Epidemiologic profile of benign versus oncologic gynecology populations: similar procedures, different patients

Lindsey Buckingham1, Lori Cory1, Colleen Brensinger1, Xiaochen Zhang2, Robert A. Burger1, Fiona Simpkins1, Emily M. Ko1

1Division of Gynecologic Oncology, University of Pennsylvania Health System. Philadelphia, PA 19107
2Institute for Population Research, The Ohio State University. Columbus, OH 19107 (USA)

Summary

Objective: We sought to compare preoperative comorbidities in patients undergoing benign versus oncologic gynecologic surgeries.

Methods: All cases of benign and malignant gynecologic surgeries in the National Surgery Quality Improvement Program (NSQIP) database between 2006-2012 were identified. Gynecologic cancers were grouped by site: uterus, ovary, cervix, and "other" including labia, vulva, vagina, pelvis, and retroperitoneum. Preoperative comorbidities were captured. Descriptive analyses were performed. 94,935 patients underwent gynecologic surgeries: 87.8% benign and 12.2% oncologic. The prevalence of cardiovascular disease, pulmonary disease, and neurologic disease differed between benign and oncologic groups (p < 0.001). In uterine, ovarian and other cancers, greater than 40% of patients had one or more comorbidities and > 5% had 2 or more, (p < 0.001). Gynecologic oncology patients were significantly older, had higher BMI, greater proportion black, and had more comorbidities than patients undergoing benign gynecologic surgery. Comorbidity profiles also differed significantly by type of gynecologic cancer. Preoperative and postoperative optimization, risk assessments, and appropriate reimbursement coverage should account for these baseline differences.

Key words: Comorbidity profile; Gynecologic cancer; Reimbursement.

Introduction

With the institution of the Affordable Care Act (ACA), quality metrics are becoming the meter stick by which hospitals and practitioners are measured and subsequently reimbursed [1]. Gynecologic oncology as a field does not yet have a specific set of quality measures, but has been evaluating and incorporating measures created by various organizations including the National Quality Forum, and Centers for Medicaid and Medicare Services, amongst others [2]. Postoperative morbidity and mortality already factor heavily into payment for services, though patient characteristics and procedural complexity have been more difficult to incorporate [1]. Within the field it is understood that gynecologic oncology patients are less healthy and have more comorbidities than a typical benign gynecologic patient. Few studies, however, have characterized the gynecologic oncology patient population in terms of preoperative health status [3-5]. Furthermore, very limited information exists regarding the comorbidity profiles of patients undergoing gynecologic surgery for oncologic versus benign conditions.

Over a decade ago, Picirrillo et al noted that accurate risk adjustment, based on accounting for pre-diagnosis co-morbidities, would be important to many realms of cancer research including outcomes and quality assessment [6]. More recent studies have shown that gynecologic oncology patients have increased risk of 30-day morbidity and mortality postoperatively [7-9], and twice the risk of hospital readmission when compared to benign hysterectomy patients [10, 11]. In the era of health care reform, large scale profiling of gynecologic oncology populations will be useful to guide novel risk calculators and inform reimbursement models.

The primary objective of the current study was to compare comorbidity profiles of patients undergoing surgery for benign gynecologic conditions versus oncologic conditions. The secondary objective was to compare differences across cancer sites to further characterize comorbidity profiles of gynecologic oncology populations.

Materials and Methods

The National Surgical Quality Improvement Program (NSQIP) is a nationally validated prospective database maintained by the American College of Surgeons. The database collects preoperative health statistics as well as 30-day morbidity and mortality data on surgical patients at both academic and community institutions across the United States [12]. The current study was exempt from IRB approval as mandated by the University of Pennsylvania Health System (IRB## 820313). Use of the ACS NSQIP database does not require written consent from human subjects.

Data were abstracted by trained surgical clinical reviewers provided by the American College of Surgeons.
Table 1. — Demographics, benign versus malignant cohorts.

