurysm has 1 case at the delivery hospitalization, I'm not sure what knowledge can be gained from estimates based on that?

4. The FDR equation only mentions hospitalization prior to and during birth hospitalizations but the Figure, Methods and Table discuss postpartum hospitalizations.

Reviewer #2:
The research letter briefly reported an investigation of whether carry forward coding might overestimate the severe maternal morbidity.

Strength: Data are from two health systems.

However, the authors are suggested to address following issues to further improve their manuscript:
1. Major concern:
a. Study hypothesis: Based on the manuscript, the authors seem to hypothesize if the codes recorded during the birth hospitalization are the same as codes recorded in the previous encounter, it would very likely be considered inaccurate coding (i.e., coding error), leading to an overestimated SMM rate. If this were the authors' study hypothesis, the authors should provide at least one reference to support it. Likewise, the authors need to investigate and report "true" (de novo) SMM rate in the study population under Results. Without the comparison baseline, it would be difficult to assess the hypothesis.

2. Others:
a. Introduction: I would suggest the authors to sharply address why it is important/needed to investigate current topic, though the authors slightly touched it under Comment. For example, whether overestimated SMM rate would have a negative impact on patient care quality and/or health center finance and (co)morbidity Index?

b. Methods: The authors are suggested to refine their methods after clarifying the study hypothesis commented above.

c. Results: I would recommend the authors to modify Table 1 based on reported factors influencing de novo SMM in the literature (e.g., race, payor - Medicaid vs. Commercial insurance) to control/reduce uncertainties.

Reviewer #3:
This is a retrospective cohort study across two healthcare systems which attempts to identify ICD codes denoting severe maternal morbidity that are inadvertently carried through a patient's chart to the delivery hospitalization, suggesting the morbidity event occurred prior to the delivery hospitalization, thus over-inflating estimates of SMM during the delivery hospitalization. This study addresses an important gap in data regarding the true incidence of SMM during the delivery hospitalization. Many current data sources for estimating SMM are limited to the delivery hospitalization and this study adds unique data by incorporating pre-pregnancy and antepartum data. The findings of this study suggest that the incidence of SMM may be overestimated when only the delivery encounter is considered and that data on SMM that only includes delivery hospitalizations should be viewed with caution.

1) Consider adding "during delivery hospitalization" to the title. It seems that some diagnoses that are carried forward to the delivery hospitalization relate to adverse outcomes that occurred during pregnancy, but not during the delivery hospitalization.

2) The authors mention in the introduction (lines 25-26) that the "potential for overestimation of SMM events at birth hospitalization…deserves exploration," but this argument would be strengthened by a description of why this is important. A clear caveat in all ICD code-based data and research is that coding is inaccurate; as long as this is uniformly the case, no significant bias is introduced into analysis. Are the authors suggesting that the ICD codes for SMM are in some way inaccurately coded in a biased way? For example, are certain types of SMM over-coded and not others? This would indeed have implications for how to target national efforts to reduce SMM, and so if this is the authors' suggestion, should be made clear from the start.

3) Why were transfusions specifically excluded from the study? (Line 39)

4) It may be beneficial to consider performing a small validation study to support the authors' findings. This could include reviewing a small subset of charts of those with a "carry forward" diagnosis to confirm that SMM did not occur during the delivery hospitalization.

5) Could the authors clarify what data is available through PCORnet? Not all readers will be familiar with this. For example, is all data deidentified? Are vitals and labs available or only diagnosis codes, like the national datasets available through HCUP?

6) Could the authors clarify the difference between antenatal and prenatal classification of SMM? (Line 48)

7) In the results, the definition of "carry forward" is not well-established enough for the sentence "An additional 525 (27.9%)…" to be clear. Does this mean 525 of the SMM events may be incorrectly coded? Or that in addition to the 1360 cases of SMM, there are another 525 cases of potentially incorrectly coded SMM? (Lines 61-63)

8) It would be helpful if the authors could also provide the distribution of SMM codes that appear pre-pregnancy. They mention in the methods that they looked at diagnoses pre-pregnancy, but this is not presented in table 1. This may provide additional information about the diagnoses that are "carried forward" and help differentiate between conditions that are chronic and complications that occur in pregnancy.

9) When describing the limitations of the study (Line 79), the authors mention "true recurrent conditions." However, in the Results section, the authors note that sickle cell crisis has one of the highest rates of potential false discovery rate (Line 67). As sickle cell crises are indeed a true recurrent condition in pregnancy, might the authors perform their analysis after excluding sickle cell crisis as an SMM event? When including a clearly "true recurrent condition" as one of the drivers of the False Discovery Rate of SMM, this could potentially over-estimate the False Discovery Rate.

