Postoperative complications of epidural analgesia at hysterectomy for gynecologic malignancies: an analysis of the National Surgical Quality Improvement Program

Sarah A Ackroyd ¹, Enrique Hernandez,^{1,2} Maureen E Roberts,^{1,2} Christina Chu,^{1,2} Stephen Rubin,^{1,2} Gina Mantia-Smaldone,^{1,2} Karen Houck^{1,2}

¹Obstetrics, Gynecology, and Reproductive Sciences, Temple University Hospital, Philadelphia, Pennsylvania, USA

²Division of Gynecologic Oncology, Fox Chase Cancer Center, Philadelphia, Pennsylvania, USA

Correspondence to

Dr Sarah A Ackroyd, Obstetrics, Gynecology, and Reproductive Sciences, Temple University Hospital, Philadelphia, PA 19140-5192, USA; sackroyd15@gmail.com

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HIGHLIGHTS

- Large database study including more than 2035 patients receiving epidural with hysterectomy for malignancy.
- Epidural was associated with higher complication rates, but mortality was unaffected.
- Epidural was associated with longer length of stay and more readmissions.

ABSTRACT

Objective The aim of this study was to identify the rate of 30-day postoperative complications after the use of epidural in women undergoing hysterectomy for gynecologic malignancy. Secondary outcome was the impact of epidural on hospital length of stay.

Methods A retrospective cohort study was conducted using the American College of Surgeons' National Surgical Quality Improvement Program database. This large dataset includes perioperative risk factors and 30-day post-operative outcomes from more than 680 hospitals. Women who underwent abdominal hysterectomy for a gynecologic malignancy from January 2014 to December 2017 were included. Adult patients (18 years or older) who underwent abdominal hysterectomy were identified using common procedure terminology and international classification of diseases codes. Only laparotomy cases were included, and minimally invasive cases (laparoscopy, transvaginal) were excluded due to the small prevalence of epidural cases in this cohort. All patients received general anesthesia. If patients were noted to have "epidural anesthesia" they were included in the epidural cohort and those receiving other adjuvant techniques (regional blocks or spinal anesthesia) were excluded. The primary outcome of interest was the 30-day occurrence of a pulmonary embolism, deep-vein thrombosis, pneumonia, and urinary tract infection. Those who received epidural analgesia were matched in a 1:1 ratio with a similar group of patients who did not receive epidural analgesia using a calculated propensity score to control for confounding factors.

Results A total of 2035 (13.8%) patients undergoing abdominal hysterectomy for a gynecologic malignancy received epidural analgesia. 1:1 propensity-matched samples included 2035 patients in both epidural and no-epidural groups. Patient characteristics between groups were similar. Overall 30-day complication rates were higher in the epidural group (75.9% vs 62.0%, $P<0.01$). Specific complications that were higher in the epidural group included: blood transfusion (28.9% vs 22.8%); wound disruption (2.0% vs 1.1%); surgical site infection

(10.1% vs 7.2%); and delay in return of bowel function (12.3% vs 9.3%) (all $P<0.05$). Hospital length of stay was significantly longer in the epidural group as compared with the no-epidural group (5.69 days vs 4.79 days, $P<0.01$) and readmissions were higher in the epidural group (10.5% vs 9.7%, $P<0.01$), but there was no difference in 30-day mortality between the groups ($P=0.62$).

Discussion The rate of 30-day complications and length of stay among women undergoing an abdominal hysterectomy for gynecologic malignancy was higher for those who received epidural analgesia, but there was no difference in 30-day mortality. Although epidural analgesia can provide a number of benefits when used for postoperative pain control, the possible association with increased 30-day morbidity and length of stay needs to be considered.

