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Use of perioperative epidural analgesia among Medicare patients undergoing hepatic and pancreatic surgery

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Abstract

Background: We sought to characterize epidural analgesia (EA) use among Medicare patients undergoing hepatopancreatic (HP) procedures, identify factors associated with EA use and asses perioperative outcomes.

Methods: Patients undergoing HP surgery were identified using the Inpatient Standard Analytic Files. Logistic regression was utilized to identify factors associated with EA receipt, and assess associations of EA with in-hospital outcomes and Medicare expenditures.

Results: Among 20,562 patients included in the study, 6.7% (n =1362) had EA. There was no difference in the odds of complications (OR 1.05, 95% CI 0.93–1.19) or blood transfusions (OR 0.90, 95% CI 0.79–1.03) with EA versus conventional analgesia (CA). The odds of prolonged LOS (OR 1.16, 95% CI 1.03–1.30) were higher with EA; the odds of in-hospital mortality were higher with conventional analgesia (OR 1.90, 95% CI 1.28–2.83). Medicare payments for liver surgery were comparable among EA ($19,500) versus conventional analgesia ($19,300, p = 0.85) and slightly higher for EA ($23,600) versus conventional analgesia ($22,000, p < 0.001) for pancreatic procedures.

Conclusion: EA utilization among Medicare patients undergoing HP was low. While EA was not associated with morbidity, it resulted in an average additional one day LOS and slightly higher expenditures in pancreatic surgery.

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Introduction

Hepatopancreatic (HP) resections are surgical procedures historically associated with increased postoperative pain.[1] In turn, inadequate pain control following surgery can increase the incidence of complications, prolong length of hospital stay, and adversely affect the patient experience.[2–4] Although the introduction of the laparoscopic approach to HP surgery may decrease pain issues in the post-operative setting,[5–7] the majority of HP cases are still performed using an open technique.[8,9] In this context, postoperative pain continues to be an issue, often requiring opiates to manage, which can have an adverse impact on both the patient and society.[10,11] Recently, there has been an increased interest in the role of epidural analgesia (EA) for pain management following major abdominal surgery due to its opioid-sparing effects, as well as the potential short- and long-term benefits associated with EA use.[2,12,13] In particular, an epidural catheter for major abdominal surgery can provide excellent analgesia in the postoperative period, allowing the patient to be pain-free at rest and when mobilizing.[14,15]

In addition to the analgesic benefits, an epidural block can decrease the acute stress response to surgery, as well as decrease the risk of cardiac, respiratory, and gastrointestinal postoperative complications.[13,16] In fact, consensus guidelines for enhanced

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recovery programs in colorectal surgery almost universally include the use of EA to address perioperative analgesia.[17,18] Despite the well-established role of EA for major abdominal surgery, its use in HP surgery is much less well defined. Certain particularities of HP surgery have hindered the utilization of EA. Specifically, there have been concerns that EA might be associated with hypotension, need for increased intravenous fluids and blood products, as well as possibly be associated with acute kidney injury due to fluid shifts.[1,19,20] Moreover, concerns about changes in postoperative coagulation after major hepatectomy have also alarmed HP surgeons around the safety of perioperative analgesia administered through an epidural catheter.[21,22]

The current study sought to characterize the use of EA among Medicare patients undergoing HP surgical procedures, as well as identify factors associated with EA use in the Medicare population. In addition, we sought to define inpatient outcomes relative to the use of EA and delineate differences in Medicare payments among patients who had EA compared with patients not managed with EA.

Methods

Study design and patient population

Medicare patients who underwent HP surgery between 2013 and 2015 were identified using the Inpatient Standard Analytic Files (IPPS-SAF). Medicare is the federal government program that provides health care coverage for people who are 65 years or older, as well as certain younger individuals with disabilities and those with End-Stage Renal Disease. The federal government is the largest single payer of health care in the United States, accounting for more than a quarter of all U.S. spending on health care. Given that Medicare data cover nearly 70% of adults aged 65 years and older, Medicare data constitutes a rich source of utilization and outcomes data.[23] Patients who were enrolled in Medicare Part A and Part B, had no additional payments from a health maintenance organization (HMO) and had no record of payment made by a primary payer, were selected. All patients with an International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM) procedure code for liver resection (50.22, and 50.3) and pancreas resection (52.51, 52.52, 52.53, 52.59, 52.6, and 52.7) who underwent elective surgery were included in the analysis. Minimally invasive surgery (MIS) was defined as a composite of laparoscopic and robotic procedures using ICD-9-CM coding (laparoscopy: 54.21, robotic: 17.4, 17.41, 17.42, 17.43, and 17.49). Patients who underwent EA for perioperative pain control were identified using ICD-9-CM procedure codes 03.90 and 03.91. All other cases were included in the "conventional analgesia" group. For all patients, demographic-specific data on age, sex, and race were collected. The Charlson comorbidity index was used to assess comorbidities.[24,25]