10) During discussion of limitations, the authors do not mention the number of cases of SMM that occur for which no ICD code is entered in the chart (for instance, due to erroneous charting); there may be significant under-estimation or under-reporting of SMM by ICD codes which counteracts the phenomenon described by the authors. Mention of this would further support the authors' concluding statements that inclusion of additional supporting data, such as vitals, would help improve detection and verification of SMM.

11) The authors may want to consider a discussion of why certain codes are more prone to "carry forward". For example, coding for "aneurysm" and "myocardial infarction" often does not allow for differentiation between acute and chronic or historical conditions. This may explain the different carry forward rates across the SMM indicators.

STATISTICAL EDITOR COMMENTS:
- lines 61-63 and 66 and Table1: Need to reconcile the various sums and proportions. From Table 1, the pre-hospitalization events = 282, while the hospitalization events = 731+ 440 (1171), for a total = 1453. The proportion of pre vs hospitalization events = 282/1453, or 19%. How does this reconcile with lines 61-63 and 66, where there were 1,360 SMM plus 525 carried forward?

- lines 51-55: Should make clear that the birth hospitalization total (denominator) includes post-partum events (as in Table 1).

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Sincerely,
Anjali J. Kaimal, MD, MAS
Associate Editor, Obstetrics
The Editors of Obstetrics & Gynecology

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RE: ONG-23-2067

Dear Editor:

Thank you for giving us the chance to enhance our manuscript entitled "*Hospital discharge codes may overestimate severe maternal morbidity.*"

Below we have listed each question raised, our response, and the position in the paper where each issue is mentioned. We submitted the revised manuscript using the "track changes" feature; pages and line numbers refer to "track changes" copy. We also submitted a clean non-edited copy of the revised manuscript.

Thank you and we look forward to hearing from you.

Sincerely,

Johanna Quist-Nelson, M.D. (for all authors)

REVIEWER #1

Reviewer#1 Comment #1
A) The authors should clarify their restrictive use of SMM (birth hospitalization only) and why a postpartum SMM would be considered false case identification?
B) Response: SMM was investigated during the antepartum, birth, and postpartum hospitalization, thus we did not use a restrictive definition of SMM (Objective 1). We have clarified this in the abstract and text that we are as noting that we are only looking for false discovery rate at birth hospitalization (Objective 2).
C) Location: Abstract: Page 2, Line 20 and Page 3, Line 43-45
D) Modified text:
Page 2: "Our objective was to identify birth hospitalization SMM diagnoses that were also coded during prior encounters, and thus potentially falsely carried forward as *de novo* SMM events."
Page 3: "to determine the potential False Discovery Rate (FDR), or the proportion of birth hospitalization SMM events that were also coded at a prior encounter and thus potentially overcounted."

Reviewer#1 Comment #2
A) The paper refers to inclusion of any "encounter during the birth hospitalization, pre-pregnancy, antepartum, and postpartum" and then "as antenatal, prenatal, birth hospitalization or postpartum." The different terms are confusing.
B) Response: The wording has been changed for clarity and consistency to indicate inpatient encounters antepartum at birth or postpartum.
C) Location: Page 3 Lines 55-57 and Page 4 Line 63-64
D) Modified text:

Page 3: “CDC SMM codes[1] were used to identify non-transfusion events during any inpatient encounter antepartum, at birth, or postpartum”
Page 4: “Demographic and clinical characteristics of the cohort are reported, stratified by timing of SMM coding as during antenatal, birth or postpartum hospitalizations.”

Reviewer#1 Comment #3
A) Typically, small cell sizes are not published; several in Table 1 are n=1. The name of the State should be removed from Table 1. I also recommend a small cell size limit be used to guide what estimates are calculated; eg, aneurysm has 1 case at the delivery hospitalization, I'm not sure what knowledge can be gained from estimates based on that?
B) Response: The small counts of n=1 and name of the state have been removed from Table 1
C) Location: Table 1
D) Modified text: Table 1 footnote “not reported due to small cell counts”

Reviewer#1 Comment #4
A) The FDR equation only mentions hospitalization prior to and during birth hospitalizations but the Figure, Methods and Table discuss postpartum hospitalizations.
B) Response: Thank you for requesting this clarification. The objective of our research letter was twofold, 1. To describe the distribution of SMM during antepartum, birth, and postpartum periods and 2. To determine the FDR detected during birth hospitalization that were also coded at a prior encounter. Thus, we plan to maintain the data about antepartum and postpartum hospitalizations in the table and figures to achieve objective 1.
C) Location: -
D) Added text: -