INTRODUCTION

Regional anesthesia provided through an epidural catheter is an effective analgesic method to improve pain control and minimize undesirable side effects of systemic opioid medications. Studies of epidural use in abdominal hysterectomy for benign disease have demonstrated lower mean pain scores, decreased morphine use, shorter time to return of bowel function, and higher patient satisfaction when compared with patients who received oral and intravenous opioid-based care.^{1,2}

Though studies demonstrate benefit in women undergoing gynecologic surgery for benign disease, studies in gynecologic oncology patients have been less consistent. While some have reported improved pain scores and opioid-sparing effects,^{3,4} others have noted no difference in pain control or opioid use.⁵ Despite variation in efficacy of reported pain control, multiple studies demonstrate mixed reviews on post-operative complications with use of an epidural.^{3–6} Epidural use has been found to

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Table 1 Patient characteristics

Variable (#, %), (mean±SD)	Unmatched			Propensity-matched		
	No-epidural n=14157	Epidural n=2035	P-value	No-epidural n=2035	Epidural n=2035	SMD
Age (years)	60.1±12.5	60.5±12.4	0.143	60.7±12.3	60.5±12.4	0.013
Ascites	1505 (10.6)	279 (13.7)	<0.001	285 (14.0)	279 (13.7)	0.011
ASA class						
1	281 (2.0)	24 (1.2)	<0.001	27 (1.3)	24 (1.2)	0.024
2	5337 (37.7)	684 (33.6)		642 (31.5)	684 (33.6)	
3	7765 (54.8)	1167 (57.3)		1215 (59.7)	1167 (57.3)	
4	772 (5.5)	160 (7.9)		151 (7.4)	160 (7.9)	
5	2 (0.0)	0 (0.0)		0 (0.0)	0 (0.0)	
BMI (kg/m ²)	31.2±9.1	30.3±9.0	<0.001	30.2	30.4	0.021
Tobacco use in 1 year prior to operation	1808 (12.8)	301 (14.8)	0.011	289 (14.2)	301 (14.8)	0.014
>10% weight loss prior to operation	514 (3.6)	80 (3.9)	0.500	79 (3.9)	80 (3.9)	0.000
Race						
Caucasian	9589 (67.7)	1295 (63.6)	<0.001	1305 (64.1)	1295 (63.6)	0.026
African-American	1440 (10.2)	169 (8.3)		183 (9.0)	169 (8.3)	
Other	673 (4.8)	87 (4.3)		97 (4.8)	87 (4.3)	
Unknown	2455 (17.3)	484 (23.8)		450 (22.1)	484 (23.8)	
Hispanic						
Yes	2103 (14.9)	451 (22.2)	<0.001	394 (19.4)	451 (22.2)	0.045
Unknown	799 (5.6)	67 (3.3)		105 (5.1)	67 (3.3)	
Co-morbidities						
Bleeding disorders	350 (2.5)	35 (1.7)	0.37	37 (1.8)	35 (1.7)	0.008
CHF	47 (0.3)	11 (0.5)	0.141	14 (0.7)	11 (0.5)	0.027
COPD	342 (2.4)	70 (3.4)	0.006	64 (3.1)	70 (3.4)	0.011
Diabetes mellitus	2257 (15.9)	294 (14.4)	0.083	287 (14.1)	294 (14.4)	0.008
Hypertension	6548 (46.3)	909 (44.7)	0.180	914 (45.0)	909 (44.7)	0.007
Steroid use	404 (2.9)	44 (2.2)	0.075	39 (1.9)	44 (2.2)	0.017
Parity	1.7±1.6	1.7±1.5	0.595	1.7±1.5	1.7±1.5	0.005
Preoperative laboratories						
Platelet count (x109/L)	287±124	274±152	0.04	277±126	274±152	0.017
Hematocrit (%)	34.4±19.4	33.3±22.7	<0.001	33.5±22.3	33.3±22.4	0.008
History of abdominal/pelvic surgery	8187 (57.8)	1198 (58.9)	0.374	1178 (57.9)	1198 (58.9)	0.018
Lymphadenectomy (% yes)	9176 (64.8)	1266 (62.2)	0.022	1246 (61.2)	1266 (62.2)	0.02
Cancer type						
Cervical	1264 (8.9)	115 (5.7)	<0.001	117 (5.7)	115 (5.7)	0.004
Ovarian	5725 (40.4)	1007 (49.5)	<0.001	990 (48.6)	1007 (49.5)	0.014
Uterine	5885 (41.6)	688 (33.8)	<0.001	675 (33.2)	688 (33.8)	0.014

