# The Journal of Bone & Joint Surgery

## Quality of care in hip fracture patients - does compliance to national standards relate to improved outcomes?

---Manuscript Draft---

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<th>JBJS-D-17-00884R2</th>
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<td><strong>Keywords:</strong></td>
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<td><strong>Corresponding Author:</strong></td>
<td>Luke Farrow, MBChB&lt;br&gt;University of Aberdeen&lt;br&gt;Aberdeen, UNITED KINGDOM</td>
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<td><strong>First Author Secondary Information:</strong></td>
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## Additional Information:

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<td>Have any of the illustrations or tables used in this article been published previously (i.e. does another party now own the copyright to any illustration or table)?</td>
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How will this work influence the practice of Orthopaedics?

Our study provides novel research and supports the use of the Scottish Standards of Care for Hip Fracture Patients as a benchmark from which all hip fracture care can be judged. It also delivers further evidence regarding the potential benefits of a multidisciplinary team approach to the management of hip fracture patients. We believe our work is relevant to patients, public, health care providers, commissioners and policy makers and has potential to reduce the global burden of hip fracture.

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@docfarrow

Abstract:

Background
Optimising the perioperative care of patients with a hip fracture is a key healthcare priority. We aim to determine if adherence to the Scottish Standards of Care for Hip Fracture Patients (SSCHFP) is associated with improved patient outcome.

Methods
Retrospective cohort study of prospectively collected data from the Scottish National Hip Fracture Audit. We assessed adherence to the SSCHFP in twenty-one Scottish hospitals over a 9-month period in 2014, and examined the effect of the guidelines on 30- and 120-day mortality, length of hospital stay, and discharge destination.

Results
A total of 1,162 patients aged over 50 years and admitted with a hip fracture were included. There was a significant association between low adherence to SSCHFP and increased mortality at 30 and 120 days (OR 3.58, 95% CI 1.75 to 7.32, p<0.001 and OR 2.01, 95% CI 1.28 to 3.12, p=0.003). Low adherence was associated with a reduced likelihood of short length of stay (OR 0.58, 95% CI 0.42 to 0.78, p<0.001), but an increased odds of discharge to a high-care setting (OR 1.63, 95% CI 1.12 to 2.36, p<0.01). Early Physiotherapy and Occupational Therapy input was associated with a reduced likelihood of discharge to a high-care setting (OR 0.64, 95% CI 0.44 to 0.98, p=0.04 and OR 0.34, 95% CI 0.23 to 0.48, p=<0.001 respectively).

Conclusions
Adherence to Scottish Standards of Care for Hip Fracture Patients is associated with better patient outcomes. These findings confirm the clinical utility of the SSCHFP and support their use as a benchmarking tool to improve quality of care in hip fracture.
Subject: Response to reviewer comments

Dear Professor Swiontkowski,

We are pleased to re-submit our paper entitled “Quality of care in hip fracture patients – does compliance to national standards relate to improved outcomes?”

We greatly appreciate you and your team taking further time to consider our work for publication in the Journal of Bone & Joint Surgery. We were pleased to see that two of the assigned reviewers felt the manuscript suitable for publication. We have endeavoured to address all of constructive comments raised by the Deputy Editor through changes to the resubmitted manuscript. We hope that our updated responses address satisfactorily the comments made by the Deputy Editor for Methods, and that he/she now feels the manuscript to be of a standard suitable for publication in JBJS.

On behalf of all co-authors, I would like to take this opportunity to again thank the editors and reviewers for their insightful comments and suggestions which have helped to improve the quality of the manuscript.

Once again I can confirm that the paper has not been submitted to, and will not be published in (in whole, or in part) any other journal. Work associated with this manuscript has previously been presented at the EFORT Congress 2017 in Vienna, Austria and at the 2017 Scottish Hip Fracture Conference in Edinburgh, Scotland. All authors have read and agreed to the contents of the manuscript in its submitted form.

Yours sincerely,

Mr Luke Farrow
Clinical Research Fellow – University of Aberdeen
For and on-behalf of all co-authors
Responses to reviewer comments

Deputy Editor for Methods:

The authors have been able to address most of my main concerns. That being said they remain recalcitrant on some very important issues and in my opinion continue to willfully try and mislead the reader with respect to the import and significance of their study. Level of evidence reflects study design and threats to validity through study bias. The potential for selection and indication as well as classification bias are substantial threats to your study that cannot be controlled for. The author's ignore these facts in their assessment of evidence level. This is level III evidence at best. Many of their arguments ring hollow. All chart reviews are technically retrospective reviews of prospective data. This is a retrospective study design plain and simple as the authors clearly disclose in the answers to my queries. All good scientific work should have an a-priori hypothesis. The authors should not try and mislead the reader that by following good scientific practice, they have somehow enhanced the utility or import of this effort. Language to this effect or giving this impression should be removed.

The authors thank the Deputy Editor for Methods for taking his/her time to further consider the paper, and for providing their helpful comments. We have endeavoured to make all of the recommended changes that have been suggested. We would like to stress that it was never our intention to mislead the reader as to the level of evidence of this study. Our initial difference of opinion stemmed from the use of a different set of criteria used to designate levels of evidence. A reference to the criteria used was included in the previous response to reviewer comments. We have now amended the manuscript in line with the Deputy Editor's advice, and with the guidance published on the JBJS website.

