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REPORTS OF ORIGINAL INVESTIGATIONS

# Epidural analgesia does not increase the rate of inpatient falls after major upper abdominal and thoracic surgery: a retrospective case-control study

# L'analgésie péridurale n'augmente pas le taux de chutes parmi les patients hospitalisés après une chirurgie abdominale haute ou une chirurgie thoracique majeure: une étude cas-témoin rétrospective

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## Abstract

**Purpose** *Postoperative epidural analgesia for major upper abdominal and thoracic surgery can provide significant benefits, including superior analgesia and reduced pulmonary dysfunction. Nevertheless, epidural analgesia may also be associated with decreased muscle strength, sympathetic tone, and proprioception that could possibly contribute to falls. The purpose of this retrospective case-control study was to search a large national database in order to investigate the possible relationship between postoperative epidural analgesia and the rate of inpatient falls.*

**Methods** *Data from the nationwide inpatient sample for 2007-2011 were queried for adult patients who underwent elective major upper abdominal and thoracic surgery. Multiple International Classification of Diseases, Ninth Revision, Clinical Modification codes for inpatient falls and accidents were combined into one binary variable. Univariate analyses were used for initial statistical analysis. Logistic regression analyses and McNemar's tests were subsequently used to investigate the association of epidural analgesia with inpatient falls in a 1:1 case-control propensity-matched sample after adjustment of patients' demographics, comorbidities, and hospital characteristics.*

**Results** *Forty-two thousand six hundred fifty-eight thoracic and 54,974 upper abdominal surgical procedures were identified. The overall incidence of inpatient falls in the thoracic surgery group was 6.54% with an increasing trend over the study period from 4.95% in 2007 to 8.11% in 2011 ($P < 0.001$). Similarly, the overall incidence of inpatient falls in the upper abdominal surgery group was 5.30% with an increasing trend from 4.55% in 2007 to 6.07% in 2011 ($P < 0.001$). Postoperative epidural analgesia was not associated with an increased risk for postoperative inpatient falls in the thoracic surgery group (relative risk [RR], 1.18; 95% confidence interval [CI], 0.95 to 1.47; $P = 0.144$) and in the upper abdominal surgery group (RR, 0.84; 95% CI 0.64 to 1.09; $P = 0.220$). Inpatient falls compared with non-falls were associated with a longer median (interquartile range) length of hospital stay in both the thoracic surgery group (11 [7-17] days vs 9 [6-16] days, respectively; $P < 0.001$) and the upper abdominal surgery group (12 [7-20] days vs 10 [6-17] days, respectively; $P < 0.001$).*

**Conclusion** *Our study suggests that postoperative epidural analgesia for patients undergoing major upper abdominal and thoracic surgery is not associated with an increased risk of inpatient falls.*

## Résumé

**Objectif** *L'analgésie péridurale postopératoire pour les chirurgies abdominales hautes et thoraciques majeures peut procurer des bienfaits importants, notamment une analgésie supérieure et une réduction de la dysfonction*

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*pulmonaire. Toutefois, l'analgésie péridurale peut également être associée à une réduction de la force musculaire, du tonus sympathique et de la proprioception – des facteurs pouvant contribuer à des chutes. L'objectif de cette étude cas-témoin rétrospective était d'analyser une importante base de données nationale afin d'évaluer la relation possible entre une analgésie péridurale postopératoire et le taux de chute des patients hospitalisés.*

**Méthode** *Les données d'un échantillon de patients hospitalisés à l'échelle nationale entre 2007 et 2011 ont été extraites pour les patients adultes ayant subi une chirurgie abdominale haute ou une chirurgie thoracique majeure non urgente. Plusieurs codes de modification clinique de la Classification internationale des maladies, 9e édition concernant les chutes et accidents des patients hospitalisés ont été combinés en une variable binaire. On a utilisé des analyses univariées pour l'analyse statistique initiale. Les analyses de régression logistique et des tests de McNemar ont été utilisés par la suite pour examiner l'association entre l'analgésie péridurale et les chutes de patients hospitalisés dans un échantillon cas-témoin apparié (1 :1) sur le score de propension après ajustement pour tenir compte des données démographiques, des comorbidités et des caractéristiques hospitalières des patients.*