REVIEWER #2

Reviewer#2 Comment #1
A) Study hypothesis: Based on the manuscript, the authors seem to hypothesize if the codes recorded during the birth hospitalization are the same as codes recorded in the previous encounter, it would very likely be considered inaccurate coding (i.e., coding error), leading to an overestimated SMM rate. If this were the authors' study hypothesis, the authors should provide at least one reference to support it. Likewise, the authors need to investigate and report "true" (de novo) SMM rate in the study population under Results. Without the comparison baseline, it would be difficult to assess the hypothesis
B) Response: We have clarified our hypothesis and added the requested reference. In regards to the second critique to report true de novo SMM rates, that is beyond the scope of this research letter but is planned future research,
C) Location: Page 3 Lines 44-45
D) Added text: “We hypothesized that some SMM events would be subject to carry over coding.[4]”
Added reference: 4. Nedkoff L, Lopez D, Hung J, Knuiman M, Briffa TG, Murray K, Davis E, Aria S, Robinson K, Beilby J, Hobbs MST, Sanfilippo FM. Validation of ICD-10-AM Coding for Myocardial Infarction Subtype in Hospitalisation Data. Heart Lung Circ. 2022 Jun;31(6):849-858. doi: 10.1016/j.hlc.2021.11.014. Epub 2022 Jan 20. PMID: 35065895.

Reviewer#2 Comment #2

A) Introduction: I would suggest the authors to sharply address why it is important/needed to investigate current topic, though the authors slightly touched it under Comment. For example, whether overestimated SMM rate would have a negative impact on patient care quality and/or health center finance and (co)morbidity Index?

B) Response: We have expanded on the importance of this research within the comments

C) Location: Page 5, Lines 91-95

D) Modified text: "Accurate SMM rates are crucial for inter-institutional and interstate maternal outcome comparisons and is essential as we targeted local and national interventions and utilize financial resources to reduce maternal morbidity and mortality.[5] Our study emphasizes acknowledges limitations in accurate SMM identification as erroneous and inconsistent coding will limit precision in defining and trending true SMM."

Reviewer#2 Comment #3

A) Methods: The authors are suggested to refine their methods after clarifying the study hypothesis commented above.

B) Response: We have clarified the study hypothesis as per Reviewer #2, comment #1. No further method

C) Location: Page 3 Lines 44-45

D) Modified text: "We hypothesized that some SMM events would be subject to carry over coding.[4]"

Reviewer#2 Comment #4

A) Results: I would recommend the authors to modify Table 1 based on reported factors influencing de novo SMM in the literature (e.g., race, payor - Medicaid vs. Commercial insurance) to control/reduce uncertainties.

B) Response: We have created a demographic table in response to the reviewer's comment and have included it as a supplemental file in the appendix.

C) Location: Page 4, Lines 84, Appendix 1

D) Modified text: "The demographics are included in Appendix 1."

REVIEWER #3

Reviewer#3 Comment #1

A) Consider adding "during delivery hospitalization" to the title. It seems that some diagnoses that are carried forward to the delivery hospitalization relate to adverse outcomes that occurred during pregnancy, but not during the delivery hospitalization.

B) Response: "During delivery hospitalization" has been added to the title.

C) Location: Title

D) Modified text: Hospital discharge codes may overestimate severe maternal morbidity during delivery hospitalization

Reviewer#3 Comment #2

A) The authors mention in the introduction (lines 25-26) that the "potential for overestimation of SMM events at birth hospitalization…deserves exploration," but this argument would be strengthened by a description of why this is important. A clear caveat in all ICD code-based data and research is that coding is inaccurate; as long as this is uniformly the case, no significant bias is introduced into analysis. Are the authors suggesting that the ICD codes for SMM are in some way inaccurately coded in a biased way? For example, are certain types of SMM over-coded and not others? This would indeed have implications for how to target national efforts to reduce SMM, and so if this is the authors' suggestion, should be made clear from the start.

B) Response: We have added wording to the introduction strengthening the argument for accurate SMM data.

C) Location: Page 3; Lines 39-40

D) Modified text: "The potential for overestimation of SMM events at birth hospitalization due to ICD-10 codes being carried forward from pre-delivery events deserves exploration to ensure accurate data to shape interventions to reduce maternal morbidity and mortality."

Reviewer#3 Comment #3

A) Why were transfusions specifically excluded from the study? (Line 39)

B) Response: Blood transfusions are commonly excluded from SMM evaluation because of the limited coding data regarding quantity of blood units transfused and ongoing concern that a blood transfusion may not accurately represent a substantial morbidity event. Recent studies by Admon et al.[3] and Chen et al[8] use non-transfusion SMM in the primary analysis.