We report the inclusion of an a-priori research hypothesis in concordance with the STROBE statement for reporting of observational studies (https://www.strobe-statement.org/index.php?id=strobe-home). We do not attempt to suggest that this enhances the quality of the study other than that inferred by adherence to good scientific practice. If there remain any concerns over a particular phrase or statement in the manuscript, we would be happy to review this specifically.

My recommendations at this time are as follows:

1. This study should be designated level III evidence - if the authors remain resistant to this, we will be at an impasse. At such a time I would advocate a delay of any plan of acceptance in lieu of further review by the Deputy Editor for Evidence or a JBJS workshop session where this can be further reviewed by the other deputy editors.

After further discussion amongst the authors and review of the level of evidence documentation listed on the JBJS website, we have updated the designation of the level of evidence of the study to Level III in accordance with the advice of the Deputy Editor.

2. The authors should not refer to their variable names in the Discussion (pace MORT 30 etc). For ease of readability and comprehension, the meaning expressed by these monikers should be spelled out in full.

We thank the Deputy Editor for their advice, and have made the suggested changes with respect to the variable names in the Discussion section.
3. The Discussion at present is overly long and tangential with a number of digressions. I highly suggest revising to a 5 paragraph format with no more than 1,000 words to improve readability and comprehension for the reader. The paragraphs could be as follows:

1. Qualitative restatement of the importance of the issue behind your study
2. Restate main findings
3. Couch findings in the context of other literature
4. Limitations
5. Take home message, practice implications, next steps. There should not be a separately designated conclusion section.

We thank the Deputy Editor for Methods for his/her insightful comments on the layout and content of the Discussion section. We have redesigned this section in accordance with the Deputy Editor’s suggestions.

We hope that the further changes to the manuscript are sufficient that the Deputy Editor for Methods finds the updated manuscript to now be of a satisfactory standard for publication in JBJS.

Reviewer 1:

I found the revised manuscript greatly improved. I have no recommended changes. The authors would like to thank Reviewer 1 for their comments and their support for publication of the manuscript within JBJS.

Reviewer 2:

After careful reassessment of the data submitted, I think the regression methods allows for significant conclusions. We see two important conclusions and that would be that older and elderly patients have a higher mortality rate at 30 and 120 days, and younger patients seem to make it through inpatient landmarks easier with less complications.

From my point of view after having a rather large number of these cases in my recent practice career, these findings are intuitive. I believe the overall perspective of this patient treatment paradigm will be of value for the practicing surgeon.

The authors are grateful to Reviewer 2 for their comments and their support for publication of the manuscript within JBJS.
Quality of care in hip fracture patients – does compliance to national standards relate to improved outcomes?

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Keywords: Hip fracture; neck of femur; clinical standards; outcome; multidisciplinary; Scottish National Hip Fracture Audit; management guidelines

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1 Quality of care in hip fracture patients - does compliance to national standards relate to improved outcomes?
Abstract

Background
Optimising the perioperative care of patients with a hip fracture is a key healthcare priority. We aim to determine if adherence to the Scottish Standards of Care for Hip Fracture Patients (SSCHFP) is associated with improved patient outcome.

Methods
Retrospective cohort study of prospectively collected data from the Scottish National Hip Fracture Audit. We assessed adherence to the SSCHFP in twenty-one Scottish hospitals over a 9-month period in 2014, and examined the effect of the guidelines on 30- and 120-day mortality, length of hospital stay, and discharge destination.

Results
A total of 1,162 patients aged over 50 years and admitted with a hip fracture were included. There was a significant association between low adherence to SSCHFP and increased mortality at 30 and 120 days (OR 3.58, 95% CI 1.75 to 7.32, p<0.001 and OR 2.01, 95% CI 1.28 to 3.12, p=0.003). Low adherence was associated with a reduced likelihood of short length of stay (OR 0.58, 95% CI 0.42 to 0.78, p<0.001), but an increased odds of discharge to a high-care setting (OR 1.63, 95% CI 1.12 to 2.36, p<0.01). Early Physiotherapy and Occupational Therapy input was associated with a reduced likelihood of discharge to a high-care setting (OR 0.64, 95% CI 0.44 to 0.98, p=0.04 and OR 0.34, 95% CI 0.23 to 0.48, p=<0.001 respectively).

Conclusions
Adherence to Scottish Standards of Care for Hip Fracture Patients is associated with better patient outcomes. These findings confirm the clinical utility of the SSCHFP and support their use as a benchmarking tool to improve quality of care in hip fracture.
Level of evidence

Level III: retrospective cohort study (therapeutic – investigating the results of a treatment).
Introduction

Despite advances in the perioperative management of hip fractures, and greater understanding of the causes of mortality and morbidity associated with hip fracture\textsuperscript{1-4}, mortality rates have remained static for four decades\textsuperscript{5}. By implementing the Scottish Standards of Care for Hip Fracture Patients (SSCHFP), Scotland became the first country to have a nationally-agreed, evidence-based collection of care standards to ensure a consistently high level of care in hip fracture\textsuperscript{1}.

Despite implementation of the SSCHFP in 2014, there are no data assessing the effect of the standards on patient outcomes. Previous studies of the UK National Hip Fracture Database demonstrated an association between national audit, guidelines, and reduction in mortality, however this is through indirect methods only\textsuperscript{2}.

The study aimed to: (1) determine which care standards are associated significantly with outcomes; (2) ascertain whether cumulative attainment of the standards is predictive of favourable outcome.