**Résultats** *Au total, 42 658 chirurgies thoraciques et 54 974 chirurgies abdominales hautes ont été identifiées. Dans le groupe chirurgie thoracique, l'incidence globale de chutes de patients hospitalisés était de 6,54 %; de plus, une tendance croissante a été observée au cours de la période à l'étude, soit de 4,95 % en 2007 à 8,11 % en 2011 ($P < 0,001$). De la même manière, dans le groupe chirurgie abdominale haute, l'incidence globale de chutes de patients hospitalisés était de 5,30 %, avec une tendance croissante de 4,55 % en 2007 à 6,07 % en 2011 ($P < 0,001$). L'analgésie péridurale postopératoire n'a pas été associée à un risque accru de chutes postopératoires des patients hospitalisés dans le groupe chirurgie thoracique (risque relatif [RR], 1,18; intervalle de confiance [IC] 95 %, 0,95 à 1,47; $P = 0,144$) ou dans le groupe chirurgie abdominale haute (RR, 0,84; IC 95 % 0,64 à 1,09; $P = 0,220$). Par rapport aux non-chutes, les chutes de patients hospitalisés étaient associées à une durée médiane prolongée (écart interquartile) du séjour hospitalier dans les deux groupes (11 [7-17] jours vs 9 [6-16] jours, respectivement; $P < 0,001$, dans le groupe chirurgie thoracique et 12 [7-20] jours vs 10 [6-17] jours, respectivement; $P < 0,001$ dans le groupe chirurgie abdominale haute).*

**Conclusion** *Notre étude indique que l'analgésie péridurale postopératoire n'est pas associée à un risque accru de chutes pendant le séjour hospitalier chez les patients subissant une chirurgie abdominale haute ou une chirurgie thoracique majeure.*

Previous studies report an inpatient fall rate of 1.4-18.2 falls per 1,000 patient days. Programs to reduce falls in hospitalized patients have become central to several national quality improvement initiatives.[1-3] Approximately one-third of inpatient falls result in some type of injury, with 3-8% resulting in serious injury, disability, or death.[1-3] The costs associated with inpatient falls are significant and may contribute to an estimated 61% increase in patient care costs.[4] The Centers for Medicare & Medicaid Services and other third-party payers in the United States (US) are limiting reimbursement to hospitals for inpatient injuries resulting from falls.[5] This initiative provides a compelling financial incentive for institutions to decrease the risk of falling. In fact, prevention of falls in hospitalized patients is one of the national quality metrics in the US.[6]

Postoperative inpatient falls occur despite prevention strategies, and therefore, identifying associated risk factors is essential.[7] To date, suggested risk factors include advanced age, history of falls, multiple medical comorbidities, pre-existing impaired gait, mobility, cognition, polypharmacy, sedatives, and psychotropics.[8,9]

Epidural analgesia is considered by many as the "gold" standard for management of pain after major upper abdominal and thoracic surgery as it provides excellent dynamic pain relief and decreases opioid requirements. This facilitates earlier ambulation with associated shorter hospital stays and a lower incidence of opioid-related adverse events.[10] Nevertheless, it is also understood that residual motor, sensory, and sympathetic blockade from epidural analgesia can result in muscle weakness, loss of proprioception, and potential for postural hypotension, all of which can impair mobility and potentially increase the risk of falling.

We used the Nationwide Inpatient Sample datasets to examine the possible relationship between postoperative epidural analgesia and the rate of inpatient falls and to determine the incidence of falls in hospitalized patients after major upper abdominal and thoracic surgery. We hypothesized that epidural analgesia would increase the incidence of inpatient falls.