ASA, American Society of Anesthesiology; BMI, body mass index; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; SMD, standard mean deviation (no difference if <0.1), all P-values >0.05.

be associated with longer duration of urinary catheterization, a greater number of venous thromboembolism events, longer anesthesia time, more frequent vasopressor use, and longer time to ambulation.^{2 5-7}

Given the growing use of multimodal analgesia, including epidurals, this study sought to identify postoperative complications

from epidural use in women undergoing hysterectomy for malignancy using a large database.⁸ The primary outcome was the occurrence of 30-day complications reported in the American College of Surgeons' National Surgical Quality Improvement Program dataset, including pulmonary embolism, venous thromboembolism,

Table 2 Propensity-matched groups – surgical characteristics and 30-day complications

Variable (#, %), (mean±SD)	No-epidural n=2035	Epidural n=2035	P-value
Operative time (minutes)	180±85	193±102	<0.001
Length of hospital stay (days)	4.79±4.52	5.69±5.21	<0.001
30-day readmission	198 (9.7)	214 (10.5)	<0.001
30-day complications (overall)	1261 (62.0)	1545 (75.9)	<0.001
Blood transfusion	463 (22.8)	587 (28.9)	<0.001
Cerebrovascular accident/stroke	6 (0.3)	11 (0.5)	0.225
Myocardial infarction	12 (0.6)	17 (0.8)	0.354
Wound disruption	22 (1.1)	40 (2.0)	0.022
Surgical site infections	146 (7.2)	205 (10.1)	0.001
Deep venous thromboembolism	24 (1.2)	28 (1.4)	0.58
Pulmonary embolism	43 (2.1)	38 (1.9)	0.570
Sepsis	109 (5.4)	104 (5.1)	0.717
Pneumonia	47 (2.3)	45 (2.2)	0.827
Urinary tract infection	66 (3.2)	70 (3.4)	0.734
Intestinal obstruction	107 (5.3)	116 (5.7)	0.543
Prolonged NPO/NGT use	189 (9.3)	250 (12.3)	0.002
Prolonged ventilation (>48 hours)	12 (0.6)	13 (0.6)	0.844
Unplanned re-intubation	15 (0.7)	21 (1.0)	0.065

NGT, nasogastric tube; NPO, nil per os.

pneumonia, and urinary tract infection. Our secondary outcome was to examine the effect of epidural anesthesia on length of stay.

METHODS

We conducted a retrospective database cohort study using the National Surgical Quality Improvement Program dataset.⁹ This is a large dataset that includes perioperative risk factors and 30-day post-operative outcomes from more than 680 hospitals. Participating hospitals submit surgical cases to the database using strict guidelines to ensure data quality and anonymity of patient information. This dataset was used due to the volume of hysterectomy cases recorded and the ability to capture a large number of epidural cases compared with traditional chart review methods. Disease burden was identified by using pre-operative ascites as a marker for larger disease burden. The dataset is publicly available and includes de-identified data, therefore, this study was considered exempt from review by the Temple University Hospital Institutional Review Board.

