Author's response to reviews

**Title:** Geographic variation in cesarean delivery in the United States by payer

**Authors:**

- Rachel Mosher Henke (Rachel.Henke@truvianhealth.com)
- Lauren M Wier (Lauren.Wier@truvianhealth.com)
- William D Marder (Bill.Marder@truvianhealth.com)
- Bernard S Friedman (Bernard.Friedman@ahrq.hhs.gov)
- Herbert S Wong (Herbert.Wong@ahrq.hhs.gov)

**Version:** 3  **Date:** 20 October 2014

**Author's response to reviews:** see over
October 19, 2014

Dr. Peter O’Donovan
Mr. Jason Pepito
Journal Editorial Office
BioMed Central

Dear Dr. O’Donovan and Mr. Pepito,

We are re-submitting our manuscript, “Geographic variation in cesarean delivery in the United States by payer” for consideration for publication in BMC Pregnancy and Childbirth. Below, we provide point by point response to the reviewers’ concerns and the editor’s recommendations. We have made extensive edits to the original manuscript in light of these critiques. We believe the article has been further strengthened and are appreciative of the review.

We look forward from hearing from you to continue the submission process.

Sincerely,

Rachel Mosher Henke, PhD, Truven Health Analytics
Lauren M. Wier, MPH, Truven Health Analytics
William D. Marder, PhD, Truven Health Analytics
Bernard S. Friedman, PhD, Agency for Healthcare Research and Quality
Herbert S. Wong, PhD, Agency for Healthcare Research and Quality
Reviewer: Katy B Kozhimannil

Major Compulsory Revisions:

1) Please describe your methods and risk adjustment strategy in greater detail (Page 7, top). Specifically, please address why race and primary expected payer (a proxy for SES) were included? There is active debate about the inclusion of SES and race/ethnicity in risk adjustment, and it may be justified, but should be done explicitly. If there is no clear justification, please consider dropping these. You may want to consult the following NQF project: [http://www.qualityforum.org/Risk_Adjustment_SES.aspx](http://www.qualityforum.org/Risk_Adjustment_SES.aspx)

The paragraph on the middle of page 7 describes the hierarchical model and the variables included, but does not provide a specific justification for including these – why are all maternal conditions (not just medical indications for cesarean) included?

Author response:

We added a rationale describing why we included race, primary expected payer, and the maternal conditions to the manuscript.

Also, is the hospital considered a level in the analysis? How is this included?

Author response:

This study focused on variation in C-section rate at the CBSA level. Therefore, we clustered each patient within CBSAs in the hierarchical models based on patient zip code rather than the hospital zip code. A study of hospital level variation in C-section rates would be fascinating but was beyond the scope of this paper.

Minor Essential Revisions:

2) The unit of analysis (CBSA, correct?) is not clear in the abstract, and interpretation of study results is confusing because it's not clear if/when the unit is an individual hospitalization or a rate or proportion of the birth hospitalizations in the CBSA. Please revise the abstract and results sections for clarity.

   - Be specific in abstract, methods, results – be clear about table 2 vs 3.

Author response:

We clarified in the abstract and introduction that we examined two different units of analysis (CBSA and individual hospitalization) in this study to achieve the two study aims.

In addition, please state the sample size (total number of CBSAs) in the methods section, not results, and please also list the percentage of all CBSAs in the US that this represents.
Author response:

The total number of CBSAs was moved to the methods section, and text was added about the percentage of all CBSAs in the United States that this represents.

3) Please describe the role of Medicaid in financing US births in the introduction (top of page 4). The following references may be useful:
http://www.ncbi.nlm.nih.gov/pubmed/23993475 and

Author response:

Text was added to the background section to highlight the role of Medicaid in financing births in the United States.

Discretionary Revisions:

4) Abstract: define “geographic area” in first sentence – CBSA?

Author response:

Because other studies have defined geographic areas differently beyond CBSA, we purposely were not to specific in the first sentence of the abstract which refers to these studies.

5) Abstract: In results here (and in main manuscript), phrases such as “Private insurance had a higher primary cesarean rate” are not clear. Is this referring to women with private insurance, or to the proportion of births in a CBSA paid by private insurance? Similar issues with clarity for “the percent African American in the population” What population, exactly?