## Methods

The data for this study were obtained from the Nationwide Inpatient Sample (NIS) of the Healthcare Cost Utilization Project of the Agency for Healthcare Quality and Research from 2007-2011.[11] The NIS consists of publically available de-identified data, and therefore, the study was considered to be exempt from review by the University of Texas Southwestern Medical Center, Dallas, Texas Institutional Review Board (STU 032014-043; April, 2014). The NIS is

**Table 1** The ICD-9-CM codes for the surgical procedures included in this study

| | |
|---|---|
| Thoracic surgical procedures (ICD-9-CM code) | |
| Pectus deformity repair (34.74) | Other intrathoracic esophagocolostomy (42.56) |
| Other chest wall repair (34.79) | Lobectomy of lung (32.4) |
| Decortication of lung (34.51) | Other intrathoracic anastomosis of esophagus (42.59) |
| Repair of pleura (34.93) | Lung volume reduction surgery (32.22) |
| Esophagectomy, not otherwise specified (42.40) | Other lobectomy of lung (32.49) |
| Partial esophagectomy (42.41) | Other and unspecified pneumonectomy (32.59) |
| Total esophagectomy (42.42) | Radical dissection of thoracic structures (32.6) |
| Intrathoracic esophagoesophagostomy (42.51) | Other excision of lung (32.9) |
| Intrathoracic esophagogastrostomy (42.52) | Complete pneumonectomy (32.5) |
| Intrathoracic esophageal anastomosis with interposition of small bowel (42.53) | Intrathoracic esophageal anastomosis with other interposition (42.58) |
| Other intrathoracic esophagoenterostomy (42.54) | Exploratory thoracotomy (34.02) |
| Intrathoracic esophageal anastomosis with interposition of colon (42.55) | |
| Upper abdominal surgical procedures (ICD-9-CM code) | |
| Partial hepatectomy (50.22) | Distal pancreatectomy (52.52) |
| Proximal pancreatectomy (52.51) | Radical subtotal pancreatectomy (52.53) |
| Other partial pancreatectomy (52.59) | Total pancreatectomy (52.6) |
| Radical pancreaticoduodenectomy (52.7) | Total gastrectomy with intestine (43.91) |
| Other total gastrectomy (43.99) | Proximal gastrectomy (43.5), |
| Distal gastrectomy (43.6) | Other partial gastrectomy (43.89) |
| Partial gastrectomy/anastomosis to jejunum (43.7) | Hepatic lobectomy (50.3) |

ICD-9CM = International Classification of Diseases, Ninth Revision, Clinical Modification

a stratified probability sample representing 20% of the US community non-rehabilitation hospitals. All included hospitals are stratified into different groups based on their geographical locations, and a sample of hospital discharges (with a probability of 0.2) is then drawn randomly from each group. The NIS hospital sampling and stratification are explained in detail at http://www.hcup-us.ahrq.gov/db/nation/nis/NISIntroduction2012.pdf (last accessed August 11, 2015). Once a hospital is selected to be part of the project, all the discharge data for that year are included in the survey. Approximately 8 million hospital discharges from about 1,000 hospitals are available in the database each year. The NIS contains data elements from each hospital stay, including patient demographics such as age, sex, and race. The dataset also includes primary and secondary diagnoses and procedures (recorded as International Classification of Diseases, Ninth Revision, Clinical Modification [ICD-9-CM] codes), hospital characteristics, severity and comorbidity measures, expected payment source, and length of hospital stay. As a measure of hospital morbidity and mortality after surgical procedures, the validated Charlson-Deyo comorbidity index was calculated for each patient in the study based on the ICD-9-CM diagnoses codes available from the database.[12] Furthermore, the Charlson-Deyo scores were collapsed into three categories, i.e., 0, 1-2, and $\geq 3$. The NIS methodology and information about this database can be accessed at http://www.hcup-us.ahrq.gov/nisoverview.jsp.

The outcome of interest for this study was the incidence of inpatient falls in patients receiving epidural analgesia for pain management after major upper abdominal and thoracic surgery. Inpatient falls were identified using the following ICD-9-CM codes: fall from chair (E88.42), fall from wheelchair (E88.43), fall from bed (E88.44), fall from other furniture (E88.45), fall from commode (E88.46), other fall (E88.88), unspecific fall (E88.89), accidents occurring in the institution (E84.97). All of the above codes were combined to create one outcome variable called inpatient accidents and falls (IAFs). Epidural analgesia was identified using the ICD-9-CM code for epidural placement of a catheter into the spinal canal for infusion of therapeutic or palliative substances (03.90). The hospital discharges with the ICD-9-CM procedure codes included in the analysis are presented in Table 1.

