GENERAL GYNECOLOGY

Common postoperative pulmonary complications after hysterectomy for benign indications

Ellen R. Solomon, MD; Tyler M. Muffly, MD; Matthew D. Barber, MD, MHS

OBJECTIVE: The purpose of this study was to estimate the incidence of postoperative pulmonary complications after hysterectomy for benign indications.

STUDY DESIGN: This was a retrospective cohort study of all women who underwent hysterectomy for benign indications at the Cleveland Clinic from Jan. 1, 2001, to Dec. 31, 2009. Exclusion criteria incorporated patients who underwent hysterectomy for premalignant or malignant conditions. *Pulmonary complications* were defined as postoperative pneumonia, respiratory failure, atelectasis, and pneumothorax based on *International Classification of Diseases*, Ninth Revision, codes.

RESULTS: In the 9-year study period, 3226 women underwent hysterectomy for benign indications (abdominal, 38.4%; vaginal, 39.3%; laparoscopic, 22.3%). Ten of the 3226 women (0.3%; 95% confidence interval, 0.17–0.57%) who underwent hysterectomy were identified with postoperative pulmonary complications. Among the different types of hysterectomy, the incidence of pulmonary complications was not different (total abdominal hysterectomy, 0.9%; vaginal hysterectomy, 0.12%; laparoscopic hysterectomy, 0.9%; $P = .8$).

CONCLUSION: The incidence of postoperative pulmonary complications after hysterectomy for benign indications is low.

Key words: gynecology, hysterectomy, pneumonia, pulmonary complication, respiratory failure

Cite this article as: Solomon ER, Muffly TM, Barber MD. Common postoperative pulmonary complications after hysterectomy for benign indications. Am J Obstet Gynecol 2013;208:54.e1-5.

Postoperative pulmonary complications are one of the most frequent causes of postoperative morbidity and death.[1] Hospital-acquired pneumonia is one of the major nosocomial infections to be found in postoperative patients and is the third most common nosocomial complication, after surgical site infection and urinary tract infection.[2] When patients undergo general anesthesia, intubation causes the chest motion and shape to change, which leads to alterations in dependent lung regions and results in atelectasis.[3] Although laparoscopy is a relatively safe procedure, patients may experience complications because of insufflation, which include mediastinal emphysema, pneumothorax, and pneumomediastinum.[4] Despite the high frequency of postoperative pulmonary complications and the extensive general surgery literature, the number of publications regarding these events after gynecologic surgery is limited (MEDLINE, January 1966 to June 2012; English language; search terms: *pulmonary complications*, *gynecology*, and *hysterectomy*). In one study, 2.16% of patients who underwent general open gynecologic surgery experienced postoperative pulmonary complications.[5] Hysterectomy in itself was not assessed specifically, and routes were not compared. In another retrospective study that assessed patients who underwent laparoscopic gynecologic procedures, the rate of postoperative pulmonary complications was 2.3%; however, oncology patients were included in this cohort.[6]

Multiple risk factors, which may increase a patient's chances of experiencing postoperative pneumonia, include cigarette smoking, advanced age, previous antibiotic exposure, endotracheal intubation, and alcohol consumption.[7] In the early postoperative period, residual anesthesia may cause patients to accumulate oropharyngeal secretions or to experience tissue edema of the upper airway.[8] In addition, general anesthesia patients are placed in the supine position, which increases aspiration risk.[9] After surgery, patients may have difficulty taking deep breaths because of pain that leads to atelectasis.[10] It has been shown that pain scores, lung function tests, and the ability to ambulate are increased in patients who undergo laparoscopic hysterectomy vs abdominal hysterectomy.[11]

The objective of our study was to estimate the incidence of postoperative pulmonary complications after hysterectomy for benign indications and to compare the incidence of pulmonary complications after laparoscopic, vaginal, and total abdominal hysterectomies.

Materials and Methods

After institutional review board approval was obtained, all hysterectomies that were performed by the members of the Women's Health Institute at the Cleveland Clinic from Jan. 1, 2001, to Dec. 31, 2009, were identified using *International Classification of Diseases*, Ninth Revision (ICD-9) codes and were then reviewed by the electronic medical

From the Center for Urogynecology and Pelvic Reconstructive Surgery, Obstetrics, Gynecology and Women's Health Institute, Cleveland Clinic, Cleveland, OH.

