## PEER REVIEW HISTORY

BMJ Open publishes all reviews undertaken for accepted manuscripts. Reviewers are asked to complete a checklist review form (**http://bmjopen.bmj.com/site/about/resources/checklist.pdf**) and are provided with free text boxes to elaborate on their assessment. These free text comments are reproduced below.

## ARTICLE DETAILS

| | |
|---|---|
| **TITLE (PROVISIONAL)** | Trends in readmission rates for safety net hospitals and non-safety net hospitals in the era of the US hospital readmission reduction program: a retrospective time series analysis using Medicare administrative claims data from 2008-2015. |
| **AUTHORS** | Salerno, Amy; Horwitz, Leora; Kwon, Ji Young; Herrin, Jeff; Grady, Jacqueline; Lin, Zhenqiu; Ross, Joseph; Bernheim, Susannah M |

## VERSION 1 - REVIEW

| | |
|---|---|
| **REVIEWER** | Richard Hoehn<br>University of Cincinnati College of Medicine Department of Surgery, USA |
| **REVIEW RETURNED** | 03-Feb-2017 |

| | |
|---|---|
| **GENERAL COMMENTS** | Thank you for the opportunity to review this manuscript entitled "Trends in readmission rates for safety net hospitals and non-safety net hospitals in the era of the US hospital readmission reduction program: a retrospective time series analysis using Medicare administrative claims data from 2008-2015". This is a very well done and well written manuscript. I have a few comments/questions:<br><br>1. My major concern is that the authors primary conclusion is that readmission rates are improving faster at safety-net hospitals. However, while the rate of change may be statistically significant, I think this is misleading. A more appropriate conclusion may be that readmission rates are declining at all hospitals, and that safety-net hospitals are doing just as good a job as other centers. This is an important finding and better supported by the data.<br>2. It appears that safety net hospitals are more often rural non-teaching hospitals in the South. What do the authors make of this?<br>3. Why are figures 2 and 3 different? What is it about the definition of safety-net hospital that affects the difference in readmission rates between the two groups? These are two of the definitions used for safety-net hospitals: which is best? |

| | |
|---|---|
| **REVIEWER** | Jason Hockenberry<br>Emory University, USA |
| **REVIEW RETURNED** | 20-Feb-2017 |

| | |
|---|---|
| **GENERAL COMMENTS** | I have read the manuscript titled "Trends in readmission rates for safety net hospitals and non-safety net hospitals in the era of the US hospital readmission reduction program: a retrospective time series analysis using Medicare administrative claims data from 2008-2015." The paper is well-written, and tackles an important subject of interest to many researchers, clinical leaders, and policymakers. There are |

| | |
|---|---|
| | some clarifying details needed.<br>Major points:<br>A. Sample selection, page 7 & 8.<br>1. Was the 12 month FFS enrollment a continuous twelve months?<br>2. More importantly, does the proportion of patients excluded by this criterion differ between safety net hospitals (SNHs) and non-SNHs? Growth in Medicare advantage (MA) plan enrollment continued apace over the period of analysis. Both the level and growth may differ by SES, and hence lead to different denominator populations at the two different hospital types. If MA it is positively correlated with SES, and SES positively correlated with probability of readmission, differences in MA trends may be understating the improvement at non-SNHs more than at SNHs, because those in MA may also be less likely to be readmitted. Thus the readmission gap may have narrowed less than is estimated here.<br>3. Was the missing zip-code exclusion similar in proportions across SNHs and non-SNHs, and consistent across the period? If not this may be leading to bias in estimate differences in readmission. If it is a constant difference this wouldn't matter much to the main point of the paper on the narrowing of the gap. However, the period of interest starting in 2008 also coincides with the real estate market collapse in some areas, and an upheaval of living arrangements not seen in a generation. These trends may differ between patient populations served at SNHs vs non-SNHs.<br>B. Safety net hospital definition, page 9 & 10<br>1. The approach defining safety-net status in two different ways is smart, as it provides alternate measures of the construct most of the papers of this sort are seeking to test. However, another commonly used definition is the top quartile of DSH percentage. Was this definition considered. The reason one might consider that measure is that it is also a Medicare/Medicaid financing related definition, and DSH payments are being reduced. So in terms of the underlying policy question of readmission and resource allocation, the hospitals getting the most DSH are likely the most financially vulnerable to these policies.<br>2. Is 2008 being used as the base year because this is the only data available? Was 2006/2007 date available to capture hospital status before the start of the great recession? Relatedly, are the housing price measures used based on 2007 or earlier data, or are they based on 2008 figures? One is not necessarily better than the other, but it helps the reader assess the degree to which the starting point was driven by the great recession effects versus long-standing SNHs under alternate definitions.<br>C. Statistical Analyses page 10 & 11<br>1. The first time point for the interrupted series analysis co-occurs with the start of the nationwide rollout of the CMS recovery audit contractor (RAC) program. This program led to a large number of short stay admissions targeted for rescinded payment. These types of stays are potentially disproportionately repeat hospitalizations. If the authors could make it clear how the visits that hospitals lost payment on show up in the claims data it would resolve measurement and policy effect assignment concerns. It is known that many of these payment claw-backs were challenged and overturned, and that the program was ultimately put on hiatus, but it is not clear how this shows up in claims. If that is not knowable, then a second best solution is probably to show that LOS for index and readmission visits is staying stable over the period, both in SNH and non-SNHs. Otherwise with the interrupted time series leaves some question as to which of the policies was driving what proportion of the result. |