Inclusion criteria were adult patients who underwent elective surgery for major upper abdominal and thoracic surgical procedures and received postoperative epidural analgesia. Non-elective, laparoscopic, robotic-assisted, cardiac, and transplant surgical procedures were excluded. We studied patients undergoing major upper

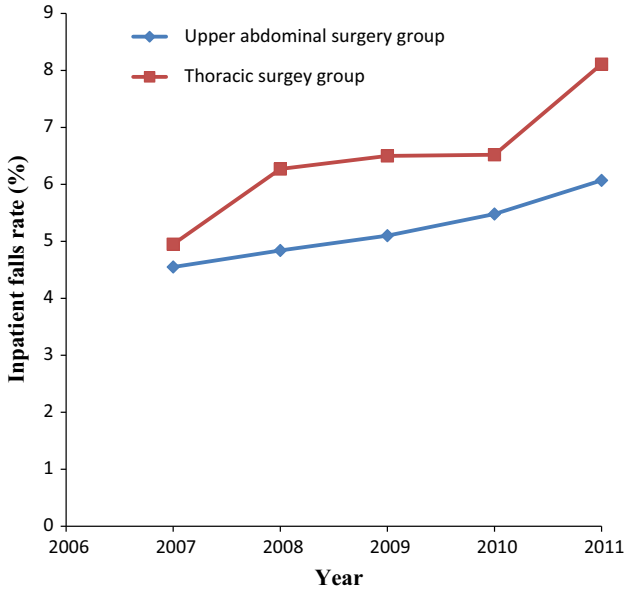


**Fig. 1** Inpatient fall trends over the study period of time from 2007-2011

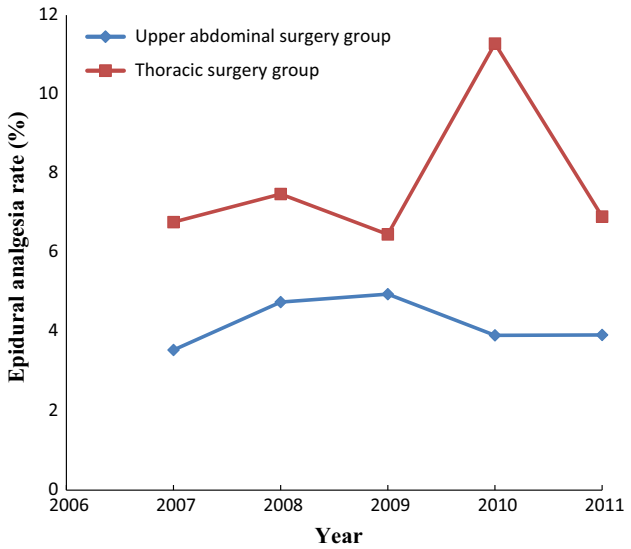


**Fig. 2** Epidural analgesia rate over the study period of time from 2007-2011

abdominal and thoracic surgical procedures separately because the spinal level of the epidural catheter placement is usually different in the two groups. The epidural catheter is usually placed at the mid-thoracic spine level for the thoracic procedures; however, it is commonly placed in the lower thoracic or upper lumbar level for the upper abdominal procedures. The difference in the epidural level may have a differential effect on autonomic block and on the motor and sensory functions in the lower extremities.

