Decision: Ask for revision

The committee was interested in the topic of your research. The following concerns were mentioned:

1. Many (most?) patients are discharged not home but to rehab facilities and SNFs. How is this accounted for?

The editorial board raises an interesting point. In New York State, most patients with hip fracture are initially discharged to rehabilitation facilities and SNFs which have lower daily costs than an acute hospital stay. Following rehabilitation at these lower-acuity facilities, patients are discharged to home or to a long-term care facility. The way we understand this comment is to ask whether perhaps our mortality statistics could be artificially skewed lower as some patients who might have stayed in the hospital longer in Sweden are instead discharged to SNF; thus credit for mortality would be attributed to the SNF and not to the index hospital stay (similar to the comment by Dr. Hollenbeak). In this case, we would expect the mortality of patients in the early discharge group (1-5 days) to have increased mortality during the time period spent in the skilled nursing facility or shortly thereafter. We have addressed this with sensitivity analyses described below. If the editorial board had a different intent with this question we would be happy to appropriately address the comment in a different manner.

2. The authors of the Swedish paper (BMJ 2015) undertook a sensitivity analysis that was flagged up by an incisive rapid response, and we don't see such a sensitivity analysis here (it was to explore the possibility of survivorship bias and the time frame adjustment by moving the goal posts of early to later discharge)

To evaluate the question of survivorship bias and time frame adjustment we undertook two separate sensitivity analyses. First, we asked whether the findings of increased mortality with later discharge would remain if the goalposts of early discharge were moved to later discharge. If our early discharge group had spent longer in the hospital (moving the goal posts back) perhaps mortality would have equalized when comparing the early and late discharge groups; likewise if the late discharge group had been discharged earlier, post-discharge mortality could have been affected. Therefore, we evaluated the risk of mortality between days 15 and 45 after hospital admission for all patients living at day 14, which creates a theoretical length of stay for all patients at 14 days.

We have added the following text and analyses to the manuscript to address this comment:

(Methods – subheading "Subgroup and sensitivity analyses")

LOS differs between patients in Sweden and in New York State. To control for a greater proportion of early discharges in New York State patients, a sensitivity analysis was performed by evaluating the odds of mortality between 15 and 45 days after hospital admission in all patients alive at 14 days post-admission, which created a theoretical LOS of 14 days for all patients in the cohort and the model was evaluated with adjusted and unadjusted logistic regression models.

and

(Results – subheading Sensitivity analyses)

In the first sensitivity analysis which moved the theoretical discharge date to day 14 after admission, 9,868 patients (5.4%) died between day 15 and 45 after admission; 3.2% of the 1-5 day cohort, 4.3% of the 6-10 day cohort, 7.0% of the 11-14 day cohort, and 18.1% of the cohort with LOS over 14 days. These were each significant at p<0.001 on chi-square analysis. In the adjusted model, LOS of 6-10 days was associated with 24% increased odds of death (95% CI 1.154-1.35; p=0.006); LOS of 11-14 days was associated with 71% increased mortality odds (95% CI 1.54-1.91; p<0.001) and LOS of greater than 14 days was associated with over four times greater odds of mortality between day 15 and 45 after admission (OR 4.62; 95% CI 4.23-5.03; p<0.001) in patients still alive at day 14 following admission. The full results from the adjusted model are available in Supplemental Table 2.

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The second sensitivity analysis performed replicated the sensitivity analysis performed in the Swedish paper (BMJ 2015). We evaluated the risk of death between 11 and 30 days after admission for patients alive at day 10 after admission with a length of stay of 10 days or less while controlling for other covariates in the primary multivariate model. Essentially these patients are those who were discharged early but could theoretically have benefitted from longer stays in the hospital if hospital stay was protective against mortality. However, it found that for each 1 day increase in length of stay for these patients, there would have been an associated 6% increase in their odds of death during 11-30 day time period after hospital admission over the study period (95% confidence interval 1.05-1.08; p<0.001 for interaction variable). Adjusted odds ratios for the interaction variable (each 1-day incremental increase in length of stay over 1 day) by year are shown below and have been added to the paper as Supplemental Table 3. (Other covariates in sensitivity analysis were not presented but are available upon request).

In conclusion, both analyses reveal no significant change in the findings of this study but do offer further support to the conclusions.

We have added the following text and analyses to the manuscript:

(Methods – subheading "Subgroup and sensitivity analyses")

The second sensitivity analysis evaluated the odds of death between 11 and 30 days for patients alive at day 10 with a length of stay of 10 days or less while controlling for other covariates in the primary multivariate model. Odds ratios for the interaction of a 1-day incremental increase in LOS were evaluated over the study period and separately for each individual year of the study.