Received June 27, 2012; revised Oct. 4, 2012; accepted Nov. 12, 2012.

The authors report no conflict of interest.

Presented as a poster at the 33rd Annual Scientific Meeting of the American Urogynecologic Society, Chicago, IL, Oct. 3, 2012.

Reprints not available from the authors.

0002-9378/$36.00

http://dx.doi.org/10.1016/j.ajog.2012.11.006

TABLE 1
Comparison of patient characteristics in those with and without postoperative pulmonary complications (n = 3226)

Variable	Patients with no postoperative pulmonary complications (n = 3216)	Patients with postoperative pulmonary complications (n = 10)	*P* value
Age, y[a]	52.3 ± 12	54.8 ± 13	.52
Body mass index, kg/m^2[a]	29.6 ± 7	29.5 ± 5	.97
Race/ethnicity, n (%)			.90
African American	803 (24.9)	4 (0.5)	
Asian/Pacific Islander	22 (0.68)	0	
White	2311 (71.9)	6 (0.3)	
Hispanic	32 (1.0)	0	
Other/unknown	46 (1.4)	0	
Tobacco use, n (%)			.70
Never used	1679 (52.1)	5 (0.15)	
Never assessed	271 (8.4)	0	
Passive	11 (0.3)	0	
Quit	903 (28.0)	4 (0.12)	
Yes	352 (10.9)	1 (0.03)	
Pack years, n[a]	4.1 ± 10	8.9 ± 13	.29
Sexually active, n (%)			.10
No	352 (10.1)	2 (0.06)	
Not asked	705 (21.85)	2 (0.06)	
Not currently	475 (14.72)	4 (0.12)	
Yes	1686 (52.26)	2 (0.06)	

[a] Data are given as mean ± SD.

Solomon. Pulmonary complications after hysterectomy for benign disease. Am J Obstet Gynecol 2013.

record. The electronic medical record was examined to confirm the occurrence of postoperative pulmonary complications. For this analysis, *pulmonary complications* were defined as a diagnosis of postoperative pneumonia, respiratory failure, atelectasis, or pneumothorax within 365 days of the procedure. *Postoperative pneumonia* was defined as postoperative fever of >38.0°C, elevated white blood cell count >12.0 k/μL, productive cough, and/or diagnosis of pneumonia by chest x-ray or computed tomography of the chest. The definition of *respiratory failure* included the requirement ventilator support after surgery or surgical intensive care unit (SICU) admission for respiratory assistance. *Symptomatic atelectasis* was defined as the requirement of intervention, such as bronchoscopy, respiratory therapy consultation, or SICU admission for a respiratory indication. *Pneumothorax* was defined as presentation on radiographic findings (chest x-ray or computed tomography of the chest). Although pulmonary embolism is an important postoperative surgical complication, we decided not to include this complication because of the nature of pulmonary embolism starting as a problem of coagulopathy that then is found in the pulmonary system. The other reason we did not include pulmonary embolism in this patient population is that the incidence has been published in the literature by 1 of the authors of this article.[12]

The timeframe for postoperative pulmonary complications was treatment or readmission for 1 of these 4 diagnoses within 365 days after surgery. Among those subjects who experienced postoperative pulmonary complications, inpatient and outpatient diagnoses and radiology reports were reviewed for information on the surgical procedure that had been performed and the patient's postoperative course. Charts were abstracted through all visits up to Dec. 31, 2009. No charts had incomplete information. The diagnosis of postoperative pulmonary complications that were gathered from ICD-9 codes overestimated the number of pneumonias by 10 patients, atelectasis by 15 patients, pneumothorax by 4 patients, and respiratory failure by 101 patients.