Primary outcomes included the occurrence of any complication, blood transfusion, prolonged length of stay (LOS) and mortality during index hospitalization. Secondary outcomes included Medicare payments for the surgical episode. Postoperative complications were determined using ICD-9 CM diagnosis codes previously identified as having the highest sensitivity and specificity for identification of post-surgical complications, including pulmonary failure, pneumonia, myocardial infarction, deep venous thrombosis (DVT)/pulmonary embolism (PE), acute renal failure, postoperative hemorrhage, surgical-site infection, and gastrointestinal bleeding.[26–28] In-hospital mortality and LOS were extracted directly from the database.

Statistical analysis

Categorical and continuous variables were presented as frequency (%) and median (and interquartile ranges [IQR]), respectively. Demographics, patient characteristics, 30- and 90-day postoperative outcomes including complications, LOS, and incidence of readmission or mortality were compared among patients who did and did not receive EA. Categorical and continuous variables were compared using chi-square and Wilcoxon rank-sum tests. Logistic regression was utilized to identify factors associated with EA receipt, as well as to assess possible associations of EA use with in-hospital morbidity and mortality, prolonged length of stay (LOS), blood transfusion, as well as overall Medicare expenditures. Statistical significance was assessed at $\alpha = 0.05$. All analyses were performed using SAS v9.4.

Results

Patient characteristics

A total of 1251 hospitals caring for Medicare patients were included in the study. Among the 20,562 patients who underwent a hepatopancreatic procedure, median age was 72 years (IQR 68-77), approximately half were male (51.6%, n = 10,601), and the vast majority were Caucasian (88.9%, n = 18,270); most patients had a Charlson comorbidity score of $\geq$3 (63.4%, n = 13,037). Surgical procedures performed included partial hepatectomy (28.5%, n = 5859), hepatic lobectomy (7.5%, n = 1533), distal pancreatectomy (22.1%, n = 4544), total pancreatectomy (2.7%, n = 545), and Whipple procedure (39.3%, n = 8081). Approximately one third of patients had a prolonged LOS ($\geq$10 days; 35.1%, n = 7227). Overall, 30- and 90-day mortality was 5.5% (n = 1130) and 9.0% (n = 1846), respectively.

Demographics and clinical outcomes associated with EA

Overall utilization of EA among Medicare patients was low, as only 6.7% (n = 1362) of patients undergoing a hepatopancreatic procedure received EA. The majority of patients who had EA underwent pancreatic surgery (68%, n = 927); in contrast, among all patients who had EA, only approximately one third had a liver procedure (32%, n = 435) (Table 1). EA was less likely