| | |
|---|---|
| | D. Discussion page 15 & 16<br>1. The first paragraph on page 15 is both obvious and speculative at the same time, so I would consider using the space to discuss different policy related points that this analysis brings up. We have very little data on the levers that hospitals are pulling to reduce readmissions. Simultaneously there is more policy relevant discussion that could be fleshed out more in place of much of this paragraph. Specifically, the authors point out in the subsequent paragraph that it has been argued repeatedly that financial margins are thinner at SNHs than non-SNHs. Since this analysis shows that those gaps have narrowed, some resources were likely disproportionately allocated to addressing it in SNHs compared to non-SNHs. All while these SNHs face looming DSH payment reductions. So where are the excess resources coming from? The authors mention there is a lack of evidence on mortality, but these authors know the correlation between hospital readmission rates and mortality rates to be low if not zero (some are coauthors on papers showing such over long trends). So this begs the question: have we been over-subsidizing the safety net? Or have we thinned further thinned the financial margins, with effects to be seen down the road? This analysis points us directly toward these provocative questions, and could be stated in place of the list of obvious potential but unverified approaches hospitals have been taking to reduce readmission.<br>2. The last paragraph on page 16 says "This study demonstrates that caring for socially disadvantaged patients does not interfere with a hospital's ability to reduce the risk of readmission." I don't think the question has ever been whether SNHs could reduce the risk, the questions have been is it at a similar cost as non-SNHs, and if not, is it socially optimal to be placing that added cost on the SNHs, or should we be taking different social policy approaches?<br>Minor point<br>In the abstract, the first sentence of the result is awkward, and may be missing a word like 'population' after the each mention of 'hospitals'. Alternatively, could it be reworded: "58.0% of safety net hospitals and 17.1% of non-safety net hospitals' patients were in the lowest quartile of socioeconomic status." |

**VERSION 1 – AUTHOR RESPONSE**

Reviewer 1:

Comment 1: My major concern is that the authors primary conclusion is that readmission rates are improving faster at safety-net hospitals. However, while the rate of change may be statistically significant, I think this is misleading. A more appropriate conclusion may be that readmission rates are declining at all hospitals, and that safety-net hospitals are doing just as good a job as other centers. This is an important finding and better supported by the data.

Response: Thank you for this comment. While we agree that the quarterly change in disparity has been small at 0.03% per quarter, over the 30 quarters of the study, it has resulted in a significant decrease in the disparity between safety net and non-safety net hospitals. We feel this change is both statistically significant and significant for understanding what is happening at these hospitals. We did revise the wording in the discussion and conclusion to remove the highlighted word substantially to ensure we did not overstate our conclusions.

"Our study shows that during the era of HRRP, risk standardized readmission rates declined more rapidly at safety net hospitals than at non-safety net hospitals after accounting for their baseline

readmission rates, by an additional 0.03 percentage points per quarter over the study period 2008-2015, substantially attenuating the gap in performance between safety net and non-safety net hospitals."

"We found that while safety net hospitals had higher readmission rates than non-safety net hospitals at baseline, their readmission rates have declined more rapidly since HRRP, substantially reducing the disparity gap in readmission rates for patients treated at safety net hospitals. Our study suggests that HRRP has been effective at improving readmission rates for all patients and decreasing disparities for patients served at safety net hospitals."

Comment 2: It appears that safety net hospitals are more often rural non-teaching hospitals in the South. What do the authors make of this?