And

(Results – subheading Sensitivity analyses)

The second sensitivity analysis attempted to replicate the sensitivity analysis performed in the Swedish paper (BMJ 2015). In patients alive at day 10 with a length of stay of 10 days or less, each 1-day increase in length of stay was associated with an 8% increased odds of death during 11-30 days from hospital admission overall (95% confidence interval 1.07-1.10; p<0.001 for a 1-day increase in LOS). Odds ratios for interaction variable (each 1-day incremental increase in length of stay over 1 day) by year are shown in Supplemental Table 3.

3. We now are left confused as to how different studies in different regions are throwing up different results and some better elaboration, as the reviewers suggest, would be very helpful

We agree – the other reviewers have requested this and we have addressed below.

4. This is a nice illustration that different health care systems are hard to compare.

We agree – we have added the following statements to the discussion:

Strengths of this study include its similarity to the Swedish dataset in terms of patient numbers, its use of unique patient identifiers to allow linkage to statewide death registries, and its high completeness in capturing a single population with a different system of care.

And

Caution should be used in extrapolating results of population-based studies when healthcare systems are dissimilar.

REFEREES COMMENTS

Reviewer: 1
Reviewer's comments

Based on a recent Swedish study that evaluated the association between length of stay (LOS) and risk of death within 30 days of discharge after a hip fracture, the authors evaluated these associations in United States using population-based registry data from New York Statewide Planning and Research Cooperative System (SPARCS) from 2010-2011. In contrast to the Swedish data, the authors found that longer LOS was associated with an increased risk of death within 30 days of discharge.

In general this is an interesting study that may indicate different effects of shorter LOS in Sweden and the US, perhaps due to different health care systems in Europe and the US.

Comments:

1. It would be necessary to evaluate these results in more detail. In the present cohort LOS was reduced to more than half (from 12.9 days-5.6 days) during the years of investigation. Therefore, I encourage the authors to:

a. evaluate whether the association between LOS and risk of death is similar during the years of follow up. Data for all years of follow up would be informative, using regression models and presenting both unadjusted and adjusted associations.

We attempted to control for year of follow-up in the original model, which contained variables for years 2000-2005 and 2006-2011. As there was a significant association between year and odds of mortality, we have now included an interaction term in the model as described below.

To evaluate the odds of death during years of follow-up, we have added Supplemental Tables 1A-1L which present odds ratios for mortality and LOS in the adjusted models for each year of the study and Supplemental Table 1M which presents odds ratios for mortality and LOS in the unadjusted model for each year of the study.

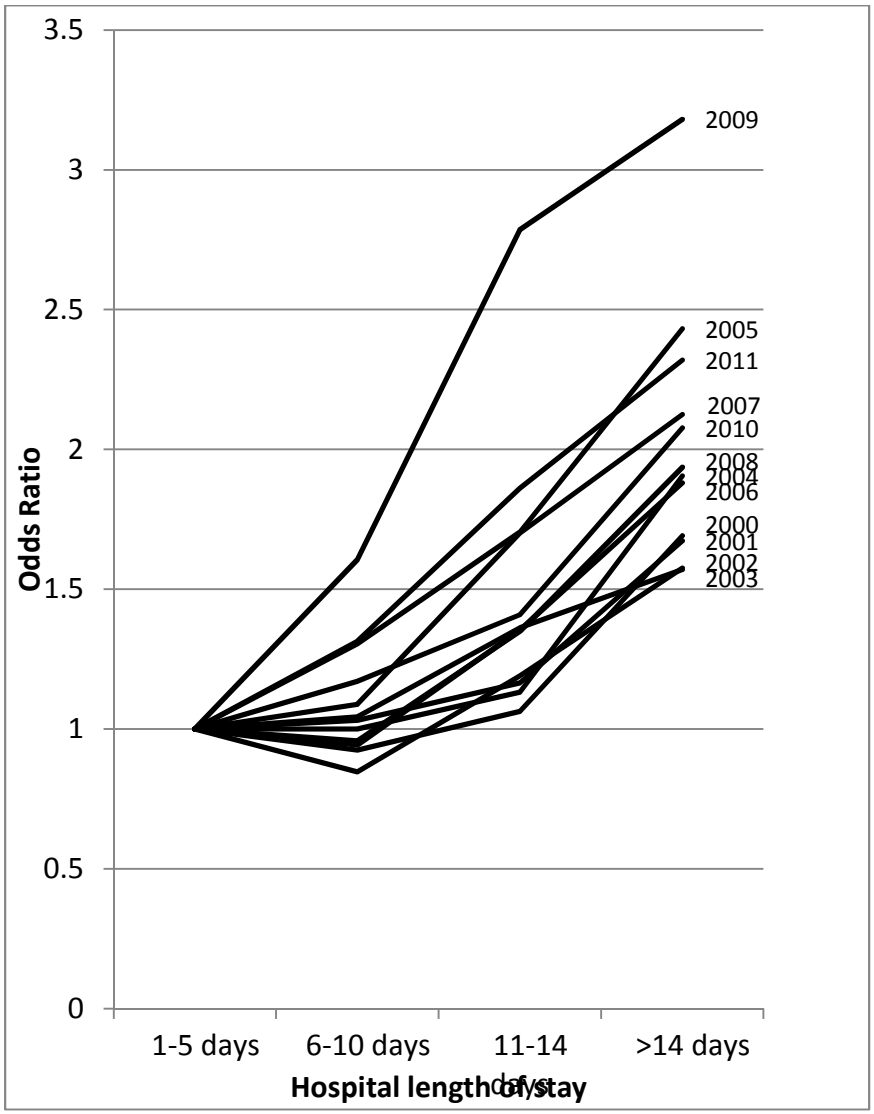
We have added the following text to the methods section:

