Author’s response to reviews

Title: Association between registered nurse staffing levels and in-hospital mortality in craniotomy patients using Korean National Health Insurance data

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Author’s response to reviews:

Thank you very much for your helpful comments.

We have carefully considered them and have done our best to properly address them. The changes are shown in red in the manuscript, and our detailed responses to the comments are presented below.

Joshua Kanaabi Mulira, DNP (Reviewer 1)

1. The paper handles an important aspect of safety in neurology nursing and it is mostly well written.

   Please clarify the how the staffing level available on paper or records of the hospital matched the actual staffing level since on some day some nurses may be on sick leave, maternity leave or annual leave. Therefore the hospital documented staffing level may be much less than what is on the ground.

   -&gt; This study included only registered nurses who actually participated in patient care, with the exclusion of those on leave or in administrative jobs. This point has been described along with the background and research methods.

2. It is important to include the reason/indication for the craniotomy because this plays a role on the risk for death or survival. For instance a craniotomy done as part of a major brain tumor is going to present a higher risk compare to a one done to relieve brain edema.

   -&gt; We analyzed mortality according factors that included the type of craniotomy. We assigned the type of craniotomy in terms of the Korean diagnosis-related group (KDRG) system.

   Major craniotomy (B01) refers to a skull base operation, intracranial vascular procedure, excision of brain tumor, seizure surgery, bypass surgery, and stereotactic surgery. Other craniotomy (B02) includes procedures for the cranial nerve, burr hole, and trephination. B03 refers to craniotomy for trauma.

   As the reviewer commented, there were significant differences in mortality according to the indication for craniotomy. There was a higher risk of mortality in the category of other craniotomy (cranial nerve procedure, burr hole, or trephination) than in the category of
craniotomy for trauma. These are described in the results section (Mortality after craniotomy by characteristics of patient, Influence of the level of nurse staffing on inpatient mortality)

3. How does the requirements of the Korean Law regarding staffing match with standards followed in international settings? This aspects will help the readers to view the utility of the findings in their respective settings.

-&gt; The nurse staffing standard according to the Enforcement Rule of Medical Service Act and the nursing fee differentiation policy have been described in the introduction. In the discussion, we described and compared the nurse staffing criteria (based on shift duty) derived from the results of our research by comparing them with those reported in international settings.

Fiona Nolan (Reviewer 2)

1. The authors should clarify from the outset that they are referring to registered nurses and also provide information as to whether nursing assistants/auxiliaries are employed on the wards in Korea.

-&gt; Nursing personnel in Korea are divided into registered nurses and nursing assistants. This study included only registered nurses who actually participated in patient care. The methods and discussion sections indicate that nursing assistants were not included.

2. The background section contains statements which encourage the reader to question the justification for this study.

-If it is known that patients are more likely to die when they have less access to nurses during their hospital stay, why conduct the study? In other words, please give a rationale for looking at craniotomy patients in particular. Also, describe the characteristics of this intervention and associated outcomes that would be useful to consider in others (e.g. those with high infection risk)

-&gt; Many studies have investigated nurse staffing levels and patients’ mortality, but no studies have presented both general ward and ICU nurse staffing levels for craniotomy patients. Since craniotomy patients are one of the highest-risk groups of patients, we embarked upon this study because we thought the role of nurses would be especially large. In Korea, craniotomy patients have the highest mortality rate after surgery, and they are known to have the largest variation in mortality rate between hospitals. Rather than integrating different types of surgical patients to explain the relationship between mortality and nurse staffing level, we thought it would be more accurate and easier to understand for readers to analyze only craniotomy patients, who have the highest mortality rate. These points have been described as part of the background.

3. If the 2.5 patients per nurse is a legal requirement, please describe what measures are taken when this is not met (i.e. when hospitals break the law). If the meaning is 'mandated' as opposed to a legal requirement, please replace the wording.

-&gt; We have changed the wording from Medical Law to the Enforcement Rule of the Medical Service Act. We further explained that although the level of 2.5 patients per nurse is expected to be maintained, it is not effective because there is no punishable penalty clause. Therefore, the rule for the number of nurses is often considered to be a recommendation, not a mandatory requirement.
4. Page 3- Lines 35–50
Please provide brief interpretation of findings to give context and assurance of your correct extraction of the statements- e.g. Any differences in team composition - numbers of nursing auxiliaries, medical staff, and others
- We have added a brief interpretation of the results of the cited literature. We explained differences according to the nurse staffing level.

5. Page 4
Please clarify whether any advanced nursing skills are required to care for this patient group
- Craniotomy patients have more severe conditions than other patients, and it is very difficult to identify the complications that may occur in patients after surgery, so they need to receive more frequent and thorough care, and high levels of nursing are required. We added to the background an indication that advanced nursing skills are needed to take care of craniotomy patients.