Author response:

We updated the abstract and main body of the manuscript to be clear that we are referring to women with health insurance coverage from different payers (private vs. Medicaid).

6) Background, page 3: First sentence – the rate of cesarean births (overall and primary cesarean) in the US rose from 1996 to 2009 and has been stable since 2009 (see: http://www.cdc.gov/nchs/data/nvsr/nvsr63/nvsr63_01.pdf and http://www.acog.org/Resources_And_Publications/Obstetric_Care_Consensus_Series/Safe_Prevention). Also, preliminary 2013 data are now available:
http://www.cdc.gov/nchs/data/nvsr/nvsr63/nvsr63_02.pdf
7) Methods, bottom of page 4: Please note the 6 excluded states.

Author response:

The 6 states not included in the analysis are now noted in the methods section.

8) Methods, page 5: “we obtained characteristics on population size…” Was this for the CBSA or ZIP level?

Author response:

This information was at the CBSA level. Text was added to clarify.

9) Results, page 7: “Adjusted rates did not vary substantially from unadjusted rates.” I think this is quite surprising and worthy of discussion in the discussion section of the manuscript. Perhaps on the bottom of page 10, it could be included?

Author response:

We added to the first paragraph of the discussion.

10) Results, page 8: “Asian and Native American backgrounds were associated” This phrase is confusing – is this referring to women with these backgrounds or the percentage of the population of this background within the CBSA?

Author response:

We updated the language to be clear that we were referring to women with these backgrounds and not population percentages.

11) Discussion, page 11: “Primary care physicians per capita were associated with…” Were the individual physicians associated with reduced rates of cesarean? Or as a CBSA-level? Also, how might the number of primary care physicians reduce the need for cesareans (following sentence)? Are there data to show this?

Author response:

We clarified the text to indicate that primary care physicians at the CBSA level were associated with reduced cesarean delivery rates. We state our hypothesize in the text that is access to primary care physicians may lead to improved access
to primary care services and earlier access to prenatal services. This was the first study to our knowledge that provides support for the link between primary care availability and cesarean section rate.

12) Conclusion, page 12: Please re-state your findings and describe how they relate to the other issues discussed in the conclusion section.

Author response:

In the conclusion section, we restate our findings and describe how they relate to the other issues discussed.
Reviewer: Jillian Patterson

The discussion however lacks ‘next steps’ in terms of how to apply this research to addressing rising CS rates.

Author response:

We noted that additional research is necessary to understand how to apply this research to addressing rising cesarean section rates. Then we provided more concrete steps related to what additional research was needed.

1. Is the question posed by the authors well defined?
The authors address the issue of geographic variation in cesarean section rates, and explore whether drivers for cesarean section differ between privately insured and Medicaid patients, with the hope of identifying modifiable drivers of cesarean section.

2. Are the methods appropriate and well described?

The authors use a mix of logistic and hierarchical logistic regression models to assess the factors determining differences in CS rates between CBSA. The use of hierarchical regression is encouraging, as it accounts for correlations in the data, however the logistic regression models built ignore such correlations. More information on the particular hierarchical models used would be useful, particularly around random intercept vs random slope models, model fitting strategy and model assessment.

Author response:

We clarified that our study used hierarchical logistic regression models (not logistic models). We used a model specified with logit link and binomial distribution because of the dichotomous outcome 1= cesarean section; 0 = vaginal delivery).

The authors state that continuous variables were centered at 0, but what they mean by this is unclear- possibly that they centered variables at the population mean?

Author response:

We edit this to make it clear that we centered variables at the population mean.

Given that other papers have found variation in CS rates by hospital (eg ref 10), why were hospitals not a level of the hierarchical model?

Author response:

Our desired focus was on area level variation therefore we clustered patients in CBSAs based on patient zip codes. Examining hospital level variation was beyond the scope of this study but certainly a worthwhile pursuit.
Details on number of hospitals per CBSA and whether some hospital catchments spread across multiple CBSAs would be helpful for interpretation of results (particularly to a non-US audience).