Response: We agree with the reviewer that safety net hospitals, using our primary definition, are more likely rural, small, non-teaching, and located in the south. This likely is because of the definition that we use to define safety net hospitals as serving a larger proportion of low SES patients. Rural, southern parts of the United States have higher rates of poverty and lower educational attainment. In addition, there are more for profit and non-teaching hospitals located in the south compared to other parts of the country. Because this definition of safety net hospitals relies so heavily on concentration of low SES patients, we did use another definition of safety net hospitals that ensures that we include all public hospitals and also any private hospital with annual Medicaid caseload that is greater than one standard deviation above the mean of its respective state's private hospital Medicaid caseload. This secondary definition does not have the concentration in southern states, as the Medicaid caseload threshold is determined by each state's proportion of Medicaid patients. Within our discussion, under limitations, we added wording to further explain this.

"Our study has several additional limitations. First, for our primary analysis, the definition of safety net hospitals uses a neighborhood indicator – the AHRQ SES index – to identify low SES patients, and is not a direct measure of patients' income, wealth, education, or other measures of SES. This index, however, is validated for Medicare patients and importantly is comprised of multiple SES characteristics not otherwise available in administrative data.21 In addition using this definition, more safety net hospitals are identified that are small, rural, and located in the South, due to the concentration of poverty in this part of the country. To address this limitation, we also performed a secondary analysis using Medicaid status as a marker of low SES, which is a patient-specific marker. We identified hospitals with significantly higher Medicaid caseloads within each state; mitigating the likelihood that one region of the country would be overrepresented. Results were similar and our results are also similar to those of a recent study which showed narrowing of disparities in readmissions for safety net hospitals using a definition based on the patients with patients with Supplemental Security Income.17"

Comment 3: Why are figures 2 and 3 different? What is it about the definition of safety-net hospital that affects the difference in readmission rates between the two groups? These are two of the definitions used for safety-net hospitals: which is best?

Response: Thank you for your question. There are many definitions of what constitutes a "safety net hospital" and no clear consensus on which definition is the best. For that reason, we replicated our main analysis using two very different definitions, as described above in the response to Comment 2. We have added a paragraph to explain the definition of safety net hospital, in the section, "Safety net hospital definition"

"There are multiple definitions of safety net hospitals, which can identify different, non-overlapping hospitals, with no consensus on the best definition20. Due to this, we chose to use one primary

definition, and in a secondary analysis use a different definition based on a different data source."

Reviewer 2

Comment A1: Was the 12 month FFS enrollment a continuous twelve months?

Response: Thank you for this question. Yes, it was a continuous 12 months. This has been added to the section study sample as highlighted below.

"We included Medicare FFS beneficiaries 65 years and older, enrolled in Medicare Part A for at least 12 consecutive months, discharged alive from any non-cancer acute care hospital from January 2008-June 2015."

Comment A2: More importantly, does the proportion of patients excluded by this criterion differ between safety net hospitals (SNHs) and non-SNHs? Growth in Medicare advantage (MA) plan enrollment continued apace over the period of analysis. Both the level and growth may differ by SES, and hence lead to different denominator populations at the two different hospital types. If MA it is positively correlated with SES, and SES positively correlated with probability of readmission, differences in MA trends may be understating the improvement at non-SNHs more than at SNHs, because those in MA may also be less likely to be readmitted. Thus the readmission gap may have narrowed less than is estimated here.

Response: We agree with the reviewer that Medicare Advantage (MA) enrollment has increased over this time period. While there is no way to know from our data specifically about MA enrollment, we were able to examine the patients that were not included based on the 12-month enrollment requirement. However, we did apply this inclusion criteria at the beginning of our cohort, prior to defining the hospitals that would be included in the study and prior to defining them as safety net hospitals versus non-safety net hospitals. Given this limitation, we examined out of the patients that were not included due to the 12-month enrollment criteria, how many would have been assigned to a safety net hospitals versus a non-safety net hospital. We compared this to the proportion of admissions in our final cohort that were assigned to safety net versus non-safety net hospitals. We found that the percent of admissions not included were similar between the two types of hospitals as shown below. There were some admissions that were not assigned to either type of hospital, because those hospitals were not included in the final analysis due to the other exclusion criteria. The results are further detailed below:

Final Cohort
Total admissions in final cohort: 52,516,213:
7,489,800 (14.3%) at safety net hospitals
45,026,413 (85.7%) at non-safety net hospitals

12-month inclusion criteria:
Total admissions NOT included due to 12-month enrollment criteria: 5,587,479
717,682 (12.8%) would be assigned to safety net hospitals
4,655,965 (83.3%) would be assigned to non-safety net hospitals
213,832 (3.8%) are missing (would have been assigned to hospital that has been excluded)

Comment A3: Was the missing zip-code exclusion similar in proportions across SNHs and non-SNHs, and consistent across the period? If not this may be leading to bias in estimate differences in readmission. If it is a constant difference this wouldn't matter much to the main point of the paper on the narrowing of the gap. However, the period of interest starting in 2008 also coincides with the real

estate market collapse in some areas, and an upheaval of living arrangements not seen in a generation. These trends may differ between patient populations served at SNHs vs non-SNHs.