C) Location: -

D) Modified text: -

Reviewer#3 Comment #4

A) It may be beneficial to consider performing a small validation study to support the authors' findings. This could include reviewing a small subset of charts of those with a "carry forward" diagnosis to confirm that SMM did not occur during the delivery hospitalization.

B) Response: We agree with the reviewer and plan to do this in future research (see also Reviewer 2, Comment 1.

C) Location: -

D) Modified text: -

Reviewer#3 Comment #5

A) Could the authors clarify what data is available through PCORnet? Not all readers will be familiar with this. For example, is all data deidentified? Are vitals and labs available or only diagnosis codes, like the national datasets available through HCUP?

B) Response: We have clarified that the PCORnet Common Data Model was deidentified and included diagnosis codes and vitals.

C) Location: Page 3, Lines 49-51

D) Modified text: "A shared deidentified database using PCORnet Common Data Model was created across both healthcare systems that included diagnosis codes and vitals at inpatient and outpatient encounters."

Reviewer#3 Comment #6

A) Could the authors clarify the difference between antenatal and prenatal classification of SMM? (Line 48)

B) Response: The wording has been changed for clarity and consistency to indicate inpatient encounters antepartum at birth or postpartum. (See also Reviewer #1, Comment #2)

C) Location: Page 3 Lines 55-57 and Page 4 Line 63-64

D) Modified text:

Page 3: "CDC SMM codes[1] were used to identify non-transfusion events during any inpatient encounter antepartum, at birth, or postpartum"

Page 4: "Demographic and clinical characteristics of the cohort are reported, stratified by timing of SMM coding as during antenatal, birth or postpartum hospitalizations."

Reviewer#3 Comment #7

A) In the results, the definition of "carry forward" is not well-established enough for the sentence "An additional 525 (27.9%)…" to be clear. Does this mean 525 of the SMM events may be incorrectly coded? Or that in addition to the 1360 cases of SMM, there are another 525 cases of potentially incorrectly coded SMM? (Lines 61-63)

B) Response: The wording has been clarified here to indicate that the 525 cases had the same codes at birth hospitalization as they did at prior inpatient or outpatient encounters,

C) Location: Page 4, Lines 78-81

D) Modified text: "An additional 525 (27.9%) SMM events were coded at the birth hospitalization but also coded at a prior encounter and thus carried forward coding (Table 1). The number of patients with SMM would be 2.4 per 100 births if the duplicative coding was included compared to 1.8 per 100 births with adjustment for de novo events."

Reviewer#3 Comment #8

A) It would be helpful if the authors could also provide the distribution of SMM codes that appear pre-pregnancy. They mention in the methods that they looked at diagnoses pre-pregnancy, but this is not presented in table 1. This may provide additional information about the diagnoses that are "carried forward" and help differentiate between conditions that are chronic and complications that occur in pregnancy.

B) Response: The pre-pregnancy diagnoses have been added to Table 1 for clarity

C) Location: Table 1.

D) Modified text: Table 1

Reviewer#3 Comment #9

A) When describing the limitations of the study (Line 79), the authors mention "true recurrent conditions." However, in the Results section, the authors note that sickle cell crisis has one of the highest rates of potential false discovery rate (Line 67). As sickle cell crises are indeed a true recurrent condition in pregnancy, might the authors perform their analysis after excluding sickle cell crisis as an SMM event? When including a clearly "true recurrent condition" as one of the drivers of the False Discovery Rate of SMM, this could potentially over-estimate the False Discovery Rate

B) Response: We appreciate the reviewer's suggestion for this post-hoc analysis and have added the adjusted False Discovery Rate excluding sickle cell disease.

C) Location: Page 5, Lines 86-88

D) Modified text: A post-hoc analysis was performed for false discovery rate excluding sickle cell crisis as patients commonly experience recurrent crises and was found to be 15.9% (95% CI: 0.14 – 0.18%).

Reviewer#3 Comment #10

A) During discussion of limitations, the authors do not mention the number of cases of SMM that occur for which no ICD code is entered in the chart (for instance, due to erroneous charting); there may be significant under-estimation or under-reporting of SMM by ICD codes which counteracts the phenomenon described by the authors. Mention of this would further support the authors' concluding statements that inclusion of additional supporting data, such as vitals, would help improve detection and verification of SMM.

B) Response: Underreporting of SMM has been added to the limitations of our study.