To control for confounding factors, several additional analyses were done. To control for a reduction in length of stay over the 12-year study period, the relationship between LOS and post-discharge mortality was evaluated for each year separately in both adjusted and unadjusted logistic regression models (Supplemental Tables 1A-M).

In every year of the study, the odds ratio for mortality increases with increasing hospital length of stay in both unadjusted and unadjusted regression models. The group with longest hospital stay - >14 days – was at significantly higher odds of mortality in every year during the study in both adjusted and unadjusted regression models.

We have added (Figure 2) which presents the adjusted odds ratios for mortality by LOS for each study year.

Figure 2: Adjusted odds ratios for mortality after controlling for comorbid characteristics, injury, and demographics each year from 2000-2011 demonstrating consistent trend in every study year of increased mortality associated with increasing hospital length of stay.



b. In addition, any interactions between LOS and the years of follow up, with respect to death after discharge is warranted.

Based on this recommendation we undertook analysis of interaction between LOS and year of follow-up with respect to death after discharge. We created an interaction term of length of stay and year after 2005. To test whether to include the interaction term, we performed likelihood ratio test which found the test statistic was equal to 15.4492 with 3 degrees of freedom and a p-value of 0.00147. Therefore, the product interaction term was added to the primary logistic regression model as a covariate. Inclusion of the interaction term between LOS and years of follow-up did not substantially alter the findings of the study. We have added the following to the methods section:

"To test whether the association between length of stay and odds of death after discharge was time dependent an interaction term of length of stay and year after 2005 was created. The likelihood ratio test found the test statistic was equal to 15.4492 with 3 degrees of freedom and a p-value of 0.00147. Therefore, the product interaction term was included in the primary logistic regression model as a covariate."

2. The SPARCS database would need some better description. Especially, the authors should describe the accuracy, sensitivity and specificity of the diagnosis captured in this database with references. To give some examples, from Table 1 only about 5% of the patients had dementia and about 3% had cancer at diagnosis. Compared to hip fracture cohorts in the US or Europe this is extremely low, and is likely resulting in residual confounding. Could the authors also gather comorbidities from other sources?

We agree that the manuscript would benefit from additional description of the SPARCS database. We have added the following text to the manuscript:

SPARCS is a comprehensive, all-payer administrative database which collects patient-level data from all non-federal acute-care facilities in the State of New York (233 hospitals during study period). The database collects information including patient demographics, diagnoses, procedures, and charges for every inpatient hospitalization, ambulatory surgical procedure, and emergency department admission. Individuals are assigned a unique, encrypted identification code allowing for longitudinal analyses. Estimated reporting completeness obtained from SPARCS inpatient annual reports during the study period from 2000-2011 ranged from 95-100% with an average of >98%.

We appreciate the astute observation regarding the apparent discrepancies between noted and expected rates of cancer and dementia. Other studies have compared rates of comorbid conditions in patients with hip fracture between other large American administrative databases (National Inpatient Sample [NIS] and National Surgical Quality Improvement Program [NSQIP]) and found some variation in rates of comorbid conditions identified (Bohl et al, "Nationwide

Inpatient Sample and National Surgical Quality Improvement Program give different results in hip fracture studies", Clin Orthop Relat Res. 2014 Jun;472(6):1672-80). In our study, comorbidities were determined using software developed based on the paper by Quan et al (Quan H et al. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. Medical Care 2005 Nov; 43(11):1073-1077) and which is part of the suite of software available with Stata. ICD-9 codes used to calculate comorbidities are included in the table below (using the Enhanced ICD-9-CM).