Materials and Methods

A retrospective analysis of prospective cohort data was undertaken utilising anonymised audit data that had been collected prospectively by the Scottish MSk Orthopaedics Quality Drive\textsuperscript{3} on behalf of Health Improvement Scotland (HIS), a monitoring subsidiary of the Scottish Department of Health. Data were collected by local audit coordinators who were employed by the individual hospitals and given the role of collecting prospective audit data which could be used for quality improvement and research purposes as part of the Scottish Hip Fracture Audit framework \textsuperscript{4}.
These data have been used by the Scottish Government as annual trend reporting of hospital-specific data, and audit data collection methods have been previously published.\textsuperscript{5-8}.

The study hypothesis was derived by the authors without prior knowledge of (or access to) the data, and the authors had no role in recruitment of patients.

At the time of audit the SSCHFP\textsuperscript{6} contained six groups of care standards relating to preoperative, perioperative, and postoperative care (Appendix A). We derived 12 individual standards which are measurable reliably from these six groups as detailed below. The SSCHFP were rolled out concomitantly with the start of the audit process. The data included all hip fracture patients (aged over 50 years) admitted to any of the twenty-one participating Scottish hospitals on a ‘one week in four’ basis (i.e. recruiting a quarter of all patients) from January-September 2014, who were followed up for 120 days following admission. Hip fracture cases were identified prospectively and data were collected from medical notes, patient information, results reporting, referral management, and admission tracking systems.

Descriptions of the demographic and outcome variables, and potential confounding co-variates are shown in Table 1.

At the individual patient level, each care standard (CS) was categorised as being either achieved (yes; score 1) or not achieved (no; score 0). Total Care Score (TCS) equates to the sum of the CS values for each patient.

The criteria for meeting each care standard were:

1. Time spent in ED < 2 hours;
2. Analgesia offered in ED;
3. ED ‘Big Six’ bundle completed: analgesia, vital signs, fluid optimisation, laboratory
   bloods, cognition assessment, pressure area assessment;
4. Inpatient assessment bundle completed within 24 hours: falls risk, nutrition,
   cognition, and pressure area assessment;
5. Comprehensive Geriatric Assessment within 48 hours;
6. Fasting for food not > 10 hours;
7. Fasting for fluids not > 4 hours;
8. Surgery within 48 hours if medically fit;
9. No routine urinary catheterisation;
10. Physiotherapy by first postoperative day;
11. Occupational Therapy by third postoperative day;
12. Discharge planning commenced within 48 hours.

There was a potential score range from 0-12, however because no patient received a TCS > 9,
results were present for the range 1-9. Scores were stratified into low-, moderate-, and high-
adherence categories with cut-off points that ensured reasonable proportions based on
frequency distribution of the sample: TCS 1-4 (Category 1 – low adherence); TCS 5-6
(Category 2 – moderate adherence); TCS ≥7 (Category 3 – high adherence).

The number of men and women who met each CS was calculated and compared using Chi-
squared test. Using bivariate logistic regression, odds ratios for the outcomes of 30- & 120-
day mortality, dichotomised length of stay in an acute orthopaedic unit (less than median
versus greater than median), and discharge destination were calculated for each CS and also
potential confounders (age, sex, and type of residence prior to admission). A multiple
regression model was then used to assess the same variables using a forward selection model with a cut-off value of p<0.10. In order to avoid overfit a maximum of 3 and 5 variables were selected for the outcomes of 30- & 120-day mortality, respectively. In the circumstance of having eligible variables in excess of those allowed, then variables with the lowest p-values on bivariate regression were selected. When two or more variables had the same p-value then those with the largest effect size were chosen. All logistic regression results are presented as OR with 95% confidence interval (CI).

Demographic and outcome data were assessed across the TCS categories through the use of Chi-squared analysis. The TCS categories were also used to determine odds ratios (OR) and 95% CI for outcome data comparing those with a low TCS (category 1; TCS≤4) with the reference category (category 2 & 3 combined; TCS ≥5). Values were adjusted for age, sex, and residence prior to admission.

Statistical analysis was carried out using SPSS for Windows (version 24.0, SPSS Inc.). P-values were set at a two-sided <0.05 significance level in all analyses. All data missing were assumed to be random as preliminary data checks demonstrated negligible differences in characteristics between patients with complete and missing data.

Our study was conducted in accordance with the 1964 Helsinki declaration and its later amendments. Approval was obtained from the governing body, NHS National Services. The study complied with the Caldicott principles – the data guardianship regulations governing the use of patient data in the United Kingdom. Given the nature of the study, ethical approval was not required. We attest that we have obtained appropriate permissions and paid any required fees for use of copyright protected materials.
Source of Funding: There was no external funding source for the study.

Results

1,162 patients (72.9% female) with hip fracture were identified and included in the data collection. The data captured 98% of eligible subjects. Follow-up data to 120 days post-admission were available for 99%, though a small number were lost to audit when transferred to other areas. The most frequent age group was 80-84 years (21.8%) with significantly lower proportions of males than females over 75 years (73.0% vs 78.4%, p=0.05).

Results for comparison of sample characteristics for those receiving optimum versus sub-optimum care according to the Scottish Standards of Care for Hip Fracture Patients are shown in Table 1. There was a significantly higher proportion of women who: underwent perioperative urinary catheterisation; had oral fluids withheld for >4 hours, and received OT input by end of the third postoperative day.