Using the 2014–2017 National Surgical Quality Improvement Program dataset procedure-targeted hysterectomy subset, adult patients (18 years or older) who underwent abdominal hysterectomy from January 2014 to December 2017 were identified using common procedure terminology and international classification of diseases codes. Only laparotomy cases were included, and minimally invasive cases (laparoscopy, transvaginal) were excluded due to the small prevalence of epidural cases in this cohort. All patients included in the study were classified as a “gynecologic cancer case” as defined by having a diagnosis of cervical, ovarian, and/or uterine cancer. All patients received general anesthesia. Epidural analgesia and no-epidural cohorts were defined by the variable

“additional anesthetic technique.” If patients were noted to have “epidural anesthesia” they were included in the epidural cohort and those receiving other adjuvant techniques (regional blocks or spinal anesthesia) were excluded.

Baseline characteristics between the unmatched cohorts were compared. A multiple logistic regression model was used to calculate a propensity score to control for patient demographics, co-morbidities, oncologic characteristics (type of cancer [ovary, cervical, uterine], ascites). All baseline characteristics were used in the propensity calculation. Patients who received epidural analgesia were matched in a 1:1 fashion with a similar group of patients who did not receive epidural analgesia using the calculated propensity score using the nearest neighborhood method.¹⁰ This method involves matching a “no-epidural case” and an “epidural case” based on similar characteristics quantified by a propensity score. This allows the two groups to have a “balanced” distribution of covariate characteristics in each group. Propensity-matched groups were assessed for balanced distribution by a standard mean deviation <0.1 between groups as acceptable level.¹¹ Cohorts were compared using chi-squared test for categorical variables and independent *t*-test for continuous variables.

The primary outcome of interest was the 30-day occurrence of a pulmonary embolism, deep-vein thrombosis, pneumonia, and urinary tract infection. These complications were chosen as they can be linked to prolonged immobility and urinary catheterization with epidural use. Additional 30-day postoperative complications included were: blood transfusion, cerebrovascular accident/stroke, myocardial infarction, wound infection, organ space surgical site infection, sepsis/septic shock, intestinal obstruction, prolonged nil per os/nasogastric tube, prolonged ventilation (>48 hours), reintubation, and readmission

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Table 3 Ovarian cancer subset – operative outcomes and 30-day complications

Variable (#, %), (mean±SD)	No-epidural n=990	Epidural n=1007	P-value
Operative time (minutes)	187±87	202±101	<0.001
Length of stay (days)	5.14±4.39	5.71±4.28	<0.001
Readmission (occurrences)	90 (9.1)	100 (9.9)	0.001
30-day complications (overall)	643 (64.9)	784 (77.9)	<0.001
Blood transfusion	257 (25.9)	335 (32.3)	<0.001
Cerebrovascular accident/stroke	2 (0.2)	5 (0.5)	0.452
Myocardial infarction	7 (0.7)	4 (0.4)	0.350
Wound disruption	4 (0.4)	10 (1.0)	0.115
Surgical site infection	50 (5.1)	80 (7.9)	0.009
Deep venous thromboembolism	9 (0.9)	15 (1.5)	0.234
Pulmonary embolism	20 (2.0)	18 (1.8)	0.704
Sepsis	50 (5.1)	55 (5.5)	0.681
Pneumonia	26 (2.6)	18 (1.8)	0.202
Urinary tract infection	32 (3.2)	37 (3.7)	0.589
Intestinal obstruction	61 (6.2)	59 (5.9)	0.776
Prolonged NPO/NGT use	113 (11.4)	134 (13.3)	0.199
Prolonged ventilation (>48 hours)	5 (0.5)	4 (0.4)	0.751
Unplanned re-intubation	7 (0.7)	10 (1.0)	0.164

NGT, nasogastric tube; NPO, nil per os.

event. Secondary outcomes included length of stay. Complications included were not graded.

All statistical analysis were performed using IBM SPSS statistics version 25 (SPSS, Chicago, IL, USA, 2017).