Table 1 Patient characteristics and Outcomes

Variable	Total n = 20,562	Conventional n = 19,200 (93.3%)	Epidural n = 1362 (6.7%)	p
Age (median, IQR)	72 (68, 77)	72 (68, 77)	72 (68, 76)	<0.001
Age Category (yr)				0.007
65–69	6216 (30.2%)	5764 (30%)	452 (33.2%)	
70–74	6242 (30.4%)	5814 (30.3%)	428 (31.4%)	
75–79	4709 (22.9%)	4411 (23%)	298 (21.9%)	
80–84	2515 (12.2%)	2373 (12.4%)	142 (10.4%)	
>84	880 (4.3%)	838 (4.4%)	42 (3.1%)	
Male	10601 (51.6%)	9911 (51.6%)	690 (50.7%)	0.49
Race				0.017
White	18270 (88.9%)	17030 (88.7%)	1240 (91%)	
AA	1304 (6.3%)	1245 (6.5%)	59 (4.3%)	
Hispanic	94 (0.5%)	88 (0.5%)	6 (0.4%)	
Other/Unknown	894 (4.3%)	837 (4.4%)	57 (4.2%)	
Charlson Score				0.27
0	2245 (10.9%)	2116 (11%)	129 (9.5%)	
1	774 (3.8%)	722 (3.8%)	52 (3.8%)	
2	4506 (21.9%)	4190 (21.8%)	316 (23.2%)	
≥3	13037 (63.4%)	12172 (63.4%)	865 (63.5%)	
Surgical approach				<0.001
MIS	2121 (10.3%)	2019 (10.5%)	102 (7.5%)	
Open	18441 (89.7%)	17181 (89.5%)	1260 (92.5%)	
Procedure				<0.001
Hepatic lobectomy	1533 (7.5%)	1457 (7.6%)	76 (5.6%)	
Total Pancreatectomy	545 (2.7%)	508 (2.6%)	37 (2.7%)	
Whipple	8081 (39.3%)	7441 (38.8%)	640 (47%)	
Partial Hepatectomy	5859 (28.5%)	5500 (28.6%)	359 (26.4%)	
Distal Pancreatectomy	4544 (22.1%)	4294 (22.3%)	250 (18.4%)	
LOS (median, IQR)	8 (5, 12)	7 (5, 12)	8 (6, 13)	<0.001
Liver	6 (4, 9)	6 (4, 9)	7 (5, 9)	<0.001
Pancreas	8 (6, 14)	8 (6, 14)	9 (7, 14)	<0.001
LOS ≥ 10 days	7227 (35.1%)	6683 (34.8%)	544 (39.9%)	<0.001
Liver	1700 (23.0%)	1599 (23.0%)	101 (23.2%)	<0.001
Pancreas	5527 (42.0%)	5084 (41.5%)	443 (47.8%)	<0.001
Overall Complications	7097 (34.5%)	6650 (34.6%)	447 (32.8%)	<0.001
90-day Readmission	6161 (30%)	5767 (30%)	394 (28.9%)	0.39
30-day Readmission	4133 (20.1%)	3867 (20.1%)	266 (19.5%)	0.59
90-day Mortality	1846 (9%)	1753 (9.1%)	93 (6.8%)	0.004
30-day Mortality	1130 (5.5%)	1078 (5.6%)	52 (3.8%)	0.005

to be used among patients undergoing surgery with an MIS approach (7.5%, n = 102 vs. conventional analgesia: 10.5%, n = 2,019, p < 0.001). Median LOS was slightly longer for patients who had EA compared with conventional analgesia (8 days, IQR 6-13 vs. 7 days, IQR 5-12, p < 0.001). Similarly, patients who had EA were more likely to experience a prolonged LOS (39.9%, n = 544, vs. 34.8%, n = 6683, p < 0.001). On the other hand, rates of unadjusted overall complications were lower among patients receiving EA (32.8%, n = 447 vs. 34.6%, n = 6,650, p < 0.001). Specifically, pulmonary complications were less likely among patients who had EA (17.1% vs. conventional analgesia: 19.6%; p = 0.023) (Table 2). Of note, patients who had EA also

Table 2 Postoperative complications among patients receiving EA and conventional analgesia

Complication	Total N = 20,562	Conventional N = 19,200	Epidural N = 1362	p
Index Visit Complications				
Pulmonary failure	4001 (19.5%)	3768 (19.6%)	233 (17.11%)	0.023
Pneumonia	511 (2.5%)	477 (2.5%)	34 (2.5%)	0.98
Myocardial infarction	270 (1.3%)	255 (1.3%)	15 (1.1%)	0.48
DVT/PE	686 (3.3%)	634 (3.3%)	52 (3.8%)	0.31
Acute Renal Failure	2496 (12.1%)	2350 (12.2%)	146 (10.7%)	0.10
Hemorrhage	282 (1.4%)	260 (1.4%)	22 (1.6%)	0.42
Surgical Site Infection	1887 (9.2%)	1753 (9.1%)	134 (9.8%)	0.38
GI Hemorrhage	114 (0.6%)	109 (0.6%)	5 (0.4%)	0.34

DVT = Deep venous thrombosis, PE= Pulmonary embolism, GI = Gastrointestinal.