To validate the Current Procedural Terminology codes with the correct diagnosis, we conducted an electronic medical record review on every chart to be certain that the Current Procedural Terminology code that was recorded matched the actual diagnosis within the electronic patient chart. If the patient did undergo hysterectomy, patient demographics and surgical history, type of hysterectomy, type of incision, concomitant procedures, and length of follow-up period at our institution were also collected. The route of hysterectomy was recorded as laparoscopic, vaginal, or abdominal. Laparoscopic hysterectomies included laparoscopic vaginal hysterectomy, laparoscopic supracervical hysterectomy, and total laparoscopic hysterectomy and all robotic-assisted hysterectomy cases. Any procedure that was not intended initially to be performed transabdominally, but was eventually completed by an abdominal incision, was considered an abdominal hysterectomy. Incision type was recorded for the abdominal approach and included Pfannenstiel, Maylard, Cherney, and midline vertical laparotomy incisions. During this chart review, we excluded patients who were <18 years old, who had had gynecologic surgery for malignancy, who had had combined benign gynecology and thoracic operations, who had undergone combined benign gynecology and upper abdominal operations, or who had incomplete medical records.

Using statistical software (JMP, version 9.0; SAS Institute, Cary, NC), we calculated the frequency and 95% confidence interval of postoperative pulmonary complication incidence. Visual evaluation of the data was performed with a histogram and statistician. Skewed data were represented with medians and ranges where appropriate. Fisher exact test was used to evaluate the relationship between postoperative pulmonary complications and categoric variables; the rank-sum Wilcoxon test was performed to evaluate the relationship between postoperative pulmonary complications and continuous variables.

RESULTS

A total of 4435 women underwent hysterectomy at the Women's Health Institute at the Cleveland Clinic from Jan. 1, 2001, to Dec. 31, 2009. Of these, 3226 women underwent hysterectomy for benign indications (abdominal, 38.4%; vaginal, 39.3%; laparoscopic, 22.3%). A total of 36 surgeons performed the hysterectomies during the 9-year period. Nine of the 3226 patients (0.3%; 95% confidence interval [CI], 0.17–0.57%) who underwent hysterectomy were identified as having experienced a postoperative pulmonary complication. One patient experienced 2 complications. Among hysterectomy types, the incidence of pulmonary complication was not statistically significant: total abdominal hysterectomy, 0.9% (95% CI, 0.03–0.27), vaginal hysterectomy, 0.12% (95% CI, 0.05–0.32), and laparoscopic hysterectomy, 0.9% (95% CI, 0.03–0.27; $P = .8$). The study population had a mean age of 52.3 ± 12 years in the patients without pulmonary complications vs 54.8 ± 13 years in the patients with pulmonary complications, which was not significant (Table 1). This analysis also included 1244 (38.2%) women who underwent at least 1 prolapse and/or incontinence procedure (Table 2). Most patients who underwent prolapse or incontinence procedures had vaginal hysterectomy (77.2%). The mean length of stay for patients without pulmonary complications was 2.32 ± 1.4 days vs 4.10 ± 2.3 days in the patients with pulmonary complications ($P = .0001$; Table 3).

TABLE 2
Concomitant surgeries in patients who experienced postoperative pulmonary complications after hysterectomy, compared with those patients who did not (n = 3226)

Variable	Patients without postoperative pulmonary complications (n = 3116)	Patients with postoperative pulmonary complications (n = 10)	*P* value
Prolapse procedure, n (%)			
Sacrospinous ligament fixation	27 (0.84)	1 (0.03)	.07
Uterosacral vaginal vault suspension	751 (23.28)	3 (0.09)	.41
McCall's	661 (20.49)	2 (0.06)	.97
Abdominal sacrocolpopexy	74 (2.29)	0	.50
Anterior/posterior repair	953 (29.50)	2 (0.06)	.49
Incontinence procedure, n (%)			
Sling	560 (17.34)	1 (0.03)	.51
Burch	116 (3.60)	0	.39
Suprapubic tube	410 (12.70)	0	.10
Adnexectomy, n (%)	1398 (43.30)	3 (0.09)	.38
Lysis of adhesions, n (%)	433 (13.40)	2 (0.06)	.85

Solomon. Pulmonary complications after hysterectomy for benign disease. Am J Obstet Gynecol 2013.

The median time from surgery to the last documented visit was 29.9 months (range, 0–110 months). Five patients did not follow up at the Cleveland Clinic after hysterectomy and were lost to follow up. Follow up consisted of an ambulatory visit at a Cleveland Clinic hospital after discharge. Seven hundred forty-nine patients (23.2%) had follow-up examinations within 3 months of surgery, and 2119 patients (65.7%) had an ambulatory visit >1 year after surgery.