Author response:

We include the set of CBSA market characteristics related to hospitals in Table 1 that are also included in the models predicting cesarean sections presented in Table 3. We found only one of these measure was related to the outcome (HHI). We are concerned that including additional hospital information in Table 1 may mislead readers to thinking these were included in the model.

Did the authors consider using a model which accounted for spatial correlation between the CBSA?

Author response:

CBSAs are typically very large geographical areas consisting of metro areas and surrounding less-populated areas, sometimes spanning across states. The heart of the hospital markets are typically nested within the metro area component of the CBSA making it less likely that there are practice patterns that span CBSAs. Regardless, it would be interesting to test the hypothesis that there are consistent practice patterns across CBSAs that are contiguously configured but that is beyond the scope of this paper.

The results from the hierarchical model are difficult to interpret (large number of decimal points needed), particularly when presented as log odds of a 1% change. Perhaps the scale of the change reported could be changed (ie 5% or 10% change in population characteristic).

Author response:

We changed the scale to easy interpretation.

The reference to Figure 1 in the methods section should be moved to the results, also please clarify whether this is based on the logistic regression or the hierarchical model.

Author response:

All results including Figure 1 were based on a hierarchical model. We have clarified this in the text.

Is it possible to distinguish between CBSA/states which weren’t included in the analysis, and those which show no difference between Private and Medicaid rates?
Author response:

We now include a list of states that were not included in the analysis. Figure 1 depicts the CBSAs where there is no difference between Private and Medicaid rates.

3. Are the data sound?
Deliveries are identified by DRG, which may miss some deliveries where the initial hospital admission was for something other than delivery (Kuklina, Matern Child Health J, 2008).

Author response:

We opted to define deliveries by DRG as it is the approach recommended by AHRQ for calculating the c-section rate as a quality indicator. If the initial hospital admission was for something other than delivery, we would also be concerned that the patient had a complication that may have a medical indication for c-section.

An assessment of the number of births missed, and births without mode of delivery information available would be useful.

Author response:

See response above. There were no births without mode of delivery information available.

There is no indication of the validity of reporting of diagnoses or procedures used in defining the population or in adjustment.

Author response:

Discharge data has its flaws. Unfortunately, we do not have data to quantitatively assess the validity of the reporting of diagnoses and procedures to include in this manuscript. However, the reporting of diagnoses and procedures related to births is likely to be among the most accurate given births are a high volume procedure at most hospitals.

In the model, there is no adjustment made for parity or induction of labor, which could be expected to influence the cesarean section rate.

Author response:

Unfortunately, we could not identify parity using discharge data. This was noted as a limitation in the discussion section. We did not include induction of labor as
a recent meta-analysis did not find a relationship between induction and cesarean section rate.


5. Are the discussion and conclusions well balanced and adequately supported by the data?

The authors report ‘notably’ more variation in CS rate for Medicaid compared with private insurance, and claim that these differences in rates can be partially explained by population and market characteristics, however there is little data given to back up this claim- including such information would be of value.

Author response:

The models presented in Table 3 provide information on how population and market characteristics differentially affect cesarean section deliveries for Medicaid and Private Insurance. Examples of specific factors that have a differential affect are noted in the results section.

6. Are limitations of the work clearly stated?

The authors recognize the limitation of missing information on parity and other covariates, however do not discuss the potential impact of this on the results. Missing covariate information would be of concern if the distribution of parity and other covariates differed between Medicaid and private insurance, where it would appear as increased variation between CSBA.

Author response:

If the distribution of unobservable medical indications of cesarean delivery varied by payer, this would widen the difference in CBSA risk-adjusted rates. We add a discussion of this to the paragraph indicating limitations.

Major reviews

1. Please provide justification for the hierarchical models chosen, and the use of logistic regression to assess variation rather than the hierarchical model

Author response:

We added justification for the model specification in the methods paper. We also clarified within the text that we used CBSA residuals from the hierarchical model that included patient indications for c-section and CBSA level factors to assess variation.
Minor essential revisions

1. Please clarify the interpretation of log odds, and the relative importance of CSBA level factors compared with individual factors in contributing to observed variation.

Author response:

To ease interpretation, we now provide odds ratios and confidence intervals in Table 3.