Table 3 Factors associated with receiving epidural analgesia

		OR	95% CI	p
Age	73 (mean)	ref	–	
	74	0.98	0.97–0.99	<0.001
Surgery Type	MIS	ref		
	Open	1.44	1.17–1.78	<0.001
Race	AA	ref	–	
	Caucasian	1.55	1.18–2.02	0.002
	Hispanic	1.44	0.60–3.43	0.41
	Other/Unknown	1.42	0.97–2.06	0.07
Procedure	Hepatic lobectomy	ref	–	
	Partial hepatectomy	1.27	0.98–1.64	0.07
	Distal Pancreatectomy	1.18	0.90–1.53	0.23
	Whipple	1.70	1.33–2.17	<0.001
	Total pancreatectomy	1.44	0.96–2.17	0.08

had a slightly lower incidence of mortality at 30- and 90-days (30-day: 3.8% vs. 5.6%; p = 0.005; 90-day: 6.8% vs. 9.1%; p = 0.004).

On multivariable analysis, age, surgical approach, race, and procedure type were associated with the odds of receiving EA (Table 3). Specifically, the odds of receiving EA decreased by 2% with every year increase in age (p < 0.001). In addition, the odds of receiving EA were 44% higher among patients undergoing open surgery (OR 1.44, 95% CI 1.17–1.7, p < 0.001), 55% higher for Caucasian patients (OR 1.55, 95% CI 1.18–2.02, p = 0.002) and 70% higher for patients undergoing a Whipple procedure (OR 1.70, 95% CI 1.33–2.17, p < 0.001).

After controlling for age, gender, race, Charlson comorbidity index, and surgical approach, there was no difference in the odds of developing a complication (OR 1.05, 95% CI 0.93–1.19) or receiving a blood transfusion (OR 0.90, 95% CI 0.79–1.03) among patients who had conventional analgesia versus EA. In contrast, while the odds of having a prolonged LOS were 16% lower among patients who had conventional analgesia versus EA (OR 0.87, 95% CI 0.77–0.98, p = 0.017), the odds of experiencing in-hospital mortality was 1.9-fold higher (OR 1.90, 95% CI 1.28–2.83, p = 0.002) (Table 4). Of note, the odds of 30- and 90-day mortality were 1.47-fold (OR 1.47, 95% CI: 1.10–1.96, p = 0.008) and 1.35-fold (OR 1.35, 95% CI: 1.09–1.68, p = 0.007) higher, respectively, for patients receiving conventional analgesia compared with EA.

Interestingly, in a subset analysis of patients who underwent a distal pancreatectomy, EA was associated with 55% higher odds of a prolonged LOS (p = 0.002) with no difference in the odds of receiving a blood transfusion, a postoperative complication or

Table 4 Perioperative outcomes of patients undergoing hepato-pancreatic surgery

Variable	Conventional	Epidural	OR	95% CI
Any Complication	6650 (34.6%)	447 (32.8%)	1.05	0.93–1.19
LOS ≥ 10 days	6683 (34.8%)	544 (39.9%)	0.87	0.77–0.98
In-hospital mortality	1336 (6.7%)	26 (3.7%)	1.90	1.28–2.83
Transfusion	1059 (6.5%)	303 (7.2%)	0.90	0.79–1.03

Table 5 Comparison of Medicare expenditures between epidural and conventional analgesia. Numbers are presented as Median (IQR) thousands USD and compared using Wilcoxon rank-sum test

	Epidural	Conventional	p
Total			
Liver	19,500 (15,800–24,600)	19,300 (15,300–29,700)	0.85
Pancreas	23,600 (17,900–37,300)	22,000 (16,800–36,400)	0.001
Open			
Liver	19,300 (15,800–24,400)	19,300 (15,300–29,900)	0.83
Pancreas	24,000 (18,000–37,400)	22,400 (16,900–36,800)	0.013
MIS			
Liver	20,800 (17,000–31,900)	18,800 (14,200–24,800)	0.14
Pancreas	21,500 (17,700–36,100)	19,900 (15,600–32,100)	0.07

in-hospital mortality among those who had EA versus CA (Supplemental Table 1). Similarly, on a subset analysis of patients who underwent a Whipple procedure, in-hospital outcomes did not differ among patient receiving EA versus conventional analgesia (Supplemental Table 2).