A total of 10 postoperative pulmonary complications (0.3%, 95% CI, 0.17–0.57%) were identified in our patient population. Zero patients experienced a pneumothorax or atelectasis based on our definitions (0%; 95% CI, 0–0.12). One patient was diagnosed with respiratory failure; 7 patients were diagnosed with pneumonia, and 1 patient was diagnosed with both respiratory failure and pneumonia. The signs and symptoms of patients who experienced respiratory failure was respiratory acidosis (pH 7.16) or alkalosis (pH 7.49) on arterial blood gas. In patients who experienced postoperative pneumonia, the most common signs and symptoms were oxygen desaturation <88% (44%), persistent tachycardia (22%), and decreased breath sounds on auscultation (33%). The most common radiographic test that was used for diagnosis of pneumonia was computed tomography of the chest, followed by chest x-ray. Pneumonia was confirmed in all of the cases by radioimaging. The patients with respiratory failure were treated with SICU admissions and endotracheal intubation or bilevel positive airway pressure. Patients who were diagnosed with pneumonia were all treated with parenteral antibiotics that were specific for hospital-acquired pneumonia. The management plan was at the discretion of the surgeon. The range of time to diagnosis of postoperative pulmonary complications was postoperative days 0-70 (median, 2 days). The median length of stay for patients who were convalescing from postoperative pulmonary complications was 4 days (range, 2–11 days).

Univariable analysis was performed between risk of postoperative pulmonary complications and route of hysterectomy,

TABLE 3
Common postoperative pulmonary complications after benign hysterectomy

Variable	Patients with no postoperative pulmonary complications (n = 3116)	Patients with postoperative pulmonary complications (n = 10)	*P* value
Type of hysterectomy, n (%)			.80
Total abdominal	1235 (38.28)	3 (0.09)	
Vaginal	1265 (39.21)	4 (0.12)	
Total laparoscopic	716 (22.19)	3 (0.09)	
Length of stay, d[a]	2.32 ± 1.4	4.10 ± 2.3	.0001
Operative time, min[a]	215.2 ± 74.4	253.6 ± 87.3	.10
Incision type, n (%)			.30
Laparotomy	679 (21.1)	3 (30.0)	
Laparoscopic	723 (22.5)	2 (20.0)	
Pfannenstiel	497 (15.5)	0	
Maylard	66 (2.5)	1 (10.0)	
Vaginal	1251 (39.0)	4 (40.0)	

[a] Data are given as mean ± SD.

Solomon. Pulmonary complications after hysterectomy for benign disease. Am J Obstet Gynecol 2013.

length of stay, length of operation, age, body mass index, ethnicity/race, previous pulmonary complications, and smoking history. None of these factors demonstrated a statistically significant association with risk of postoperative pulmonary complications. There were no deaths associated with hysterectomy or postoperative pulmonary complications.

COMMENT

Our study found that the incidence of postoperative pulmonary complications in patients who undergo hysterectomy for benign disease is extremely low (0.3%; 95% CI, 0.17–0.57%) and that, among hysterectomy types, the incidence was not significantly different (total abdominal hysterectomy, 0.9%; vaginal hysterectomy, 0.12%; and laparoscopic hysterectomy, 0.9%; $P = .8$).

Hysterectomy is the most common gynecologic procedure performed in the United States. It is therefore important to quantify the perioperative morbidities that are associated with this surgery.[13] Diagnosis of postoperative pulmonary complications significantly increases the patient's length of hospital stay and increases hospital costs.[14] Thus, it is imperative to determine whether certain routes of hysterectomy or concomitant procedures may increase the risk of these complications. Compared with the published literature, this incidence is lower than observed.[5,6] However, frequency of pulmonary complications has been studied only in the general gynecology population, and these studies do not specifically address hysterectomy route. Although our data do not suggest an increase in postoperative pulmonary complications with concomitant antiincontinence or prolapse procedures, there has been a reported increased rate of perioperative complications (22.9% compared with 16.5%; odds ratio, 1.5; 95% CI, 1.04–2.2; $P = .3$) observed in patients who undergo vaginal hysterectomy with concomitant reconstructive procedures.[15]