RESULTS

A total of 106, 667 women who underwent hysterectomy are included in the database and 42 138 of these patients had cervical, ovarian, or uterine cancer. Of the patients with cancer, 16 192 underwent a hysterectomy via laparotomy and 2035 patients (13.8%) of them received both general anesthesia and epidural analgesia. Patient characteristics between unmatched groups were not similar on many variables. The 1:1 propensity-matched samples included 2035 patients in both the no-epidural group and epidural group. Matching on patient characteristics was balanced between the epidural and no-epidural groups as demonstrated by standardized mean difference <0.1 (Table 1).

Operative time, length of stay, and 30-day complications between propensity-matched epidural analgesia and no-epidural groups are displayed in Table 2. Patients who received epidural had statistically significantly ($P<0.001$) longer operative times (mean 192 min) than those who did not (181 min). The overall 30-day complication rate was higher in the epidural group compared with the no-epidural group (75.9% vs 62.0%, $P<0.01$, respectively). Compared with the no-epidural group, the proportion of specific complications in the epidural group included a higher rate of blood transfusion (28.9% vs 22.8%, $P<0.01$), increased rate of wound disruption (2.0% vs 1.1%, $P<0.05$), increased rate of surgical site infection (10.1% vs 7.2%, $P<0.01$), and increased rate of prolonged nil per os or nasogastric

tube use (12.3% vs 9.3%, $P<0.01$). The epidural group experienced a higher rate of readmissions vs the no-epidural group with 10.5% vs 9.7% ($P<0.01$), respectively. The most common reasons for readmission among the 412 patients who were readmitted included wound space/surgical site infection and sepsis. Other 30-day complications were not significantly different between the groups and there was no difference in 30-day mortality, with 13 deaths in the no-epidural group and 18 in the epidural group ($P=0.62$). Overall length of stay was significantly longer in the epidural group as compared with the no-epidural group (mean 5.69 days vs 4.79 days, $P<0.001$).

Given a high prevalence of ovarian cancer patients in the cohort (44.7%), a subset analysis of this group was performed. Baseline characteristics between propensity-matched groups were similar. Operative characteristics and 30-day complications are displayed in Table 3. In patients receiving epidural analgesia, operative time was longer (202 vs 187 min, $P<0.001$) and these patients experienced a longer length of stay with a mean of 5.71 days compared with 5.14 days in the no-epidural group, $P<0.001$. Similar to the overall group, the ovarian subset demonstrated a higher overall 30-day complication rate in the epidural group, with 77.9% experiencing a complication compared with 64.9% in the no-epidural group ($P<0.001$). However, when each complication was analyzed individually, the only difference was a higher blood transfusion rate in the epidural group (32.3% vs 25.9%, $P<0.001$).

DISCUSSION

Using a large, nationwide database we report an elevated overall 30-day postoperative complication rate in those who received epidural analgesia at time of hysterectomy. We hypothesized that

complications such as pulmonary embolisms, venous thromboembolisms, pneumonia, and urinary tract infections may be more common in those receiving epidural analgesia, as these can be linked to immobility, but did not see these differences. Instead, in patients who received an epidural we found a higher rate of blood transfusions, wound disruption, surgical site infection, and prolonged nil per os or nasogastric tube use and 1-day longer length of stay.

The use of epidural analgesia in benign gynecologic cases has been widely studied with numerous studies citing improved postoperative pain and faster return to normal bowel function compared with traditional patient controlled analgesia or oral opioid.^{12–14} In gynecologic oncology patients, the use of epidural is not as well studied. Published studies are smaller in size and a majority are retrospective. Furthermore, these studies have not shown consistent results with respect to complications and pain control.