Medicare payments

Overall, there was no difference in risk-adjusted Medicare payments for patients who underwent liver resection who did versus did not have EA (Table 5). Among patients undergoing pancreatic surgery, Medicare payments were higher among patients receiving EA by a median difference of $1600 ($p = 0.001$) (Table 5). When payments were stratified by surgical approach, median payments remained higher for patients undergoing an open pancreatic resection with median costs associated with EA exceeding conventional analgesia by $1600 ($p = 0.013$). Conversely, among patients undergoing MIS pancreatic resection, as well as patients undergoing liver surgery irrespective of surgical approach, there was no difference in Medicare payments among patients who received EA versus conventional analgesia.

Discussion

Hepatic and pancreatic surgical procedures are associated with increased postoperative pain and morbidity.[29,30] To this point, adequate pain management in patients undergoing HP resection is essential for achieving optimal patient recovery.[31,32] Patients with better pain relief following surgery have less psychological distress, fewer surgical complications, and faster mobilization. In this context, EA has emerged as a method to improve pain management and reduce perioperative complications in major abdominal surgery. The role of EA use in liver and pancreatic surgery remains controversial and poorly defined, however. The current study was important because it characterized the overall utilization and outcomes of EA among patients undergoing pancreatic and hepatic surgery in a nationally representative cohort. Of note, overall use of EA among Medicare patients undergoing HP surgery was very low, as only 6.7% of patients received EA. Of interest, EA use was associated with a decreased incidence of certain complications such as respiratory failure, as well as decreased odds of overall in-hospital mortality, with no increase in the odds of blood transfusion. While EA was associated with a slight prolongation of hospital stay, overall Medicare payments were comparable among patients who had EA versus conventional analgesia. Importantly, the odds of 30- and 90-day mortality were higher with the use of conventional analgesia, compared with EA.

Data regarding outcomes associated with EA use in patients undergoing pancreatic resections have been conflicting. Single institution series have reported that, despite improved pain control, patients receiving EA had increased rates of major complications.[33,34] Conversely, larger population-level studies reported improved perioperative outcomes with EA use in patients undergoing pancreatectomy.[35–37] For example, Sanford *et al.* reported that EA was independently associated with decreased postoperative LOS, decreased hospital charges and decreased in-patient mortality.[35] Moreover, Amini *et al.* in an analysis of the Nationwide Inpatient Sample of patients undergoing HP surgery noted that the use of EA was associated with a lower risk of postoperative pneumonia and respiratory failure than conventional analgesia.[36] In the present study, EA was more commonly utilized in patients undergoing pancreatic surgery (68%) compared with patients undergoing hepatic resection (32%) ($p < 0.001$). Perhaps not surprisingly, EA utilization was higher among patients who underwent a Whipple procedure than individuals who had a distal pancreatectomy, irrespective of surgical approach (Fig. 1). Interestingly, in the subset of patients who underwent a distal pancreatectomy, the use of EA was not associated with increased odds of developing a complication, blood transfusion or in-hospital mortality, however, patients who received EA were at 55% higher odds of experiencing a prolonged LOS (Supplemental table 1). In contrast, among patients who underwent a Whipple procedure, in-hospital outcomes were comparable among patients who received EA versus conventional analgesia (Supplemental table 2).

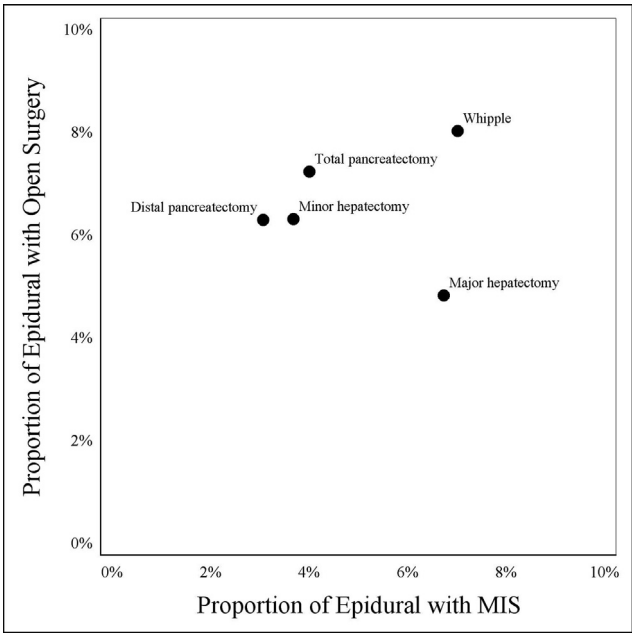

Figure 1 Utilization of Epidural Analgesia across procedures and surgical approach