Response: Thank you for this comment. We agree that the missing zip code information may be unevenly distributed. However, we did apply this exclusion criteria prior to defining safety net hospitals. Therefore, these admissions would not count in the definition of safety net hospitals. We did a similar analysis as above to determine if these patients had been included, which hospitals would they have been assigned to and compared that with the proportions in the final cohort. There were slightly higher proportion of patients that would have been assigned to safety net hospitals, but the absolute numbers associated with this exclusion were very small compared to the overall cohort. Detailed numbers outlined below:

Final Cohort
Total admissions in final cohort: 52,516,213:
7,489,800 (14.3%) at safety net hospitals
45,026,413 (85.7%) at non-safety net hospitals

Missing zip code exclusion:
Total admissions excluded due to missing zip code: 267,796
49,761 (18.9%) would be assigned to safety net hospitals
189,145 (70.6%) would be assigned to non-safety net hospitals
28,890 (10.8%) are missing (would have been assigned to hospital that has been excluded)

Comment B1: The approach defining safety-net status in two different ways is smart, as it provides alternate measures of the construct most of the papers of this sort are seeking to test. However, another commonly used definition is the top quartile of DSH percentage. Was this definition considered. The reason one might consider that measure is that it is also a Medicare/Medicaid financing related definition, and DSH payments are being reduced. So in terms of the underlying policy question of readmission and resource allocation, the hospitals getting the most DSH are likely the most financially vulnerable to these policies.

Response: Thank you for this comment. We agree that there are many valid definitions of safety net hospitals, including DSH status. We chose the specific definitions that we used to define safety net status because they were based on the proportion of low SES patients that a hospital serves. We feel this is an important concept to explore since many have raised concerns that these low SES patients may have factors outside of the control of the hospital that will make it difficult for hospitals to reduce readmission rates.

Comment B2: Is 2008 being used as the base year because this is the only data available? Was 2006/2007 date available to capture hospital status before the start of the great recession? Relatedly, are the housing price measures used based on 2007 or earlier data, or are they based on 2008 figures? One is not necessarily better than the other, but it helps the reader assess the degree to which the starting point was driven by the great recession effects versus long-standing SNHs under alternate definitions.

Response: Thank you for this question and raising the concern about timing and the recession. Our dataset was only available from January 2008 through June 2015. We did not have access to data prior to 2008. The adjustments we used for the AHRQ SES index based on housing prices was for 2008, the same year we used to calculate the SES index of each of our patients. This is clarified in safety net hospital definition with added text as highlighted below:

“We identified safety net hospitals based on the proportion of patients that had low SES in the

baseline year of 2008. For our primary analysis, patient SES was defined based on the validated Agency for Healthcare Research and Quality (AHRQ) SES index, adjusted for cost of living.21 This index uses the following census data variables to create an index from 0-100 percent: unemployment, percent below US poverty line, median income, median value of owner occupied homes, percent with less than high school education, percent with at least 4 years college, percent of homes with crowding. We adjusted the variables median income and median value of owner occupied homes using the Bureau of Economic Analysis's Regional Price Parity adjustment22 from 2008 to account for regional cost of living differences. We defined low SES patients as patients who live in a zip code with a SES index score in the lowest quartile of all zip codes. "

Comment C1: The first time point for the interrupted series analysis co-occurs with the start of the nationwide rollout of the CMS recovery audit contractor (RAC) program. This program led to a large number of short stay admissions targeted for rescinded payment. These types of stays are potentially disproportionately repeat hospitalizations. If the authors could make it clear how the visits that hospitals lost payment on show up in the claims data it would resolve measurement and policy effect assignment concerns. It is known that many of these payment claw-backs were challenged and overturned, and that the program was ultimately put on hiatus, but it is not clear how this shows up in claims. If that is not knowable, then a second best solution is probably to show that LOS for index and readmission visits is staying stable over the period, both in SNH and non-SNHs. Otherwise with the interrupted time series leaves some question as to which of the policies was driving what proportion of the result.

Response: Thank you for pointing out that important concurrent policy issue in 2010. We do not have the ability to identify payments that were paid and rescinded and possibly paid again. We added to our limitations paragraph in order to address this as a limitation to the interrupted time series analysis in our discussion as stated below.