### Statistical analysis

Although the NIS database reports up to fifteen procedures in any given discharge, we used only the primary surgical procedure in our analysis (Table 1). A logistic regression model was used to calculate propensity scores (the conditional probability for having postoperative IAFs). This model was based on patient demographic characteristics, type of healthcare insurance, hospital characteristics, primary surgical procedures, patient comorbidities, and number of chronic conditions and procedures in the database. A 1:1 case-control propensity-matched sampling of patients who experienced IAFs with those who did not have IAFs was created using a greedy 8 to 1 digit-matching algorithm technique.[13]

Univariate analyses utilizing the PROC FREQ procedure of the SAS® 9.3 software (SAS Institute, Cary, NC, USA) were conducted to obtain descriptive statistics on the non-matched sample. McNemar's tests were used to describe baseline characteristics of patients in the matched sample for dichotomous variables and to evaluate the relative risk (RR) associated with the use of postoperative epidural analgesia on the rate of IAFs. We used PROC UNIVARIATE and conditional logistic analyses to assess other non-dichotomous variables in the matched sample. Continuous variables are summarized as means and standard deviations (SD), except heavily skewed distributions which are reported as medians and interquartile ranges [IQR]. A Wilcoxon signed-rank test is used to compare skewed continuous variables in the matched sample. Discrete variables are presented as frequencies and percentages. The trend in postoperative IAFs across the five-year study period was assessed with the Cochran-Armitage trend test. All statistical analyses were two-tailed and a $P$ value of 0.05 was considered statistically significant.

## Results

We identified 42,658 thoracic surgical procedures and 54,974 upper abdominal surgical procedures that met the inclusion criteria. The overall incidence for IAFs in the thoracic group was 6.54% (2,789 out of 42,658), with an increasing trend over the study period from 4.95% in 2007 to 8.11% in 2011 ($P < 0.001$). Similarly, the overall incidence of IAFs in the upper abdominal group was 5.30% (2,914 out of 54,974), with an increasing trend from 4.55% in 2007 to 6.07% in 2011 ($P < 0.001$) (Fig. 1). In contrast, the rate of postoperative epidural catheter placement over the study period was variable without an apparent trend (Fig. 2).

A 1:1 case-control propensity-matched sample was created for each of the two groups. Table 2 describes the

**Table 2** Baseline characteristics of patients undergoing thoracic procedures in the case-control propensity matched sample

| Characteristics | Postoperative inpatient falls | | | | *P* value |
|---|---|---|---|---|---|
| | No ($n$ = 2,243) | | Yes ($n$ = 2,243) | | |
| | *n* | % | *n* | % | |
| Postoperative epidural analgesia | 184 | 8.2 | 158 | 7 | 0.144 |
| Age (yr), mean (SD) | 63.2 (14.6) | | 63.8 (14.9) | | 0.142 |
| Female sex | 873 | 38.9 | 881 | 39.1 | 0.807 |
| Race | | | | | |
| White | 1,849 | 82.3 | 1,830 | 81.6 | 0.671 |
| Black | 130 | 5.8 | 150 | 6.7 | |
| Hispanic | 158 | 7 | 146 | 6.5 | |
| Other | 106 | 4.7 | 117 | 5.2 | |
| Hospital | | | | | |
| Small | 233 | 10.4 | 211 | 9.4 | 0.543 |
| Medium | 465 | 20.7 | 473 | 21.1 | |
| Large | 1,545 | 68.9 | 1,559 | 69.5 | |
| Urban location of hospital | 2,203 | 98.2 | 2,186 | 97.5 | 0.081 |
| Procedure in teaching hospital | 1,058 | 47.2 | 1,076 | 48 | 0.591 |
| Number of chronic conditions | 5[4-8]* | | 6 [4-8]* | | 0.849 |
| Number of procedures on record | 5 [3-7]* | | 5 [3-8]* | | 0.821 |
| Charlson comorbidity index | 3 [2-4]* | | 3 [2-4]* | | 0.788 |
| Patient comorbidities | | | | | |
| Hypertension | 1,194 | 53.2 | 1,233 | 55 | 0.243 |
| Diabetes mellitus with chronic complications | 58 | 2.6 | 75 | 3.3 | 0.135 |
| Heart failure | 179 | 8 | 208 | 9.3 | 0.123 |
| Chronic lung disease | 970 | 43.3 | 981 | 43.7 | 0.740 |
| Obesity | 169 | 7.5 | 194 | 8.7 | 0.171 |
| Hypothyroidism | 220 | 9.8 | 241 | 10.7 | 0.302 |
| Weight loss | 293 | 13.1 | 298 | 13.3 | 0.825 |
| Liver disease | 53 | 2.7 | 66 | 2.9 | 0.227 |
| Anemia | 612 | 27.3 | 626 | 27.9 | 0.640 |
| Electrolytes abnormalities | 746 | 33.3 | 790 | 35.2 | 0.166 |
| Renal failure | 173 | 7.7 | 214 | 9.5 | 0.029 |
| Depression | 197 | 8.8 | 207 | 9.2 | 0.602 |