TABLE 1. ICD-9-CM and ICD-10 Coding Algorithms for Charlson Comorbidities

Comorbidities	Deyo's ICD-9-CM +	ICD-10 *	Enhanced ICD-9-CM *
Myocardial infarction	410.x, 412.x	I21.x, I22.x, I25.2	410.x, 412.x
Congestive heart failure	428.x	I09.9,I11.0, I13.0, I13.2, I25.5, I42.0, I42.5-I42.9, I43.x, I50.x, P29.0	398.91, 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 425.4-425.9, 428.x
Peripheral vascular disease	443.9, 441.x, 785.4, V43.4 Procedure 38.48	I70.x, I71.x, I73.1, I73.8, I73.9, I77.1, I79.0, I79.2, K55.1, K55.8, K55.9, Z95.8, Z95.9	093.0, 437.3, 440.x, 441.x, 443.1-443.9, 447.1, 557.1, 557.9, V43.4
Cerebrovascular disease	430.x-438.x	G45.x, G46.x, H34.0, I60.x-I69.x	362.34, 430.x-438.x
Dementia	290.x	F00.x-F03.x, F05.1, G30.x, G31.1	290.x, 294.1, 331.2
Chronic pulmonary disease	490.x-505.x, 506.4	I27.8, I27.9, J40.x-J47.x, J60.x-J67.x, J68.4, J70.1, J70.3	416.8, 416.9, 490.x-505.x, 506.4, 508.1, 508.8
Rheumatic disease	710.0, 710.1, 710.4, 714.0-714.2, 714.81, 725.x	M05.x, M06.x, M31.5, M32.x-M34.x, M35.1, M35.3, M36.0	446.5, 710.0-710.4, 714.0-714.2, 714.8, 725.x
Peptic ulcer disease	531.x-534.x	K25.x-K28.x	531.x-534.x
Mild liver disease	571.2, 571.4-571.6	B18.x, K70.0-K70.3, K70.9, K71.3-K71.5, K71.7, K73.x, K74.x, K76.0, K76.2-K76.4, K76.8, K76.9, Z94.4	070.22, 070.23, 070.32, 070.33, 070.44, 070.54, 070.6, 070.9, 570.x, 571.x, 573.3, 573.4, 573.8, 573.9, V42.7
Diabetes without chronic complication	250.0-250.3, 250.7	E10.0, E10.1, E10.6, E10.8, E10.9, E11.0, E11.1, E11.6, E11.8, E11.9, E12.0, E12.1, E12.6, E12.8, E12.9, E13.0, E13.1, E13.6, E13.8, E13.9, E14.0, E14.1, E14.6, E14.8, E14.9	250.0-250.3, 250.8, 250.9
Diabetes with chronic complication	250.4-250.6	E10.2-E10.5, E10.7, E11.2-E11.5, E11.7, E12.2-E12.5, E12.7, E13.2-E13.5, E13.7, E14.2-E14.5, E14.7	250.4-250.7
Hemiplegia or paraplegia	344.1, 342.x	G04.1, G11.4, G80.1, G80.2, G81.x, G82.x, G83.0-G83.4, G83.9	334.1, 342.x, 343.x, 344.0-344.6, 344.9
Renal disease	582.x, 583-583.7, 585.x, 586.x, 588.x	I12.0, I13.1, N03.2-N03.7, N05.2-N05.7, N18.x, N19.x, N25.0, Z49.0-Z49.2, Z94.0, Z99.2	403.01, 403.11, 403.91, 404.02, 404.03, 404.12, 404.13, 404.92, 404.93, 582.x, 583.0-583.7, 585.x, 586.x, 588.0, V42.0, V45.1, V56.x
Any malignancy, including lymphoma and leukemia, except malignant neoplasm of skin	140.x-172.x, 174.x-195.8, 200.x-208.x	C00.x-C26.x, C30.x-C34.x, C37.x-C41.x, C43.x, C45.x-C58.x, C60.x-C76.x, C81.x-C85.x, C88.x, C90.x-C97.x	140.x-172.x, 174.x-195.8, 200.x-208.x, 238.6
Moderate or severe liver disease	456.0-456.21, 572.2-572.8	I85.0, I85.9, I86.4, I98.2, K70.4, K71.1, K72.1, K72.9, K76.5, K76.6, K76.7	456.0-456.2, 572.2-572.8
Metastatic solid tumor	196.x-199.1	C77.x-C80.x	196.x-199.x
AIDS/HIV	042.x-044.x	B20.x-B22.x, B24.x	042.x-044.x

Quan H, Sundararajan V, Halfon P, et al. Coding algorithms for defining Comorbidities in ICD-9-CM and ICD-10 administrative data. Med Care. 2005 Nov; 43(11): 1130-9.

Even with some variation between administrative datasets, we agree that the rates of dementia calculated with this method seem low relative to the expected population of hip fracture patients; this coding algorithm, although well cited, does not include common "dementia" diagnoses such as Alzheimer's (ICD-9-CM code 331.0) or "Persistent mental disorders due to conditions classified elsewhere" (ICD-9-CM 294.xx). When these additional codes are included the analysis to define dementia the overall frequency in the population is 23.46%. We have changed the definition of dementia to include the additional ICD-9 codes and updated the frequency in Table 2.

Patients with ICD9 codes for pathologic fracture were not included in the analysis which may slightly decrease the number of cancer diagnoses in the cohort. However, we agree that the 3% rate is likely low. The ICD-9 codes used to calculate the "Cancer" comorbidity with the software included only patients who had a diagnosis code for cancer, but not the more common ICD-9 codes for "personal history of cancer" (ICD-9-CM V10.x). When those codes are included the frequency of cancer or history of cancer is 12.51%. We have changed the definition of cancer for defining comorbidities to include patients with a history of cancer.