"Another limitation specific to the interrupted time series at the 2010 time point, is that the passing of HRRP occurred simultaneously with the recovery audit contractor (RAC) program, under which short stay payments were rescinded. It is possible that this program affected payments to safety net versus non-safety net hospitals differently. However, it is known that readmissions would be less likely to be affected by this policy, as those stays are more likely to be longer. Additionally, this would not affect the overall results of narrowing disparities, only the potentially causal effect at the time point of 2010. "

Comment D1: The first paragraph on page 15 is both obvious and speculative at the same time, so I would consider using the space to discuss different policy related points that this analysis brings up. We have very little data on the levers that hospitals are pulling to reduce readmissions. Simultaneously there is more policy relevant discussion that could be fleshed out more in place of much of this paragraph. Specifically, the authors point out in the subsequent paragraph that it has been argued repeatedly that financial margins are thinner at SNHs than non-SNHs. Since this analysis shows that those gaps have narrowed, some resources were likely disproportionately allocated to addressing it in SNHs compared to non-SNHs. All while these SNHs face looming DSH payment reductions. So where are the excess resources coming from? The authors mention there is a lack of evidence on mortality, but these authors know the correlation between hospital readmission rates and mortality rates to be low if not zero (some are coauthors on papers showing such over long trends). So this begs the question: have we been over-subsidizing the safety net? Or have we thinned further thinned the financial margins, with effects to be seen down the road? This analysis points us directly toward these provocative questions, and could be stated in place of the list of obvious potential but unverified approaches hospitals have been taking to reduce readmission.

Response: Thank you for pointing out this important policy relevant point. We do feel that it is

important to explain potential mechanisms in which this decrease in disparity may have occurred and there is some evidence of how hospitals are addressing readmissions (citations 24-27). We have decided to keep this paragraph. We do feel the specific points and questions raised in this comment about the payments are important and have added more focus on that in the following paragraph. We also have further clarified that mortality rates have no correlation with readmission rates, but noted that we have not studied that specifically looking at differences between safety net and non-safety net hospitals. The changes are highlighted below:

"Though these early results are promising, they should be viewed with caution. Patients discharged from safety net hospitals are still more likely to be readmitted within 30 days than those discharged from non-safety net hospitals, although the difference is now less than one percentage point. Additionally, this study does not assess unintended consequences of readmission reduction efforts, such as inappropriately diverting patients to emergency or observation care. A recent study by Zuckerman et al found no correlation between change in readmission rate and change in observation-service use, but studies have not been done specifically in the safety net hospital population.6 Another potential unintended consequence would be diversion of resources from other important quality and safety initiatives to readmission efforts. There is evidence that mortality has not increased with the nationally declining readmission rate overall,4 but we do not know if there has been a differential effect in safety net hospitals compared to non-safety net hospitals. We also do not know if a potentially disproportionate amount of resources to reducing readmission rates are being spent at safety net hospitals, which could potentially threaten financial margins with downstream effects such as closures or not having funds to invest in other initiatives."

Comment D2: The last paragraph on page 16 says "This study demonstrates that caring for socially disadvantaged patients does not interfere with a hospital's ability to reduce the risk of readmission." I don't think the question has ever been whether SNHs could reduce the risk, the questions have been is it at a similar cost as non-SNHs, and if not, is it socially optimal to be placing that added cost on the SNHs, or should we be taking different social policy approaches?

Response: We agree with the reviewer that one question is whether it will cost safety net hospitals more to reduce readmission rates. However, we do feel that many have argued that the factors related to a socially disadvantaged patient being readmitted are out of the control of the hospital and that the hospital would not be able to reduce the risk of readmission, even with improved care.

Minor Comment: In the abstract, the first sentence of the result is awkward, and may be missing a word like 'population' after the each mention of 'hospitals'. Alternatively, could it be reworded: "58.0% of safety net hospitals and 17.1% of non-safety net hospitals' patients were in the lowest quartile of socioeconomic status."

Response: Thank you for this suggested wording. We agree that the suggested wording is more clear and it has been changed as recommended.

**VERSION 2 – REVIEW**

| | |
|---|---|
| **REVIEWER** | Richard Hoehn, MD<br>Department of Surgery<br>University of Cincinnati College of Medicine<br>USA |
| **REVIEW RETURNED** | 09-Apr-2017 |

| | |
|---|---|
| **GENERAL COMMENTS** | Thank you for addressing our concerns |

| | |
|---|---|
| **REVIEWER** | Jason Hockenberry<br>Emory University |
| **REVIEW RETURNED** | 24-Apr-2017 |

| | |
|---|---|
| **GENERAL COMMENTS** | The revision addresses the prior concerns. |