Results of bivariate logistic regression analysis demonstrated that absence of urinary catheterisation, OT input by the end of the third postoperative day, younger age, and a pre-admission residence of home/sheltered housing (FROMHome) were associated significantly with a lower risk of mortality at 30 (MORT30) and 120 days (MORT120). Female sex was also associated with a significantly lower risk of MORT120. The completion of all inpatient assessment bundles within 24 hours of admission, geriatrician input within 48 hours, absence of catheterisation, and younger age were all associated with a significantly greater likelihood of a short length of stay (LOS_short) i.e. an acute orthopaedic LOS less than the median LOS. FROMHome was associated with an acute orthopaedic LOS that was significantly longer
than the median LOS ($\text{LOS}_{\text{Long}}$). Care variables associated with a significantly higher chance of discharge to a high care destination (destination other than home/sheltered housing; $\text{DEST}_{\text{other}}$) included: discharge planning within 48 hours; completion of the ED Big Six bundle, and geriatrician input within 48 hours. Care variables associated with a significantly higher likelihood of discharge to a low care destination (home/sheltered housing; $\text{DEST}_{\text{home}}$) included: time in ED <2 hours; PT input by the first postoperative day; OT input by the third postoperative day; fasting for fluids not > 4 hours, absence of catheterisation, and younger age. Full results of this analysis are shown in Table 2.

Results of the forward selection multiple logistic regression demonstrated that two variables were associated significantly with a greater odds of reduced MORT$_{30}$: OT input by the end of the third postoperative day, and younger age. These associations were similar for MORT$_{120}$, with the addition of a reduced risk of death in patients admitted FROM$_{\text{Home}}$, those not undergoing urinary catheterisation, female sex, and younger age. Outcomes associated with a significantly greater likelihood of a LOS$_{\text{short}}$ included: absence of catheterisation, and younger age. FROM$_{\text{Home}}$ was associated with a significantly increased likelihood of LOS$_{\text{Long}}$. Only one care standard was associated with a significantly greater odds of discharge to $\text{DEST}_{\text{other}}$: Commencement of discharge planning within 48 hours of admission. PT and OT input by the first and third postoperative days respectively, absence of urinary catheterisation, younger age, and fasting for fluids not > 4 hours were associated with a significantly higher likelihood of discharge $\text{DEST}_{\text{home}}$. Details of these results are shown in Table 2.
Comparison of patient characteristics and outcome across categories of Total Care Score (TCS) revealed significant differences in age, pre-admission residence, survival at 30- and 120-days, discharge destination, and length of stay (Table 3).

Low TCS was associated with a significantly increased MORT$_{30}$ and MORT$_{120}$ (OR 3.58, 95% CI 1.75 to 7.32, p<0.0001 & OR 2.01, 95% CI 1.28 to 3.12, p=0.003 respectively), and a significantly lower probability of LOS$_{short}$ (OR 0.58, 95% CI 0.42 to 0.78, p<0.0001). Low TCS was also associated significantly with an increased likelihood of DEST$_{other}$ (OR 1.63, 95% CI 1.12 to 2.36, p<0.01) (Table 4).

Discussion

Hip fracture is an important source of morbidity and mortality, with a threefold higher age- and sex-standardised mortality rate compared to that of the general population\textsuperscript{9}. The incidence of hip fracture is rising due to the ageing population\textsuperscript{10}, placing increasing pressures on healthcare systems. The Scottish Standards of Care for Hip Fracture Patients (SSCHFP) were introduced in 2014 to ensure a consistently high standard of care across all hospitals managing hip fracture.

This study found a significant association between cumulative attainment of the SSCHFP and reduced 30- & 120-day mortality, increased likelihood of a short length of admission, and higher probability of discharge to a destination equivalent to the pre-fracture level of care. Analysis of individual care variables through multiple regression indicates that the impact of the standards as a whole is greater than the sum of the parts, and highlights the importance of a multidisciplinary team approach to the care of hip fracture patients.
The association between prompt physiotherapy and greater likelihood of discharge to a favourable destination highlights the importance of early mobilisation of patients to reduce the requirement for further care in a rehabilitation unit.

Adherence to the SSCHFP was reasonably good, with the exception of fluid and food fasting times (both of which are associated with increased post-operative mortality\textsuperscript{11}), and the Emergency Department Big Six bundle (completion of which was achieved in only 10.1\%, which represents an area deserving of further research).

The demographic characteristics of the patients captured were consistent with expected patterns of hip fracture in the U.K., and with the findings of similar studies\textsuperscript{3,12,13}, making these findings relevant and generalisable. A number of factors which predict hip fracture mortality have previously been described in the literature, including: patient age; ASA grade; pre-fracture mobility; gender, and hip fracture type\textsuperscript{7,14}. Unfortunately, these variables are non-modifiable and therefore cannot be altered by medical interventions. Previous studies related to the U.K. National Hip Fracture Database have demonstrated an association between national audit, management guidelines, and reduction in mortality, however these data were obtained through indirect methods\textsuperscript{2}.