*Median [interquartile range]

baseline characteristics of patients of the case-control propensity-matched sample in the thoracic procedures group. Of the 2,789 patients with IAFs, 546 patients were excluded because of missing data, and the remaining 2,243 patients were matched to the non-IAF (control) group. Table 3 shows the baseline characteristics of patients of the case-control propensity-matched sample in the upper abdominal procedure group. Of the 2,914 patients with IAFs, 610 patients were excluded because of missing data, and the remaining 2,304 patients were matched to the non-IAF (control) group.

Postoperative epidural analgesia was not associated with an increased risk for postoperative IAFs in the thoracic surgery group (RR, 1.18; 95% confidence interval [CI], 0.95 to 1.47; $P = 0.144$) and the upper abdominal surgery group (RR, 0.84; 95% CI, 0.64 to 1.09; $P = 0.220$). The patients who experienced IAFs had a longer median [IQR] hospital stay than patients in the control group: thoracic surgery group (11 [7-17] days *vs* 9 [6-16] days, respectively; $P < 0.001$); upper abdominal surgery group (12 [7-20] days *vs* 10 [6-17] days, respectively; $P < 0.001$).

## Discussion

The key finding of this study was that epidural analgesia is not associated with postoperative IAFs in patients who

**Table 3** Baseline characteristics of patients undergoing major upper abdominal procedures in the case-control propensity-matched sample

| Characteristics | Postoperative inpatient falls | | | | *P* value |
|---|---|---|---|---|---|
| | No ($n$ = 2,304) | | Yes (n = 2,304) | | |
| | *n* | % | *n* | % | |
| Postoperative epidural analgesia | 104 | 4.5 | 123 | 5.3 | 0.220 |
| Age (yr), mean (SD) | 61.8 (15.1) | | 62.5 (15.2) | | 0.129 |
| Female sex | 1,081 | 46.9 | 1,079 | 46.8 | 0.953 |
| Race | | | | | |
| White | 1,602 | 69.5 | 1,576 | 68.4 | 0.956 |
| Black | 221 | 9.6 | 225 | 9.8 | |
| Hispanic | 274 | 11.9 | 285 | 12.4 | |
| Other | 207 | 8.9 | 218 | 9.5 | |
| Hospital | | | | | |
| Small | 196 | 8.5 | 207 | 8.9 | 0.841 |
| Medium | 485 | 21.1 | 479 | 20.8 | |
| Large | 1,623 | 70.5 | 1,618 | 70.2 | |
| Urban location of hospital | 2,255 | 97.8 | 2,252 | 97.7 | 0.763 |
| Procedure in teaching hospital | 1,548 | 67.2 | 1,527 | 66.3 | 0.512 |
| Number of chronic conditions | 5 [3-7]* | | 5 [3-7]* | | 0.917 |
| Number of procedures on record | 5 [3-8]* | | 5 [3-8]* | | 0.863 |
| Charlson comorbidity index | 3 [1-8]* | | 3 [1-6]* | | 0.022 |
| Patient comorbidities | | | | | |
| Hypertension | 1,241 | 53.9 | 1,255 | 54.5 | 0.679 |
| Diabetes mellitus with chronic complications | 72 | 3.1 | 80 | 3.5 | 0.509 |
| Heart failure | 162 | 7 | 158 | 6.9 | 0.817 |
| Chronic lung disease | 372 | 16.2 | 369 | 16 | 0.904 |
| Obesity | 284 | 12.3 | 317 | 13.8 | 0.149 |
| Hypothyroidism | 210 | 9.1 | 210 | 9.1 | 1 |
| Weight loss | 447 | 19.4 | 470 | 20.4 | 0.396 |
| Liver disease | 156 | 6.8 | 151 | 6.6 | 0.768 |
| Anemia | 531 | 23.1 | 545 | 23.7 | 0.626 |
| Electrolytes abnormalities | 846 | 36.7 | 852 | 36.9 | 0.855 |
| Renal failure | 142 | 6.2 | 137 | 5.9 | 0.757 |
| Depression | 210 | 9.1 | 213 | 9.2 | 0.878 |