We have added Table 1 which describes ICD-9-CM codes used to define each comorbidity.

Table 2 and multivariate models have been updated with the expanded definition for these variables. Following these changes, the primary findings of the investigation are not substantially altered.

3. In the Discussion the authors mention that "care in New York State varies with location, and socioeconomic factors," yet, no estimate of socio-economic situation is presented. This would be of high interest, and the results should be adjusted for this factor if available. Also, information would be of value describing the different hospitals in this area. Are there important differences and how many are there? Are all hospitals in this area registered in the SPARCS database, or is there a selection of patients that could explain the very low prevalence of comorbidities?

SPARCS does not explicitly contain socioeconomic status for patients. It does contain a code for the county in which a patient resides. Using data from the US Census Bureau collected in the American Community Survey we determined estimated mean household income for each of 62 counties in the State of New York and grouped patients into quartiles based on mean county household income. Patients in the lowest and highest quartiles did not differ significantly in 30-day mortality, while those in the middle two quartiles had increased odds of mortality. We interpret these data with caution as significant socioeconomic variation may exist in each

county and affect access to care which is not be captured in this analysis. When including these variables in the adjusted analysis, the primary findings of the investigation are not substantially altered and given the concerns we have about the extrapolation of county-level data to individuals we prefer to not include these variables in the final text. We have added the following text to the limitations section of the discussion:

"*Patient socioeconomic status may affect access to care in New York State more than in single-nation European populations*[4] *but is not included in the database and therefore could not be assessed as a covariate."*

Although the names of treating hospitals are included, there is not a clear ranking system for hospitals in New York State or quality of hip fracture care provided. All non-federal hospitals treating patients with hip fractures in the state are included (233 total) as mentioned previously. While assessment of care at individual hospitals would be interesting, a full analysis of quality of care at individual hospitals is beyond the scope of this investigation and may be a direction for future research.

The comment regarding comorbidity prevalence has been addressed above.

4. Given the low prevalence of comorbidities it would also be of value to investigate whether the results are similar according to subgroups. Given the number of hip fractures this seems feasibly from a power perspective.

Several subgroup analyses have been performed. First, we looked at subgroup analysis based on discharge destination. This is shown in Supplemental Tables 4A-4I. The results of subgroup analysis based on disposition reveal that for all discharge dispositions other than "hospice" or "against medical advice" there was a significant association between length of stay of >14 days and higher risk of mortality. In the "skilled nursing facility" and "inpatient rehabilitation" subgroups (the most common dispositions) longer length of stay was associated with significantly higher mortality risk in the 6-10 day, 11-14 day, and >14 day cohorts in the adjusted model when compared to a LOS of 1-5 days. Of the 6.9% of patients discharged to home, hospital length of stay longer than 14 days was significantly associated with higher mortality but a significant relationship was not present for shorter lengths of stay.

A second subgroup analysis was performed for patients with the five most common comorbid conditions, as shown in Supplemental Tables 5A-5E. Hospital LOS greater than 5 days was associated with significantly higher mortality risk in patients with cancer; for patients with

dementia, CHF, and COPD there was a significantly increased mortality risk for LOS over 10 days but not in the 6-10 day group.

In conclusion, subgroup analysis did not find any cohorts where the primary study conclusions were significantly altered or where longer length of stay was associated with decreased early mortality following discharge.

The following text has been added to the manuscript:

Subgroup analysis

Results of subgroup analysis are shown in Supplemental Tables 4-5. For all discharge dispositions other than "hospice" or "against medical advice" there was a significant association between length of stay of >14 days and higher odds of mortality. In the "skilled nursing facility" and "inpatient rehabilitation" subgroups (the most common dispositions) longer length of stay was associated with significantly higher mortality odds in the 6-10 day, 11-14 day, and >14 day cohorts in the adjusted model when compared to a LOS of 1-5 days. Of patients discharged to home, hospital length of stay longer than 14 days was significantly associated with higher mortality but a significant relationship was not present for shorter lengths of stay. Hospital LOS greater than 5 days was associated with significantly higher mortality odds in patients with cancer; for patients with dementia, CHF, and COPD there was a significantly increased mortality odds for LOS over 10 days but not in the 6-10 day group. In no subgroup analysis was longer length of stay associated with decreased early mortality following discharge.

5. The risk of death should decrease with increasing follow up time. This will also influence the risk of death for those discharged early. Therefore, additional analysis is of value taking this risk into account, this should likely strengthen the associations found.

To evaluate whether risk of death increases with increasing follow-up time we assessed the odds of death between 1 and 15 days after discharge in the adjusted logistic regression model and compared it to odds of death between 16 and 30 days after discharge. The results of this analysis are shown below. We interpret the results to suggest that hospital length of stay is a marker for overall mortality risk; patients who are discharged early carry lower odds of mortality regardless of follow-up duration compared with those with longer lengths of stay.