Our finding that cumulative attainment of care standards confers a clinical benefit that is greater than the sum of its parts reflects an increasing recognition of the importance of ‘marginal gains’ in healthcare, and the involvement of a multidisciplinary team of specialists is the clinical manifestation of this philosophy. The importance of
geriatrician input in the management of complex elderly hip fracture patients supports the findings of previous studies\textsuperscript{15, 16}. Absence of urinary catheterisation was associated significantly with improved outcomes, and although catheterisation is often a marker of frailty, previous evidence supports avoidance of its routine use in hip fracture\textsuperscript{17-20}. There are a number of strengths to this study. To our knowledge, it is the only direct assessment of a set of nationally-agreed clinical standards for hip fracture management with respect to patient outcome measures. Although this study is observational, it is unlikely that randomized controlled trials would be a suitable means of assessing these care quality and outcome relationships, and any such attempt is unlikely to be sufficiently inclusive to be generalisable to a real-world population. This study therefore represents the best available evidence in this setting. The prospective collection of data avoids the bias of case ascertainment associated with most retrospective cohort or case-control studies. Compliance to care standards was determined by auditors performing data collection and not by the study authors. These individuals were independent of our research group and were working within the framework of a national health institution with the purpose of improving the quality of care provided to patients. The follow-up rate was high (92\%) ensuring fair capture of all outcomes; data collection was at individual patient level, and the case-by-case recruitment method limited inaccuracies. The study cohort was recruited nationally across 21 hospitals, thus our findings are representative of the general population and are applicable to other populations with similar demographics. The study highlights areas of interest for future research, such as the role of the individual ED interventions, and the effects of prolonged fasting on recovery and outcome. Since we reported care standard and outcome relationship, the findings are likely to be generalisable and applicable to global populations.
We were unable to control for any known or unknown confounders due to the retrospective nature of the analysis. The type of data collection also means that inferences from the study can only be interpreted on a national level. **Further prospective studies are required to** better understand and gain deeper insight into the impact of case-mix and individual patient level prognostic factors, including pre-admission performance status and specific details pertaining to operative management. This approach will allow to **estimate the effects of the SSCHFP on an individual patient level.** The assessment of the impact of care standards on patient outcome has significant policy implications. **This study provides useful initial data pertaining to the effects of the SSCHFP on patient outcome.** Further research is required in order to confirm our findings in an independent dataset prior to internal and external validation.

**Cumulative attainment of the Scottish Standards of Care for Hip Fracture Patients is associated with better patient outcomes.** The higher level of compliance to the care standards was associated with lower mortality at 30 and 120 days, shorter length of acute orthopaedic admission, and a greater probability of discharged to a destination equivalent to the pre-fracture level of care. Furthermore, a multidisciplinary approach to care, with early geriatrician and allied health professional involvement, was associated with favourable outcomes.

**Our findings provide the best evidence currently available to clinicians, service commissioners, and healthcare improvement agencies that the SSCHFP are clinically beneficial and represent a benchmark by which to organize the optimal management of hip fracture patients globally.**
References

1. Scottish Standards of Care for Hip Fracture Patients. 2014. 05/02/2017. Available from: 


4. SHFA Audit Guidelines and Definitions. 2016. Available from: 


Acknowledgements

The authors acknowledge the contribution of Jane Campbell to the creation of the above manuscript through her work in the delivery of the Scottish national hip fracture audit.

Disclosure

"Competing interests: All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work."

The lead author affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.
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<th>Optimum care</th>
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<td>Discharge planning within 48 hours from admission</td>
<td>239 (20.7)</td>
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<td>Time in ED &lt;2 hours</td>
<td>165 (16.2)</td>
<td>116 (15.4)</td>
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<td>Analgesia given in ED</td>
<td>956 (94.1)</td>
<td>706 (94.3)</td>
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<td>All six of big six ED bundle complete*</td>
<td>103 (10.1)</td>
<td>79 (10.6)</td>
<td>913 (89.9)</td>
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<td>All inpatient assessment bundle complete within 24 hours**</td>
<td>686 (59.9)</td>
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<td>Geriatric input within 48 hours from admission</td>
<td>276 (26.6)</td>
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<td>Period of pre-operative fasting ≤10 hours</td>
<td>277 (24.7)</td>
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<td>PT review by end of first post-operative day</td>
<td>779 (69.3)</td>
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<td>No catheterisation</td>
<td>453 (40.3)</td>
<td>315 (38.2)</td>
<td>672 (59.7)</td>
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<td>Time to theatre within 48 hours of admission</td>
<td>919 (89.8)</td>
<td>680 (89.7)</td>
<td>104 (10.2)</td>
</tr>
<tr>
<td>Length oral fluids withheld pre-operatively &lt;4 hours</td>
<td>216 (19.4)</td>
<td>161 (19.9)</td>
<td>896 (80.6)</td>
</tr>
<tr>
<td>OT review by end of third post-operative day</td>
<td>467 (42.3)</td>
<td>358 (44.4)</td>
<td>638 (57.7)</td>
</tr>
</tbody>
</table>

Number presented are N(%) for categorical variables. * Big six ED bundle includes: Analgesia given; blood tests performed; optimisation of fluid balance; pressure area assessment; vital signs recorded and delirium screening. ** Inpatient assessment bundle includes: formal cognitive assessment; fluid, food and nutrition assessment; pressure area assessment (Waterlow scoring); falls risk assessment; MDT care.
Table 2 – Bivariate outcome data for those receiving each care standard compared with not receiving the same care, including confounders (1st column) and then multiple regression of forward selected variables (2nd column)