*Median [interquartile range]

undergo major upper abdominal and thoracic surgery. Nevertheless, we did observe a significant increasing trend in IAFs from 2007-2011. The increasing trend in IAFs may be due to the recent emphasis on early ambulation and on the reporting of IAF events. Another finding of this study was that patients who experienced an IAF had a hospital stay one to two days longer than patients who did not experience an IAF. Since the two groups were matched for demographics and comorbid conditions, we conclude that the difference in the length of hospital stay was a consequence of falling.

There is a lack of previous studies assessing the association between postoperative epidural analgesia and IAFs. Memtsoudis *et al.*[14] observed a lower incidence of postoperative falls with neuraxial anesthesia (i.e., epidural or spinal anesthesia) when compared with general anesthesia. Nevertheless, they did not study the effects of postoperative continuous epidural analgesia on the rate of IAFs. In a systematic review and meta-analysis, the risk factors for falls were assessed after major lower extremity orthopedic surgical procedures in patients ($n$ = 4,000) receiving peripheral nerve blockade. Interestingly, the results of the analysis revealed a statistically significant higher risk of falls in patients with continuous lumbar plexus blockade compared with single injection lumbar plexus blockade or no blockade.[15] A continuous lumbar

plexus block may be comparable with lumbar epidural analgesia with respect to its motor, sensory, and autonomic block of the lower extremities, although this will depend on the spinal levels affected by epidural analgesia. Presumably, in our study, epidural analgesia was achieved without functionally significant lower extremity compromise that would contribute to falling, as was the case with continuous lumbar plexus block.

Ilfeld *et al.*[16] pooled data from three randomized controlled studies investigating the relationship between continuous peripheral nerve blocks and postoperative falls in patients with hip and knee arthroplasty and postulated a causal relationship. Memtsoudis *et al.*[17] used data from 400 hospitals evaluating the risk factors for falls after total knee arthroplasty and found a lower rate of falls than that observed in our study (1.6% *vs* 4.5-8.1%). An explanation for their lower rate of falls may be due to the fact that only one code was used to identify inpatient falls (E84.97, accidents occurring in residential institution). In contrast, we used several ICD-9-CM codes identifying inpatient falls. Another important difference may be related to demographics and comorbidities of the included patient populations.

Although our study used a large national sample, there are several limitations relating to the use of retrospective administrative datasets, such as errors in coding and an inability to retrieve relevant data other than what is provided in the dataset. The NIS used only ICD-9-CM codes for epidural placement during the study period; however, many hospitals use the current procedural terminology codes in their discharge records. Consequently, we may have missed some patients who received epidural analgesia. The database does not provide clinically relevant information regarding the epidural technique (e.g., the type, loading dose, and rate of administration of local anesthetic and opioids used) or the duration of the postoperative epidural drug administration. The temporal relationship between the fall and epidural analgesia was not recorded in the database; therefore, falls could have occurred several days after discontinuation of epidural analgesia without any relationship. Although we identified a relatively large number (> 2,000) of patients who experienced inhospital falls following major upper abdominal and thoracic surgery, we acknowledge that a relatively small percentage (< 9%) of patients received epidural analgesia. Large prospective studies are necessary to disassociate postoperative epidural analgesia more definitively from inhospital falls in these patient populations.

In conclusion, this retrospective case-control study from the NIS analysis suggests that there is no relationship between postoperative epidural analgesia for major upper abdominal and thoracic surgery and the rate of inpatient falls. Therefore, these results suggest epidural analgesia should not be avoided due to concern for increasing the risk of postoperative falls in these patient populations.