Our study has limitations and strengths. The use of ICD-9 codes introduces bias. We attempted to overcome this, in part, by reviewing each chart to confirm findings. Given the low incidence of postoperative pulmonary complications in the patients who underwent gynecologic procedures, our ability to explore specific risk factors was restricted. Our study was retrospective and used the electronic medical record; therefore, if our patients with postoperative pulmonary complications were treated at outside hospitals, we would not necessarily have captured all complications. Furthermore, our search terms for the ICD-9 codes may have limited all possible diagnoses that are associated with postoperative pulmonary complications. Given the low incidence of postoperative pulmonary complications in this group, our ability to investigate specific risk factors within our study population is limited significantly because of inadequate power. There was selection bias in this study, given the diversity and number of surgeons who were included during the analysis of the data. It was surprising that only 23% of our patients were seen within the 6-week postoperative period and is possible that we were unable to capture all the postoperative visits for this time period and thus underestimated pulmonary complications in this way.

In our study, based on a significance level of .025 to adjust for comparison of the proportion of postoperative pulmonary complications in vaginal hysterectomy with that of total abdominal hysterectomy and total vaginal hysterectomy to that of total laparoscopic hysterectomy, we would have needed 3448 patients with postoperative pulmonary complications in each group for 80% power.

Strengths of our study include the relatively large size of the cohort and the focus on a specific, well-defined surgical population: women who had undergone hysterectomy for benign disease. ■

REFERENCES

1. Doyle RL. Assessing and modifying the risk of postoperative pulmonary complications. Chest 1999;115(suppl):77-81S.

2. Wren SM, Martin M, Yoon JK, Bech F. Postoperative pneumonia-prevention program for the inpatient surgical ward. J Am Coll Surg 2010;210:491-5.

3. Tusman G, Bohm SH, Warner DO, Sprung J. Atelectasis and perioperative pulmonary complications in high-risk patients. Curr Opin Anaesthesiol 2012;25:1-10.

4. Murdock CM, Wolff AJ, Van Geem T. Risk factors for hypercarbia, subcutaneous emphysema, pneumothorax, and pneumomediasti-

num during laparoscopy. Obstet Gynecol 2000;95:704-9.
5. Pappachen S, Smith PR, Shah S, Brito V, Bader F, Khoury B. Postoperative pulmonary complications after gynecologic surgery. Int J Gynaecol Obstet 2006;93:74-6.
6. Graybill WS, Frumovitz M, Nick AM, et al. Impact of smoking on perioperative pulmonary and upper respiratory complications after laparoscopic surgery. Gynecol Oncol 2012;125:556-60.
7. Rello J. Bench-to-bedside review: therapeutic options and issues in the management of ventilator-associated bacterial pneumonia. Crit Care 2005;9:259-65.
8. Xue FS, Li BW, Zhang GS, et al. The influence of surgical sites on early postoperative hypoxemia in adults undergoing elective surgery. Anesth Analg 1999;88:213-9.
9. Drakulovic MB, Torres A, Bauer TT, Nicolas JM, Nogue S, Ferrer M. Supine body position as a risk factor for nosocomial pneumonia in mechanically ventilated patients: a randomised trial. Lancet 1999;354:1851-8.
10. Platell C, Hall JC. Atelectasis after abdominal surgery. J Am Coll Surg 1997;185:584-92.
11. Ellström M, Olsen MF, Olsson JH, Nordberg G, Bengtsson A, Hahlin M. Pain and pulmonary function following laparoscopic and abdominal hysterectomy: a randomized study. Acta Obstet Gynecol Scand 1998;77:923-8.
12. Solomon ER, Frick AC, Paraiso MFR, Barber MD. Risk of deep venous thrombosis and pulmonary embolism in urogynecologic surgical patients. Am J Obstet Gynecol 2010;203:510.e1-4.
13. Brill AI. Hysterectomy in the 21st century: different approaches, different challenges. Clin Obstet Gynecol 2006;49:722-35.
14. Fry DE. A systems approach to the prevention of surgical infections. Surg Clin North Am 2009;89:521-37, x.
15. Heisler CA, Weaver AL, Melton LJ 3rd, Gebhart JB. Effect of additional reconstructive surgery on perioperative and postoperative morbidity in women undergoing vaginal hysterectomy. Obstet Gynecol 2009;114:720-6.