<table>
<thead>
<tr>
<th></th>
<th>30-day mortality</th>
<th>120-day mortality</th>
<th>Acute Orthopaedic length of stay below median</th>
<th>Discharge destination not home/sheltered</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Column 1</td>
<td>Column 2</td>
<td>Column 1</td>
<td>Column 2</td>
</tr>
<tr>
<td>BR OR (95% CI) p-value</td>
<td>0.71 (0.39 to 1.27)</td>
<td>0.25</td>
<td>0.76 (0.50 to 1.13)</td>
<td>0.18</td>
</tr>
<tr>
<td>Discharge planning within 48 hours from admission</td>
<td>0.67 (0.33 to 1.38)</td>
<td>0.28</td>
<td>0.88 (0.54 to 1.41)</td>
<td>0.60</td>
</tr>
<tr>
<td>Time in ED &lt;2 hours</td>
<td>0.72 (0.30 to 1.73)</td>
<td>0.47</td>
<td>0.81 (0.41 to 1.60)</td>
<td>0.54</td>
</tr>
<tr>
<td>Analgesia given in ED</td>
<td>1.05 (0.49 to 2.26)</td>
<td>0.90</td>
<td>0.79 (0.43 to 1.45)</td>
<td>0.44</td>
</tr>
<tr>
<td>All six of big six ED bundle complete*</td>
<td>0.87 (0.62 to 1.50)</td>
<td>0.87</td>
<td>1.10 (0.80 to 1.51)</td>
<td>0.57</td>
</tr>
<tr>
<td>All inpatient assessment bundle complete within 24 hours**</td>
<td>0.70 (0.40 to 1.23)</td>
<td>0.22</td>
<td>0.92 (0.64 to 1.33)</td>
<td>0.66</td>
</tr>
<tr>
<td>Geriatric input within 48 hours from admission</td>
<td>0.19 (0.70 to 2.04)</td>
<td>0.52</td>
<td>1.30 (0.90 to 1.87)</td>
<td>0.16</td>
</tr>
<tr>
<td>Period of pre-operative fasting ≤ 10 hours</td>
<td>0.68 (0.41 to 1.10)</td>
<td>0.12</td>
<td>0.74 (0.53 to 1.04)</td>
<td>0.09</td>
</tr>
<tr>
<td>PT review by end of first post-operative day</td>
<td>0.71 (0.39 to 1.27)</td>
<td>0.25</td>
<td>0.76 (0.50 to 1.13)</td>
<td>0.18</td>
</tr>
<tr>
<td>Factor</td>
<td>OR (95% CI)</td>
<td>p</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------------------------------------------------------------</td>
<td>---------------</td>
<td>-------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absence of Catheterisation</td>
<td>0.54 (0.32 to 0.92)</td>
<td>&lt;0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time to theatre within 48 hours of admission</td>
<td>0.86 (0.38 to 1.94)</td>
<td>0.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length oral fluids withheld pre-operatively &lt;4 hours</td>
<td>0.51 (0.24 to 1.08)</td>
<td>0.005</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OT review by end of third post-operative day</td>
<td>0.26 (0.14 to 0.50)</td>
<td>&lt;0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Younger age</td>
<td>0.71 (0.48 to 1.21)</td>
<td>&lt;0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residence prior to admission = Home/Sheltered</td>
<td>0.56 (0.35 to 0.92)</td>
<td>&lt;0.001</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

BR = Bivariate regression, MR = Multiple regression; OR = Odds ratio; 95% CI = 95% Confidence interval. Discharge destination = discharge destination from acute orthopaedic unit: Home/Sheltered housing vs. other (e.g. further rehab, NHS continuing care). * Big six ED bundle includes: Analgesia given; blood tests performed; optimisation of fluid balance; pressure area assessment; vital signs recorded and delirium screening. ** Inpatient assessment bundle includes: formal cognitive assessment; fluid, food and nutrition assessment; pressure area assessment (Waterlow scoring); falls risk assessment; MDT care.
### Table 3 - Comparison of characteristics of patients and outcome categories across total care variable score (TCS) categories in the Scottish National Hip Fracture Audit (year 2014-2015)

<table>
<thead>
<tr>
<th>TCS Score</th>
<th>1-4 N= (%)</th>
<th>5-6 N= (%)</th>
<th>≥7 N= (%)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;75</td>
<td>51 (35)</td>
<td>73 (50)</td>
<td>21 (15)</td>
<td><strong>0.002</strong></td>
</tr>
<tr>
<td>75-84</td>
<td>110 (38)</td>
<td>149 (52)</td>
<td>28 (10)</td>
<td></td>
</tr>
<tr>
<td>≥85</td>
<td>163 (51)</td>
<td>129 (41)</td>
<td>26 (8)</td>
<td></td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>77 (40)</td>
<td>100 (52)</td>
<td>16 (8)</td>
<td>0.25</td>
</tr>
<tr>
<td>Female</td>
<td>247 (44)</td>
<td>251 (45)</td>
<td>59 (11)</td>
<td></td>
</tr>
<tr>
<td><strong>Weekday admission?</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>205 (45)</td>
<td>213 (47)</td>
<td>37 (8)</td>
<td>0.84</td>
</tr>
<tr>
<td>No</td>
<td>119 (40)</td>
<td>138 (47)</td>
<td>38 (13)</td>
<td></td>
</tr>
<tr>
<td><strong>Pre-fracture residence</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home/Sheltered</td>
<td>228 (40)</td>
<td>283 (49)</td>
<td>66 (11)</td>
<td><strong>0.0001</strong></td>
</tr>
<tr>
<td>Other</td>
<td>93 (56)</td>
<td>64 (39)</td>
<td>8 (5)</td>
<td></td>
</tr>
<tr>
<td><strong>Alive at 30 days post admission</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>33 (72)</td>
<td>12 (26)</td>
<td>1 (2)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Yes</td>
<td>287 (41)</td>
<td>337 (49)</td>
<td>70 (10)</td>
<td></td>
</tr>
<tr>
<td><strong>Alive at 120 days post admission</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>61 (60)</td>
<td>36 (36)</td>
<td>4 (4)</td>
<td><strong>0.001</strong></td>
</tr>
<tr>
<td>Yes</td>
<td>259 (41)</td>
<td>313 (49)</td>
<td>67 (10)</td>
<td></td>
</tr>
<tr>
<td><strong>Discharge level of care</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home/Sheltered</td>
<td>229 (48)</td>
<td>207 (43)</td>
<td>46 (9)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Other</td>
<td>71 (30)</td>
<td>136 (58)</td>
<td>28 (12)</td>
<td></td>
</tr>
<tr>
<td><strong>Length of stay in acute care</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below median</td>
<td>143 (38)</td>
<td>189 (50)</td>
<td>48 (12)</td>
<td><strong>0.002</strong></td>
</tr>
<tr>
<td>Above median</td>
<td>181 (49)</td>
<td>162 (44)</td>
<td>27 (7)</td>
<td></td>
</tr>
<tr>
<td><strong>Length of stay in Hospital</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below median</td>
<td>157 (39)</td>
<td>204 (51)</td>
<td>41 (10)</td>
<td><strong>0.04</strong></td>
</tr>
<tr>
<td>Above median</td>
<td>167 (48)</td>
<td>147 (42)</td>
<td>34 (10)</td>
<td></td>
</tr>
</tbody>
</table>
**Table 4 – Adjusted odds ratios and corresponding 95% CI for each selected outcome for low total care variable score (TCS) category (TCS 1-4) compared with categories 2 & 3 (TCS ≥5) (reference category)**