	Length of stay	Odds Ratio	2.50 %	97.50 %	P-value
1-15 days after discharge	6-10 days	1.03	0.93	1.14	0.6
	11-14 days	1.33	1.16	1.53	<0.001
	>14 days	1.91	1.68	2.16	<0.001
16-30 days after discharge	6-10 days	1.13	1.01	1.26	0.04
	11-14 days	1.33	1.13	1.55	<0.001
	>14 days	2.06	1.79	2.37	<0.001

We have added the following text to the methods section under Subgroup and sensitivity analyses:

To evaluate whether risk of death increases with increasing follow-up time, adjusted logistic regression models were created to compare the odds of death between 1 and 15 days after discharge and 16 and 30 days after discharge.

We have added the following text to the results section under Subgroup analysis:

Length of stays longer than 10 days were associated with similarly elevated odds of mortality during days 1-15 and 16-30 after discharge.

6. The Discussion needs more depth. There are several other studies that have investigated the association between LOS and risk of death, both in hip fracture patients and other cohorts.

We agree and have added the following paragraph to the discussion:

Other authors have attempted to determine the relationship between hospital LOS and mortality or other outcomes in hip fracture patients. Kondo et al compared length of stay and mortality after hip fractures between three Japanese and two United States hospitals with vastly different LOS.[12] Although they found lower mortality in the Japanese hospitals with longer lengths of stay, the small sample size make interpretation of the results challenging. Dubljanin-Respovic et al found no effect of LOS on 1-year mortality in a consecutive series of 228 Serbian hip fracture patients[13] and Heyes et al found an increased readmission rate associated with increasing LOS after hip fracture in a Northern Ireland hospital system.[14] The relationship between LOS and mortality has also been studied in non-hip fracture populations. Kaboli et al analyzed over 4 million admissions through the United States Veterans Affairs Medical System and found LOS decreasing for all diagnoses by 1.46 days and a concomitant decrease in all cause 90-day mortality. [15] In acute heart failure patients, Reynolds et al found an association between longer initial LOS and increased all-cause mortality.[16] Both of these studies were in a United States population and support the findings of an association between decreased LOS and decreased mortality in New York hip fracture patients. The contradictory results between American studies and that found in the Swedish hip fracture data highlight the challenges in interpreting studies on length of stay across populations which have different healthcare systems.

7. Covariates are usually evaluated towards the exposure not the outcome, although this will likely not affect the conclusions. I can see the value also of the present presentation.

While we agree that covariates (comorbid conditions) may affect risk of sustaining a hip fracture, we believe they also influence the outcome (mortality). Prior research has shown that increased comorbid conditions are associated with increased hospital costs and length of stay. Findings in this paper suggest increased comorbid conditions are associated with increased risk of mortality following discharge. Inclusion may identify avenues for intervention or further study, and sensitivity analyses excluding comorbid conditions do not substantially alter the findings of our manuscript (available upon request). Therefore we prefer to include them in the manuscript.

8. As mentioned above the risk of death is decreasing with increasing LOS after a hip fracture. This may well also affect the proportional hazard assumption. A description how this assumption was tested, and not violated should be added to the manuscript.

We appreciate this suggestion. To evaluate interactions between LOS, comorbid conditions, demographics, year of fracture, fracture characteristics and treatments, we originally used Cox proportional hazard regression models. To ensure our model's accuracy, we evaluated the proportional hazards assumption and found a Chi-square value of 365.12 and a p-value of <0.001 – therefore the model violated the proportional hazards assumption. To avoid this issue, we have changed our adjusted analyses to a logistic regression model which does not require a proportional hazards assumption. This change did not substantially alter the findings of the investigation. All adjusted data presented in the revised manuscript has been assessed with the logistic regression model.

The methods section has been changed from "Multivariate proportional hazard regression…" to "*Multivariate logistic regression analysis evaluated risk of mortality*…"

9. It would be of value if the authors can present causes of death. For those that die within 30 days of surgery, the death should usually be regarded as influenced by surgery.

Our original data application from SPARCS requested, and was approved for, causes of death. Unfortunately this information was missing from our official dataset. We have contacted the

SPARCS administrators and requested new data transmission including the approved cause of death data, however, it has not yet arrived.

We agree that an evaluation of specific cause of death would be useful if available, although we suspect that cause of death reported in our dataset will suffer from the same limitations seen in the Swedish study. In the Swedish paper, the most common cause of death was "expos[ure] to non-specified factor" and more detailed information was not available. For this reason we intend to replicate this analysis when given the data but few autopsies are performed in New York State in this population.

We have added the following statement to the limitations section:

"Finally, specific cause of death was not available as few autopsies are performed in this population."