Among patients undergoing liver surgery, there remains a concern that EA use might be associated with increased hypotension, need for more intravenous fluids, and possibly increased risk of subsequent acute kidney injury. Recently, a randomized controlled trial (RCT) compared EA with local anesthetic infiltration via abdominal wound catheters in combination with patient controlled analgesia (AWC-PCA) for patients undergoing open hepatectomy.[38] The study noted that the EA group had increased demand for vasopressors; however, fluid requirements and overall LOS were comparable among the different groups. A separate RCT comparing EA use versus intravenous PCA noted similar rates of complications, prolonged length of stay and mortality, with no differences in hypotensive episodes, transfusion, or renal failure between the groups.[39] Similarly, in a study evaluating the role of EA in a fast-track liver resection protocol for cirrhotic patients, Siniscalchi *et al.* noted no difference in the incidence of postoperative complications among patients who received EA versus conventional analgesia, with respiratory complications being observed only in patients treated with postoperative systemic opiates.[40] Several other studies have described that patients receiving EA had decreased rates of respiratory failure/pneumonia, acute renal failure and death after HP resections, an association that has also been reported in other types of operations.[12,35,41,42] The findings of the current study add to the current body of evidence, as we similarly noted no difference in the incidence of acute renal failure, blood transfusions or overall complications among patients who received EA versus patients who had conventional analgesia. In fact, patients who received EA had a lower incidence of respiratory complications following HP procedures and lower odds of in-hospital mortality. Collectively, the data strongly suggest that EA appears not to increase the risk of postoperative complications, and might in fact have a beneficial role in preserving respiratory system function compared with the use of conventional opioid-based analgesia.

Another important aspect of the current study was that it examined health care expenditures relative to the use of EA. Data in the literature regarding the influence of EA use on the costs of the surgical episode are largely lacking. Amini *et al.* compared hospital charges - rather than costs incurred by payers - among patients who underwent a Whipple procedure who received EA versus conventional analgesia and reported that hospital charges were lower when EA was utilized.[37] In the present study, despite the slightly longer LOS observed for patients who received EA (8 days vs. 7 days), when risk-adjusted Medicare payments were analyzed, EA was associated with increased expenditures only among patients undergoing an open pancreatic resection, with the difference in median Medicare payments for EA versus conventional analgesia totaling $1600 ($p = 0.013$) (Table 5). Payments for patients undergoing MIS pancreatic procedures were, however, comparable among EA and conventional analgesia. For liver resection, median Medicare payments for patients receiving EA and conventional analgesia were also comparable regardless of the surgical approach utilized.

The results of the current study should be interpreted in light of several limitations. Given that the study was performed using Medicare data, findings may not be generalizable to a population younger than 65 years or patients using other types of health care insurance. As with any study performed using administrative data, the accuracy of information was dependent on appropriate coding for procedures and complications. Moreover, potential institutional confounders, such as hospital size, procedure volume and teaching status could not be accounted for in risk-adjustment. Furthermore, the Standard Analytic Files did not include information on the use of ERAS protocols. As such, the analyses likely represent a mix of hospitals that follow standardized ERAS protocols and hospitals in which use of epidural analgesia and other standards of care were the result of individual provider clinical discretion. Also, we were unable to stratify patients in the conventional analgesia group according to the analgesia regimen utilized (e.g., intravenous opioids, wounds catheters, transversus abdominis plane block, patient-controlled analgesia, etc.). In addition, due to the lack of granular clinical data, factors such as duration of EA use, timing of catheter removal, effectiveness of pain control, patient satisfaction, and procedure-related complications (e.g. epidural hematoma and hypotension) could not be assessed. However, the purpose of this study was not to assess EA efficacy, but rather to characterize the utilization of EA among Medicare patients and assess in-hospital outcomes of EA versus conventional analgesia in this patient population.

In conclusion, EA utilization was very low among Medicare patients undergoing liver and pancreatic resection. EA was more

commonly utilized among patients undergoing pancreatic procedures, as well as among patients undergoing open surgery. While EA was not associated with increased risk of complications or blood transfusion, it was associated with a substantial decrease in the odds of in-hospital mortality. While LOS was slightly prolonged with the use of EA, overall Medicare payments were comparable for liver surgery and marginally higher for pancreatic resections.

Conflict of interest

None declared.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.hpb.2018.12.008.