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Odds ratio</th>
<th>95% CI</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 day mortality</td>
<td>3.58</td>
<td>1.75 to 7.32</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>120 day mortality</td>
<td>2.01</td>
<td>1.28 to 3.12</td>
<td>0.003</td>
</tr>
<tr>
<td>Length of acute orthopaedic stay (LOS)</td>
<td>0.58</td>
<td>0.42 to 0.78</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>shorter than median</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discharge destination not Home/Sheltered</td>
<td>1.63</td>
<td>1.12 to 2.36</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Values adjusted for age, sex and location of residence prior to admission.
CME Questions Submission Form

Enter all questions on this form. A total of 3 multiple-choice questions are required. Please review the Guidelines for Creation of CME Questions in the Author Resource Center section of the JBJS website before submitting your questions.

Manuscript number: JBJS-D-17-00884
Article title: Quality of care in hip fracture patients - does compliance to national standards relate to improved outcomes?

Question 1

I. Does this question have an associated image or images?
☐ Yes ☒ No

(If YES – upload image(s) separately using the “CME Question Figure” item option in the Attach Files screen of Editorial Manager. Include a one to two sentence description of each figure here. All figures should be at least 5x7 inches with a resolution of 300 ppi.)

II. Question: (A patient-care scenario is preferred when appropriate; see Guidelines link above)

Increased compliance to the Scottish Standards of Care for Hip Fracture Patients (SSCHFP) was associated with which improved outcomes?

III. Options: (In alphabetical or logical order. Please do not use “all of the above” or “none of the above” as potential answer choices.)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>Improved 30 &amp; 120 day mortality</td>
</tr>
<tr>
<td>B.</td>
<td>Improved 120 day mortality and reduced length of stay</td>
</tr>
<tr>
<td>C.</td>
<td>Reduced length of stay and lower likelihood of discharge to a high care destination</td>
</tr>
<tr>
<td>D.</td>
<td>Improved 30 day mortality, reduced length of stay and lower likelihood of discharge to a high care destination</td>
</tr>
<tr>
<td>E.</td>
<td>Improved 30 &amp; 120 day mortality, reduced length of stay and lower likelihood of discharge to a high care destination</td>
</tr>
</tbody>
</table>

IV. Answer: (must be clearly the best of the options)
V. Correct Answer Location: Please identify the manuscript section where the correct answer is located (e.g. “Results” or “Discussion”)

☑️ E.

VI. Supporting Statement: Please include one sentence from the section identified above supporting the correct answer.

Results Paragraph 1

We found a significant association between cumulative attainment of the Scottish Standards of Care for Hip Fracture Patients (SSCHFP) and reduced MORT\textsubscript{30} & MORT\textsubscript{120}, increased likelihood of LOS\textsubscript{short}, and lower probability of discharge DEST\textsubscript{other}
Question 2

V. Does this question have an associated image or images?

☐ Yes  ☒ No

(If YES – upload image(s) separately using the “CME Question Figure” item option in the Attach Files screen of Editorial Manager. Include a one to two sentence description of each figure here. All figures should be at least 5x7 inches with a resolution of 300 ppi.)

VI. Question: (A patient-care scenario is preferred when appropriate; see Guidelines link above)

Prompt post-operative physiotherapy was associated with which improved outcome?

VII. Options: (In alphabetical or logical order. Please do not use “all of the above” or “none of the above” as potential answer choices.)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>Reduced 30 day mortality</td>
</tr>
<tr>
<td>B.</td>
<td>Reduced 120 day mortality</td>
</tr>
<tr>
<td>C.</td>
<td>Shorter length of acute orthopaedic stay</td>
</tr>
<tr>
<td>D.</td>
<td>Increased chance of discharge to home or sheltered accomodation</td>
</tr>
<tr>
<td>E.</td>
<td></td>
</tr>
</tbody>
</table>

VIII. Answer: (must be clearly the best of the options)

☐ A.  ☐ B.  ☐ C.  ☒ D.  ☐ E.