There are conflicting findings over the complications associated with epidural use in the gynecologic oncology population. One of the first studies reported in the gynecologic oncology population used a cohort of 107 patients who received an epidural compared with 98 patients who received patient-controlled analgesia after laparotomy. They reported longer anesthesia time, more use of intraoperative vasopressors, increased intensive care admissions, increased blood transfusion occurrences, and increased time to ambulation among those receiving an epidural.⁵ In a larger study of 237 patients undergoing laparotomy for gynecologic cancer, Courtney-Brooks et al reported improved pain control but found a longer duration of urinary catheterization and a higher incidence of venous thromboembolism.⁶ The study was limited due to the retrospective nature and small complication numbers (five cases in the epidural group and three cases in the no-epidural group). Another retrospective study in 97 patients with gynecologic malignancy compared patient-controlled analgesia to postoperative epidural and found less nausea with epidural, but noted a three-fold increase in urinary tract infections and prolonged urinary catheterization.⁷ While small in size and mostly retrospective, these studies raise a question over the complications associated with epidural use.

Complications were also reported in prospective trials, but the number and size of those trials are limited. A prospective trial in patients undergoing laparotomy for endometrial cancer reported more opioid analgesic use, higher rates of postoperative complications in those who received an epidural (86% in the epidural group and 66% in the no-epidural group, $P < 0.01$), and a longer length of stay. The complications were not classified as serious or contributing to morbidity/mortality, and included infection and broad categories such as gastrointestinal, neurological, and musculoskeletal complications, but no details were provided.^{15,16} Two small, randomized controlled trials reported improved pain control with epidural analgesia and no difference in nausea/emesis, or postoperative ileus.^{3,17} The first trial included 67 patients undergoing laparotomy for malignancy and the authors noted no difference in complications but reported worse pruritus and increased urinary retention among patients receiving epidural compared with patients receiving patient-controlled analgesia.¹⁷ The second study, which included 45 patients in the epidural group, noted no difference in rates of pruritus, nausea, or ileus, but reported higher paresthesia and motor weakness in patients who received epidural analgesia compared with patient-controlled intravenous analgesia.³

Our study identified higher blood transfusion rate, higher rate of wound complications, and longer duration of nil per os or nasogastric tube use in the epidural group. Although this latter difference was only 3 percentage points higher in the epidural group compared with the no-epidural patients. The time period of our study preceded the publication of enhanced recovery after surgery (ERAS) guidelines for gynecology. The ERAS guidelines encourage early resumption of oral intake and early ambulation.¹⁸ These strategies may impact the outcomes we observed. However, early ambulation can be compromised in patients who have an epidural.

A study that specifically looked at the impact that an ERAS protocol had on gastrointestinal function after gynecologic cancer surgery included 99 laparotomy patients who received epidural analgesia. They found that epidural use was associated with worse bowel recovery with a 2.6-fold increased likelihood of postoperative ileus ($P = 0.02$).¹⁹

Given these mixed findings, we sought to examine the 30-day postoperative complications associated with the use of epidural analgesia in patients undergoing abdominal hysterectomy for gynecologic malignancy using a large, nationwide database. Our data represents the largest cohort studied in this topic, with 2035 patients receiving epidural analgesia included. We hypothesized that complications linked to immobility such as pulmonary embolism, venous thromboembolism, and urinary tract infections may be more common in the epidural group. Although we did not find an increase in these complications, we did find an elevated overall 30-day complication rate in those who received epidural analgesia compared with those who did not (75.9% vs 62.0%, respectively, $P < 0.001$). There were notable differences between the groups with a higher rate of blood transfusions (28.9 vs 22.8%, $P < 0.01$) and higher rates of wound disruption and surgical site infection in the epidural group compared with the no-epidural group. Patients who received an epidural experienced prolonged nil per os or nasogastric tube use more often than patients in the no-epidural group and on average spent almost 1 day longer (mean of 0.9 days) in the hospital. Although a 1-day prolongation of hospitalization may not seem clinically important, it is associated with significant financial loss to the hospital.