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**Conflicts of interest** None declared.

## References

1. *DiBardino D*, *Cohen ER*, *Didwania A*. Meta-analysis: multidisciplinary fall prevention strategies in the acute care inpatient population. J Hosp Med 2012; 7: 497-503.
2. *Hill KD*, *Vu M*, *Walsh W*. Falls in the acute hospital setting—impact on resource utilization. Aust Health Rev 2007; 31: 471-7.
3. *Schwendimann R*, *Buhler H*, *De Geest S*, *Milisen K*. Falls and consequent injuries in hospitalized patients: effects of an interdisciplinary falls prevention program. BMC Health Serv Res 2006; 6: 69.
4. *Bates DW*, *Pruess K*, *Souney P*, *Platt R*. Serious falls in hospitalized patients: correlates and resource utilization. Am J Med 1995; 99: 137-43.
5. *Mattie AS*, *Webster BL*. Centers for Medicare and Medicaid Services "never events": an analysis and recommendations to hospitals. Health Care Manag (Frederick) 2008; 27: 338-49.
6. *National Quality Forum.* List of SREs. Available from URL: http://www.qualityforum.org/Topics/SREs/List_of_SREs.aspx (accessed September 2015).
7. *Johnson RL*, *Duncan CM*, *Ahn KS*, *Schroeder DR*, *Horlocker TT*, *Kopp SL*. Fall-prevention strategies and patient characteristics that impact fall rates after total knee arthroplasty. Anesth Analg 2014; 119: 1113-8.
8. *Krauss MJ*, *Evanoff B*, *Hitcho E*, *et al*. A case-control study of patient, medication, and care-related risk factors for inpatient falls. J Gen Intern Med 2005; 20: 116-22.
9. *Nakai A*, *Akeda M*, *Kawabata I*. Incidence and risk factors for inpatient falls in an academic acute-care hospital. J Nippon Med Sch 2006; 73: 265-70.
10. *Popping DM*, *Elia N*, *Van Aken HK*, *et al*. Impact of epidural analgesia on mortality and morbidity after surgery: systematic review and meta-analysis of randomized controlled trials. Ann Surg 2014; 259: 1056-67.
11. *HCUP Nationwide Inpatient Sample (NIS)*. Healthcare Cost and Utilization Project (HCUP). 2007-2011. Agency for Healthcare Research and Quality, Rockville, MD. Available from URL: www.hcup-us.ahrq.gov/nisoverview.jsp (accessed September 2015).
12. *Deyo RA*, *Cherkin DC*, *Ciol MA*. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. J Clin Epidemiol 1992; 45: 613-9.
13. *Parsons LS.* Reducing Bias in a Propensity Score Matched-Pair Sample Using Greedy Matching Techniques. Proceedings of the

Twenty-Sixth Annual SAS® Users Group International Conference, Cary, NC: SAS Institute Inc., 2001. Available from URL: http://www2.sas.com/proceedings/sugi26/p214-26.pdf (accessed September 2015).

14. *Memtsoudis SG, Dy CJ, Ma Y, Chiu YL, Gonzalez Della Valle A, Mazumdar M*. In-hospital patient falls after total joint arthroplasty: incidence, demographics, and risk factors in the United States. J Arthroplasty 2012; 27: 823-8.e1.
15. *Johnson RL*, *Kopp SL*, *Hebl JR*, *Erwin PJ*, *Mantilla CB*. Falls and major orthopaedic surgery with peripheral nerve blockade: a systematic review and meta-analysis. Br J Anaesth 2013; 110: 518-28.
16. *Ilfeld BM*, *Duke KB*, *Donohue MC*. The association between lower extremity continuous peripheral nerve blocks and patient falls after knee and hip arthroplasty. Anesth Analg 2010; 111: 1552-4.
17. *Memtsoudis SG*, *Danninger T*, *Rasul R*, *et al*. Inpatient falls after total knee arthroplasty: the role of anesthesia type and peripheral nerve blocks. Anesthesiology 2014; 120: 551-63.