2. Move reference to Figure 1, and if possible remove CSBA not included in the analysis.

Author response:

We now reference Figure 1 near the beginning of the results section. CBSAs not included in the analysis are “removed” from the map by being absent of color.
Editor's Comment:

----------------------------------------------
This is a good paper but there are methodological weaknesses which the referees have described clearly. These should be addressed. As pointed out by one referee, the authors should take account of readers outside the USA. The attention of the authors is drawn to the published paper on variation in CS rates in England (Bragg et al, Variation in rates of caesarean section among English NHS trusts after accounting for maternal and clinical risk: cross sectional study "http://www.ncbi.nlm.nih.gov/pubmed/?term=bragg%2C+caesarean+variation#"BMJ. 2010;341:c5065. doi: 10.1136/bmj.c5065.)

Author response:

We have updated the background section to include a reference to this valuable contribution to the literature.
Reviewer: Gillian Hanley

Major revisions
1. It’s not clear to me whether the CBSA is based on where the mother lived or where she delivered? This has important implications in terms of interpreting the results and should be made clear in the paper.

Author response:

We include a note that the CBSA is based on the patients’ zipcode in the methods section.

2. The authors discuss that there was more variation in the Medicaid population but they don’t actually provide any numbers to back up that assertion. What about rates of variation? How do they differ between Medicaid and private insurance?

Author response:

We provide a statistical comparison of the variation in rates for Medicaid and private insurance in Table 2.

3. When you say that the differences can be partially explained by the differing relationships between population and market characteristics, can you provide the numbers that back up that assertion as well?

Author response:

The models presented in Table 3 provide information on how population and market characteristics differentially affect cesarean section deliveries for Medicaid and Private Insurance. Examples of specific factors that have a differential affect are noted in the results section.

4. This paragraph in the methods section reads “We calculated unadjusted and risk-adjusted CBSA cesarean delivery rates by payer. Risk-adjusted rates were calculated as observed cesarean delivery rate divided by expected cesarean delivery rate, multiplied by the overall CBSA average cesarean delivery rate. The expected delivery rate was estimated using a discharge-level logistic model using cesarean delivery as the outcome, adjusting for maternal and neonatal characteristics associated with an increased risk of cesarean delivery.” But then I never see any expected or risk-adjusted rates reported in the paper.

Author response:
We provide a statistical comparison of the variation in adjusted rates for Medicaid and private insurance in Table 2.

5. The results section on Geographic regions is only two sentences long and really doesn’t say anything concrete about regional variation. Can you provide some stats that are variation-specific? Rates of variation, etc?

Author response:

We provide a statistical comparison of the variation in rates for Medicaid and private insurance in Table 2. This table includes the coefficient of variation which is a specific metric of variation.

6. I’m unclear about what this study adds to the literature. It seems like it is probably the comparison between cesarean section by private insurers and Medicaid that is novel and original but that doesn’t really come through in the paper. Can the authors add some text that puts these findings in context of what we already know about cesarean section? We already know there is regional variation, we already know that obs and GPs have higher rates than midwives. We already know what is predictive of increased CS. The authors need to communicate what addition to the literature their study has made.

Author response:

We add text describing how our study contributes to the literature in the introduction section.

7. What do we already know about differences in CS between Medicaid and private insurance? Can the authors provide a paragraph in the discussion placing their study in the context of this broader literature?

Author response:

We add text to the discussion section to better couch our study and its findings in the literature.

Minor essential revisions
1. It seems to me that this paper spends considerably more time discussing predictors across payers and examining whether risk factors are associated differently with cesarean section among Medicaid and privately insured populations. It seems rather less focused on regional variations in cesarean section. Thus, I find that the title is misleading. I would recommend revising it to reflect the focus on the comparison between the payers.

Author response:
We recommend changing the title to: Geographic variation in cesarean delivery in the United States by Payer

Discretionary revisions
1. Is it possible to provide information about validity and reliability of data sources? I did find myself wondering about data quality and a few references to some studies that have the validated the datasets in use would be an easy way to avoid this

Author response:

The developers of the HCUP files conduct an extension examination of the integrity of the discharge files received include a comprehensive check of the completeness of specific data fields. For additional information about HCUP Quality Control Procedures, please review http://www.hcup-us.ahrq.gov/db/quality.jsp.