A recent study published the largest single-center cohort of 305 patients receiving an epidural as part of an ERAS protocol. The authors report decreased opioid use and no significant differences in complications.⁴ Our study and the study by Huepenbecker et al both included a large cohort in the epidural group compared with previous studies, whose cohort of patients receiving epidural analgesia were much smaller.⁴ As the rate of postoperative complications are generally low, it is possible that differences in complication rates may only be appreciated in larger cohorts. There is no clear answer as to whether or not epidural analgesia use for gynecologic malignancy is without risk. Several studies including our own demonstrate that epidural use may be associated with a higher rate of complications and prolonged hospitalization, although it could be argued that the differences in the rates of specific complications may not be clinically significant.

There may be beneficial aspects of postoperative epidural that we are not able to address due to study design. Many studies in the gynecologic oncology population report improved pain but this conclusion is not definitively established. Some studies report that patients receiving epidural analgesia report equivalent pain, and

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use more morphine equivalents and adjuvant medication than the no-epidural group,^{5 15} while other studies report improved pain scores,^{3 17 20} and decreased sedation and opioid-side effects.²⁰ One study even commented that patient satisfaction with postoperative pain control was significantly improved in the epidural group compared with the patient controlled analgesia group.¹⁷ To definitely answer these questions, a prospective randomized trial is needed.

Epidural analgesia is increasingly becoming part of ERAS protocols in gynecologic oncology.^{4 19} These protocols employ multimodal analgesia methods to decrease opioid use and its undesirable side effects, which may lead to faster recovery and shorter hospital stay. Surgeons must consider many aspects of surgical planning and patient care when deciding on which modalities to use for postoperative pain control. Individual patient characteristics are important in making the selection. Further investigation into surgical complexity and utility of epidural with respect to complications should be performed.

On a systems level we must consider the cost that a procedure can have on the patient as well as the healthcare system. In our epidural group, we report higher rates of complications and note a mean 0.9 day longer length of hospital stay. Longer length of stay has also been reported by others.^{5 15} One study examining American College of Surgeons' data reported that, on average, postsurgical hospitalizations with complications cost 48% more than uncomplicated surgical hospitalizations.²¹ Our study identified a higher rate of complications in the epidural group, surgical-site infection being one of them. Surgical-site infections is one of the higher cost complications identified by the American College of Surgeons.²²

While we present the largest cohort of epidural use after hysterectomy for gynecologic cancer, we acknowledge that our findings are limited due to the challenges associated with database studies. The observed increased in 30-day complication rate in the epidural group could be due to the use of epidural analgesia in presumably more complex surgical cases. The epidural group did have a slightly longer operative time than the no-epidural group. However, the percentage of patients undergoing lymphadenectomy was approximately 62% in the matched comparison groups. Due to the database design we are unable to comment on pain improvement, use of other pain control modalities, and specifics of epidural duration/logistics. Our study reported 13.8% epidural use, possibly related to NSQIP not consistently capturing these data vs a small prevalence of epidural use in this patient population. Furthermore, ERAS guidelines for gynecology were more widely promoted after the time interval included in our study. The increased complication rate we observed may have diminished if the perioperative care had followed an ERAS protocol. Given the latency in publication of available databases we did not have access to more recent data.

CONCLUSION

Epidural analgesia is associated with a higher 30-day complication rate and longer hospitalization: however, these complications were not fatal. The benefits of epidural analgesia in patients undergoing hysterectomy for a gynecologic malignancy need to be weighed against the possible complications and the impact a longer hospitalization may have on the patient and healthcare system. A

sufficiently powered prospective randomized trial is warranted to further explore this topic.

Twitter Sarah A Ackroyd @drpengu1n

Contributors SAA conceived the subject and design of the study, acquired the dataset, performed the statistical analysis, interpreted the data, and produced the primary draft of the manuscript. EH and KH provided assistance with study design, critique for academic content, analysis and interpretation of the data, and thorough review and revision of the manuscript. MER, CC, GM-S, and SR provided critique for academic content, interpretation of the data, and thorough review and revision of the manuscript. All authors agree with the manuscript results and conclusions.

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ORCID iD

Sarah A Ackroyd <http://orcid.org/0000-0001-9070-616X>

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