Reviewer: 2

Recommendation:

Comments:
The article by Nikkel and colleagues considers the association between LOS and mortality among patients with hip fracture in a New York, statewide population. The article is motivated by recent work from Sweden, which suggests that longer stays are associated with lower mortality. Using a statewide discharge data set, Nikkel et al. regress mortality on LOS categories and find that longer stays are associated with higher mortality, the opposite of the Swedish data. Overall, the analysis is sound and the paper is well written and easy to follow.

I have the following suggestions:

Major Issues

The authors argue that differences between health care systems between the US and Sweden could account for the difference in effect of LOS on mortality. But the specific differences are not spelled out. What differences could cause longer LOS to lower mortality in Sweden but increase mortality in the US? For example, in the US there is pressure for hospitals to transfer patients to rehab hospitals and SNFs. If US hospitals respond to these incentives then they

would have a lower LOS on average, and a lower mortality since the transferring institutions would receive "credit" for the mortality. If Swedish hospitals do not have the same pressure as a result of a publicly financed system, then could this explain the difference between the countries?

We have attempted to explain some of the specific differences in populations which may account for the different effect of LOS on mortality, namely differing mean LOS between the populations. However, we wish to be careful in drawing conclusions about differences which cannot be supported by the data. Since no direct comparisons between the populations exist (through analysis of a combined international database, for example) we believe the key finding and significance of our investigation is to highlight the limitations in external validity when using population-based databases to make conclusions dependent on healthcare utilization patterns.

We have added text to the discussion in response to this comment and the following comment below.

Are rehab and SNFs used in Sweden the way they are in the US? If this is the case, then to really have comparable results you would need to link inpatient admissions to their step down admissions. It would also imply that the LOSes reported in the two analysis (Sweden and New York) are really different measures. Are there other explanations for the differences in your results?

This is an interesting question; we believe there are differences in how rehabilitation/SNFs are used in Sweden and the United States. Dr. Nordstrom, the author of the Swedish study, has shown in another study which has been accepted to JAMDA but not yet published that found an association between early discharge to temporary nursing homes and increased mortality (as in the BMJ article) but for patients discharged to home the risk of death increased with longer length of stay (as in our study).

We have performed subgroup analysis of patients based on discharge destination as described in the response to the first reviewer. In contrast to the Swedish finding mentioned above, early discharge to temporary nursing homes in subgroup analysis for the New York population is still associated with decreased mortality.

To evaluate the question of whether the LOS's reported in the two analyses (Sweden and New York) are different measures, we undertook the sensitivity analysis to assess risk of mortality between 15 and 45 days after hospital admission as described above. However, this comment is insightful, and actually may hint at the key difference between the two analyses. Mean LOS is longer in the Swedish study and higher costs of inpatient hospital stays relative to skilled nursing or long-term care facilities in the United States exerts pressure on hospitals to

discharge patients earlier to a lower level of care. We believe our results highlight limitations in the external validity of using large population-based studies when healthcare systems between Europe and the United States have different patterns of utilization.

We have added the following text to the discussion:

"Differences exist in time to management of hip fracture; standard of care in Sweden is fracture stabilization within 24 hours. In our study of New York State patients, 19.4% waited more than 2 days for surgery, and increased time to surgery was associated with longer LOS. With the known relationship in the hip fracture literature between increased time to surgery and increased mortality,[10 11] these findings may explain part of the differences in healthcare systems. No discharge destination was available for the Swedish study so direct comparisons between patients discharged to rehabilitation facilities or home is not possible. However, notable differences exist in hospital length of stay between the Swedish and New York populations. In the New York population, where insurers exert pressure to discharge patients to less costly rehabilitation facilities, nearly 40% of patients were discharged within five days and 82% discharged in 10 or fewer days. In contrast, only 18% of patients were discharged within five days and less than half were discharged in 10 days or less in Sweden where a publicly financed system may not have the same incentives. These major differences in financial considerations and mean LOS after hip fracture may partly explain the contradictory results seen in the two studies."

For much of the paper the authors are careful about not inferring causality between LOS and mortality. But there are places where this is implied. For example, page 10, line 1, "LOS did not influence mortality"; page 11, line 1, "altering LOS influence mortality rates"; line 23 "influences on mortality". I would recommend that you maintain the language of "association" rather than "influence" or other words that suggest that LOS is causing the mortality effect. Unless you can explain how LOS would "cause" mortality rates, I think a more likely explanation for your finding is that there is some other (unobserved or unmeasured) variable that is associated with both LOS and mortality that is the driving factor here.

We agree that LOS itself is unlikely to cause the mortality effect and appreciate the suggestions. We have made the following changes:

The first sentence of the discussion has been replaced with:

"*In this study of New York State patients, a shorter inpatient hospital stay was associated with increased rates of survival after hip fracture. The relationship between hospital length of stay and mortality is important and is likely multifactorial*."

The phrase "altering LOS influence mortality rates" has been removed.

The phrase "influences on mortality" has been replaced with "*associations with mortality*"

The last sentence of the paper makes a leap from New York data to the US population. I would recommend that you not try to generalize, and that you limit your inferences to New York since it is likely that other states and the average for the US look different from New York.