V. Correct Answer Location: Please identify the manuscript section where the correct answer is located (e.g. “Results” or “Discussion”)

Discussion paragraph 3

VI. Supporting Statement: Please include one sentence from the section identified above supporting the correct answer.

The link between prompt physiotherapy and greater likelihood of a better discharge destination highlights the importance of early mobilisation of patients to reduce chance of needing further care in a rehabilitation unit
Question 3

IX. Does this question have an associated image or images?
☐ Yes ☒ No

(If YES – upload image(s) separately using the “CME Question Figure” item option in the Attach Files screen of Editorial Manager. Include a one to two sentence description of each figure here. All figures should be at least 5x7 inches with a resolution of 300 ppi.)

X. Question: (A patient-care scenario is preferred when appropriate; see Guidelines link above)

Which of the 12 assessed Scottish Standards of Care for Hip Fracture Patients had the poorest compliance?

XI. Options: (In alphabetical or logical order. Please do not use “all of the above” or “none of the above” as potential answer choices.)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>Discharge planning within 48 hours from admission</td>
</tr>
<tr>
<td>B.</td>
<td>Geriatric input within 48 hours from admission</td>
</tr>
<tr>
<td>C.</td>
<td>All six of big six ED bundle complete</td>
</tr>
<tr>
<td>D.</td>
<td>Time to theatre within 48 hours of admission</td>
</tr>
<tr>
<td>E.</td>
<td>Length oral fluids withheld pre-operatively &lt;4 hours</td>
</tr>
</tbody>
</table>

XII. Answer: (must be clearly the best of the options)

☐ A. ☐ B. ☒ C. ☐ D. ☐ E.

V. Correct Answer Location: Please identify the manuscript section where the correct answer is located (e.g. “Results” or “Discussion”)

Table 1

VI. Supporting Statement: Please include one sentence from the section identified above supporting the correct answer.

Total receiving optimum care for all six of big six ED bundle complete = 10.1%
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- Is your study a clinical trial of an investigational medicinal product?
- Is your study one or more of the following: A non-CE marked medical device, or a device which has been modified or is being used outside of its CE mark intended purpose, and the study is conducted by or with the support of the manufacturer or another commercial company (including university spin-out company) to provide data for CE marking purposes?
- Does your study involve exposure to any ionising radiation?
- Does your study involve the processing of disclosable protected information on the Register of the Human Fertilisation and Embryology Authority by researchers, without consent?
- Is your study a clinical trial involving the participation of practising midwives?

**Question Set 2**

- Will your study involve research participants identified from, or because of their past or present use of services (adult and children's healthcare within the NHS), for which the UK health departments are responsible (including services provided under contract with the private or voluntary sectors), including participants recruited through these services as healthy controls?
• Will your research involve collection of tissue or information from any users of these services (adult and children's healthcare within the NHS)? This may include users who have died within the last 100 years.
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Question Set 3

• Does your research involve recruiting adults who lack capacity to consent for themselves, including participants retained in study following the loss of capacity?
• Will your research involve whole organs retained from a post mortem examination carried out on the instructions of the Procurator Fiscal?
• Will your research involve the analysis of DNA from bodily material, collected on or after 1st September 2006, and this analysis is not within the terms of consent for research from the donor?

Question Set 4

• Is your research health-related and involving prisoners?
• Does your research involve xenotransplantation?
• Is your research a social care project funded by the Department of Health (England)?

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# STROBE Statement—checklist of items that should be included in reports of observational studies

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<td>(a) Indicate the study’s design with a commonly used term in the title or the abstract</td>
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<td>(b) Provide in the abstract an informative and balanced summary of what was done and what was found</td>
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<td><strong>Introduction</strong></td>
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<td>Present key elements of study design early in the paper</td>
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<td>Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection</td>
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<td>6</td>
<td>(a) Cohort study—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up. Case-control study—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls. Cross-sectional study—Give the eligibility criteria, and the sources and methods of selection of participants.</td>
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<td>(b) Cohort study—For matched studies, give matching criteria and number of exposed and unexposed. Case-control study—For matched studies, give matching criteria and the number of controls per case</td>
<td>N/A</td>
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<td>Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable</td>
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<td>For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group</td>
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<td>Describe any efforts to address potential sources of bias</td>
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Continued on next page
### Quantitative variables

Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why.

### Statistical methods

- *(a)* Describe all statistical methods, including those used to control for confounding.
- *(b)* Describe any methods used to examine subgroups and interactions.
- *(c)* Explain how missing data were addressed.
- *(d)* **Cohort study**—If applicable, explain how loss to follow-up was addressed.
- **Case-control study**—If applicable, explain how matching of cases and controls was addressed.
- **Cross-sectional study**—If applicable, describe analytical methods taking account of sampling strategy.

- *(e)* Describe any sensitivity analyses.

### Results

#### Participants

- *(a)* Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed.
- *(b)* Give reasons for non-participation at each stage.

© Consider use of a flow diagram.

#### Descriptive data

- *(a)* Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders.
- *(b)* Indicate number of participants with missing data for each variable of interest.
- *(c)* **Cohort study**—Summarise follow-up time (eg, average and total amount).

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#### Outcome data

- **Cohort study**—Report numbers of outcome events or summary measures over time.
- **Case-control study**—Report numbers in each exposure category, or summary measures of exposure.
- **Cross-sectional study**—Report numbers of outcome events or summary measures.

#### Main results

- *(a)* Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included.
- *(b)* Report category boundaries when continuous variables were categorized.
- *(c)* If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period.

Continued on next page
Other analyses 17 Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses

Discussion

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Other information

| Funding 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | N/A |

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.