C) Location: Page 5, Lines 101-102

D) Modified text: "Limitations include the potential for true recurrent conditions and reliance on ICD-10 coding designed for billing and could also underreport SMM"

Reviewer#3 Comment #11

A) The authors may want to consider a discussion of why certain codes are more prone to "carry forward". For example, coding for "aneurysm" and "myocardial infarction" often does not allow for differentiation between acute and chronic or historical conditions. This may explain the different carry forward rates across the SMM indicators.

B) Response: We have added this succinct description of the limitations of coding to the discussion

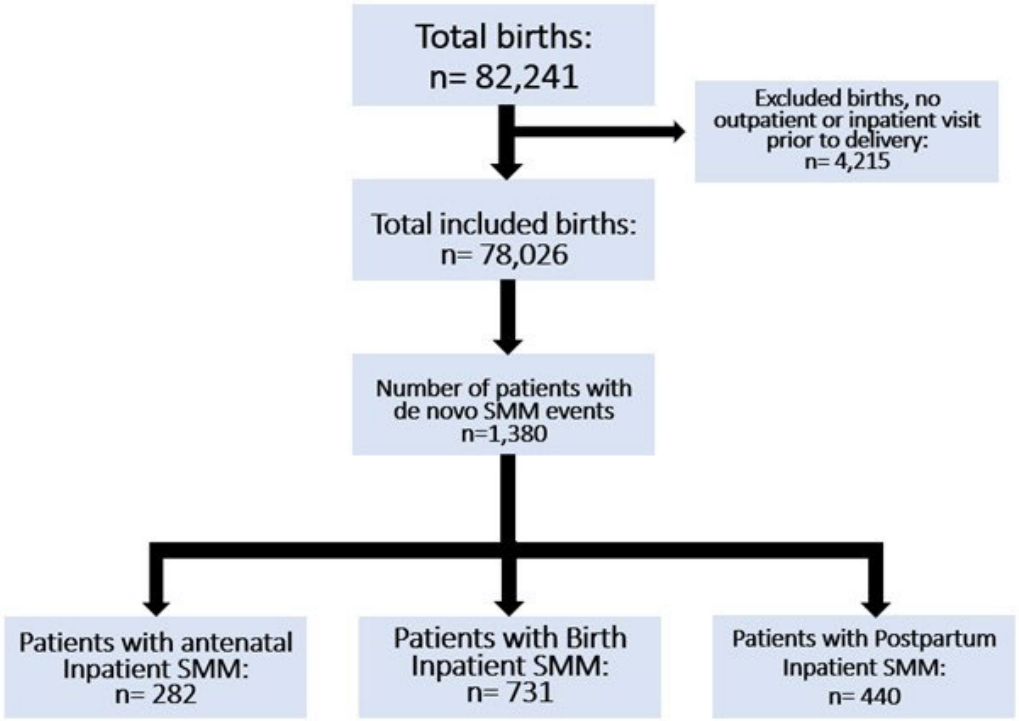
C) Location: Page 5, Lines 96-97

D) Modified references: "Notably, coding for some conditions, such as myocardial infarction, do not allow for differentiation between acute or historical conditions.[4]"

Statistical Editor Comment #1

A) lines 61-63 and 66 and Table1: Need to reconcile the various sums and proportions. From Table 1, the pre-hospitalization events = 282, while the hospitalization events = 731+ 440 (1171), for a total = 1453. The proportion of pre vs hospitalization events = 282/1453, or 19%. How does this reconcile with lines 61-63 and 66, where there were 1,360 SMM plus 525 carried forward?

B) Response: These numbers do not add up due to patients experiencing multiple events. We have added this to the text and as a footnote of Table 1 for clarity. Additionally, we have created a figure listed below, however given the limitations of the figures for this research letter type we have not included it. We would be happy to include this figure as an appendix if the editor desires.



Appendix 2: Study flow diagram of patients with non-transfusion severe maternal morbidity codes, excluding duplicate severe maternal morbidity codes

C) Location: Page 5, Line 83, and Footnote of Table 1.
D) Modified text:
Page 5: "There were 62 patients with multiple events."
Table 1 footnote: "Numbers in SMM categories are not additive as some patients had multiple SMM (n=62), 34 patients with SMM at delivery & postpartum, 10 patients with SMM antenatal and at delivery, 7 patients with SMM antenatal and postpartum, 11 patients with SMM at all three time frames"

Statistical Editor Comment #2
A) lines 51-55: Should make clear that the birth hospitalization total (denominator) includes post-partum events (as in Table 1).
B) Response: We have clarified the wording.
C) Location: Page 4, Lines 77-78
D) Modified text: "Out of 78,026 births, 1,380 (1.8%) experienced an SMM during antepartum, birth, or postpartum hospitalization."