6. Page 7
The presentation of grading systems for hospitals based on nurse staffing is confusing. Are the hospitals in breach of legal requirements when they are graded over 2? Are they required by government to take measures to improve their staffing?
Also, please indicate whether the grading of hospitals is within the public domain, and if so, are they likely to cause concern to the patients receiving treatment within them?
- In the background and methods of the study, we have described that hospitals receive incentives from the government based on the nursing grade.
If the nursing grade is better than grade 6, the hospital can receive this incentive. It is also stated that the nursing grade results are open to the public for reference when members of the public choose a hospital.

7. Page 9 Lines 32–35:
Changing wording throughout from 'hospital' to medical institution' is confusing. Please use the same term throughout the paper.
- Since this study was aimed at hospital-level medical institutions, we have used the term ‘hospital’ instead of ‘medical institution’ throughout the study.

8. Page 10 Lines 2–9:
This isn't clear I'm afraid- can you reword?
- I apologize that this part was not clear. It has been reworded as follows:
“In terms of the ICU nurse staffing grades, 64 hospitals (31.5%) had grade 3-4 staffing (≥0.63 and <0.88 beds per nurse). There were 29,408 patients (62.9%) in hospitals with grade 1-2 staffing (<0.63 beds per nurse). In terms of the overall nurse staffing grade, 24,687 patients (52.8%) were treated at hospitals with the highest nursing level (<1.25 beds per nurse) (Table 1).”

9. Page 11 Line 32:
please insert full wording for CCs on first use
- The full wording of CCs, “complications and comorbidities,” has been inserted.

10. Page 12 Line 43:
The following sentence should be explained 'other variables, in addition to the level of nurse staffing, were found to show certain tendencies in all three models in terms of their effects on inpatient mortality after craniotomy.'
These other variables are important. 'Certain tendencies' is a strange description- they are either significant or not. Please indicate which, and also where nurse staffing ranks in relation to impact on morality, compared to, for example, numbers of doctors.

Instead of the expression "certain tendencies", it is stated that other patient- and hospital-level variables had a statistically significant effect on mortality. It is also stated that the nurse staffing level had the strongest effect of all variables on mortality.

11. Page 15 Line 35:
please indicate whether the assertion that nursing numbers are reduced to cut costs is profession-specific i.e. nursing numbers are reduced in preference to doctors' numbers

It has been stated that the number of nurses tends to be the first target for reduction because they account for the largest proportion of the number of health care workforce.

12. Page 16: Lines 2-13:
Please clarify that these examples are for registered nurses working with clinical teams, and demonstrate that you are aware of the composition of these teams (e.g. nursing assistants, medical assistants, advanced practitioners and allied health professionals). This is necessary to assure the reader that you are aware that patient care is delivered by a team. The use of the examples within a Korean context can then be explored for relevance

The following content has been added.
In Korea, registered nurses also provide team-based care with a variety of personnel, including nursing assistants. In this study, only the number of registered nurses, not nursing assistants, was analyzed.

13. Lines 24-27
What is medical law? Does it mean 'the legal framework within which healthcare is provided in Korea'. for example?
Reference to the specific acts of government passing the laws would be needed.

We changed the term “medical law” to the Enforcement Rule of the Medical Service Act. The rule for the number of nurses is considered a recommendation, not a mandatory requirement.

14. Line 50:
Please explain the difference between the number of beds and number of patients.

We have explained the difference between the number of beds and the number of patients. Because the bed occupancy rate is not 100%, the actual number of patients may be less than the number of beds.

15. Finally the findings in relation to the importance of other variables on mortality of this patient group, in addition to nurse staffing, are very important to present clearly and without ambiguity.

In addition to nurse staffing, we further explained other variables that affect the mortality of craniotomy patients in the results.

16. A robust review of the regression analysis and modelling is needed.

GEE logistic regression has the advantage of correcting the standard error in parameter estimation that results from correlations among patients in the same hospital. In this study, the robust Huber-White sandwich method, which is used when there are more than 40 clusters in GEE regression, was applied.
17. The description of what this study adds to existing knowledge is weak. The authors should come back to the question about 'why craniotomy?' The importance of craniotomy care is further described throughout the study. Craniotomy patients are among those with the most severe diseases. In Korea, craniotomy patients have the highest mortality rate after surgery.

18. Access to this large dataset is unusual and could be highlighted by the authors in terms of potential benefits, as most countries do not have a central repository such as this. Thank you for your comment. We have emphasized the use of a large national dataset for research purposes in the conclusions.