We agree with the comments and have limited our inferences to New York. In addition, we have added the following statement to the limitations section:

"*The population of New York State patients studied may vary from other statewide populations in the United States, and our findings may not be generalizable to populations in other states or countries."*

Minor Issues

Abstract, Objective. Consider saying "determine whether…" rather than "determine if…".

We have changed the phrasing to "*determine whether*…"

Page 10, line 10. Consider revising the phrase "…and this trend was dominant in the overall cohort…" I cannot tell what you mean.

This sentence has been revised to read, "*For the overall cohort of all hip fracture patients and the sub-group of surgically treated patients, increased LOS was associated with increased mortality*."

Reviewer: 3

Reviewed: My recommendation is to Accept for publication, after revisions noted below.

This is a very important paper examining a large U.S. (in this case, New York State) based population results of hip fracture length of stay effect on mortality, with comparison that to a European (in this case Sweden) hip fracture length of stay study results.

That said, the authors should emphasize, in addition to their conclusions, one important takeaway point: that different health systems in varying geographic locations (i.e. Europe v. Asia v. North America. etc.) can have a profound effect on how patients fare after a hip fracture, therefore conclusions by the reader of these study results from these locations should take these differences into account. In this case, results from a large Swedish population cannot be generalized to a US population, and vice versa.

We appreciate the kind words regarding the study and agree with this comment; we have added the following statements to the discussion:

The population of New York State patients studied may vary from other statewide populations in the United States, and our findings may not be generalizable to populations in other states or countries.

And

Caution should be used in extrapolating results of population-based studies when healthcare systems are dissimilar.

In regards to the above, one question for the author's is: Have you looked at similar studies from other countries (i.e. Britain, Germany, Japan, etc) to see if similar discrepancies also exist when compared to the U.S. New York State population you studied?
We did perform a literature search for other studies looking at length of stay and mortality after hip fracture or other medical conditions and have added a paragraph to the discussion as described above. In general, studies from the United States support the association between decreased length of stay and decreased mortality, presumably because healthier (and therefore lower-risk) patients are discharged from the hospital earlier.

And Also: Have you considered looking at not just the New York State population, but other states in the U.S. to see how they have compared to each other?
Although we would like to test the validity of our results against other state databases, SPARCs only contains data for New York State admissions. We are not aware of and do not have access to other databases from the United States which contain both closed systems (all-payers) and unique identifiers or mortality data. Other databases in the United States were considered for this analysis. National Inpatient Sample (NIS) contains data from multiple states but does not contain mortality data or unique identifiers which would permit linkage to state mortality data. Data from the National Surgical Quality Improvement Program (NSQIP) does not completely capture all hip fracture diagnoses as the data collected varies somewhat by year and is only a subset of patients from each participating hospital.

For Page 6, Line 21: You mentioned that "healthcare systems in Europe and the United States differ in both LOS and usual discharge destination." Can you provide more detail as to how they exactly differ?
We have added some details as to how they differ in the introduction and the discussion.

In the introduction we have added:

In contrast, hospital discharge in certain European countries trends toward discharge to home with a lesser percentage admitted to rehabilitation facilities (NHFD).

In the discussion we have added:

“However, notable differences exist in hospital length of stay between the Swedish and New York populations. In the New York population, where insurers exert pressure to discharge

patients to less costly rehabilitation facilities, nearly 40% of patients were discharged within five days and 82% discharged in 10 or fewer days. In contrast, only 18% of patients were discharged within five days and less than half were discharged in 10 days or less in Sweden where a publicly financed system may not have the same incentives. These major differences in financial considerations and mean LOS after hip fracture may partly explain the contradictory results seen in the two studies."

And similarly for Page 11, line 56: You mention that " interpretation of their results would require knowledge of the average time to surgery for Swedish hip fracture patients." Have you considered contacting the author's of that Swedish study to see if they could provide that information? Having that information would make for a stronger comparison difference that your paper suggests exists between US and European healthcare systems.

We have contacted the authors of the Swedish study. Their response was:

"About 25 years ago Professor KG Thorngren started a database that collects information about all hip fractures in Sweden. One of the key findings when analyzing the data was that a delay in operation of more 24 hours after admission to hospital with a hip fracture increased the risk of death. This resulted in recommendations that all patients should be operated within 24 hours. I recently analyzed these data again, and today there is no association between time from admission to operation and the risk of death, perhaps since almost all patients are operated within 24 hours"

We have added the following text to the discussion:

Differences exist in time to management of hip fracture; standard of care in Sweden is fracture stabilization within 24 hours. In our study of New York State patients, 19.4% waited more than 2 days for surgery, and increased time to surgery was associated with longer LOS. With the known relationship in the hip fracture literature between increased time to surgery and increased mortality,[10 11] these findings may explain part of the differences in healthcare systems.