|                          | Benign (n = 83374) | Malignant (n = 11561) | p-Value |
|--------------------------|--------------------|-----------------------|---------|
| **Age (y)***             | 46 [39-54]         | 61 [53-70]            | < 0.001 |
| **Race**                 |                    |                       | < 0.001 |
| White                    | 56571 (70.3)       | 8870 (78.3)           |         |
| Black                    | 10055 (12.5)       | 856 (7.6)             |         |
| Asian                    | 2222 (2.8)         | 355 (3.1)             |         |
| American Indian or Alaska Native | 616 (0.8)   | 27 (0.2)              |         |
| Native Hawaiian or Pacific Islander | 251 (0.3) | 20 (0.2)              |         |
| Unknown                  | 10745 (13.4)       | 814 (7.8)             |         |
| **Ethnicity Hispanic**   | 9602 (13.3)        | 814 (7.8)             | < 0.001 |
| **BMI (kg/m²)***         | 27.8 [24-32.8]     | 29.7 [24.6-36.6]      | < 0.001 |
| **Smoker**               | 14779 [17.7]       | 1449 [12.5]           | < 0.001 |
| **ASA Class**            |                    |                       | < 0.001 |
| 1                        | 13936 (16.7)       | 388 (3.4)             |         |
| 2                        | 55136 (66.2)       | 5480 (47.4)           |         |
| 3                        | 13733 (16.5)       | 5317 (46)             |         |
| 4                        | 478 (0.6)          | 363 (3.1)             |         |
| 5                        | 9 (0.0)            | 3 (0.0)               |         |
| Missing data             | 51 (0.1)           | 10 (0.1)              |         |
| **Functional Status Pre-Surgery** |             |                       | < 0.001 |
| Independent              | 82824 (99.3)       | 11267 (2.1)           |         |
| Partially Dependent      | 360 (0.4)          | 239 (2.1)             |         |
| Totally Dependent        | 39 (0.0)           | 41 (0.4)              |         |
| Unknown                  | 151 (0.2)          | 14 (0.1)              |         |
| **Surgical Procedure**   |                    |                       | < 0.001 |
| TAH                      | 16658 (20.0)       | 38.52 (33.3)          |         |
| TLH                      | 9004 (10.8)        | 2176 (18.8)           |         |
| VH                       | 11177 (13.4)       | 181 (1.6)             |         |
| LASH                     | 6369 (7.6)         | 89 (0.8)              |         |
| LAVH                     | 9279 (11.1)        | 1016 (8.8)            |         |
| Radical Hysterectomy     | 139 (0.2)          | 2151 (18.6)           |         |
| Lymphadenectomy          | 20 (0.0)           | 210 (1.8)             |         |
| Other                    | 29646 (35.6)       | 1735 (15.0)           |         |

*Age and BMI are reported as median, IQR

Gynecologic surgeries between 2006-2012 were identified from the NSQIP dataset. Patients were identified, using post-diagnosis ICD-9 codes to ensure correct categorization. Benign patients were identified by codes 211.8, 218.0, 218.1, 218.2 218.9, 219.0, 219.1, 219.8, 219.9, 220, 221.0, 221.1, 221.2, 221.8, and 221.9. Gynecologic oncology patients were grouped by site: uterus (ICD-9: 182.X, 233.2), ovary (ICD-9: 183.X, 158.9, 198.6), cervix (ICD-9: 180.X, 233.1), and “other” including labia, vulva, vagina, pelvis, and retroperitoneum (ICD-9: 158, 158.9, 183.2, 184.X, 233.31, 233.32). Patients with fallopian tube and primary peritoneal cancers were analyzed with the ovarian cancer cohort.

Age and race were the demographics included for data analysis. Comorbid health conditions including diabetes, dyspnea, Chronic Obstructive Pulmonary Disease (COPD), cardiovascular disease, hypertension, transient ischemic attack, and stroke were collected, and body mass index (BMI) (calculated by weight and height) was included for each patient.

Patients were compared in groups: benign versus oncologic, and cancer patients to one another by site of disease. In order to create profiles of benign and oncologic gynecology patients, comorbidity distributions were analyzed by diagnosis and by number of discrete comorbidities. We examined the prevalence of common comorbidities for each patient group. Because a Charlson comorbidity score could not be calculated with the available data, comorbidity scores were calculated by summation of individual comorbidities. Univariate and bivariate statistics were performed as well as logistic regression models. Median and interquartile ranges (IQR) were used to describe continuous variables. Frequency and percentage were presented for categorical variables. Mann-Whitney, Kruskal-Wallis test and Chi-square test were used for comparisons among groups. A two-sided P value of 0.05 was considered sta-
Table 2. — Demographics by disease site.

| Age (y)* | Uterine (n = 7047) | Ovary (n = 2971) | Cervical (n = 1032) | Other (n = 511) | p-Value |
|----------|-------------------|-----------------|---------------------|----------------|---------|
| Race     |                   |                 |                     |                | < 0.001 |
| White    | 5474 (79)         | 2287 (78.7)     | 709 (70.9)          | 400 (80.6)     |         |
| Black    | 547 (7.9)         | 182 (6.3)       | 94 (9.4)            | 33 (6.7)       | < 0.001 |
| Asian    | 211 (3.0)         | 79 (2.7)        | 59 (5.9)            | 6 (1.2)        |         |
| American Indian or Alaska Native | 11 (0.2) | 11 (0.4) | 5 (0.5) | 0 (0.0) |         |
| Native Hawaiian or Pacific Islander | 12 (0.2) | 5 (0.2) | 3 (0.3) | 0 (0.0) |         |
| Unknown  | 674 (9.7)         | 343 (11.8)      | 130 (13)            | 57 (11.5)      |         |
| Ethnicity Hispanic | 453 (7.0) | 202 (7.6) | 136 (14.8) | 23 (5.1) | < 0.001 |
| BMI (kg/m^2)* | 32 [26.3-39.2] | 26.6 [23-31.9] | 26.6 [22.6-31.9] | 27.9 [23.8-33.1] | < 0.001 |
| Smoker   | 664 (9.4)         | 392 (13.2)      | 278 (26.9)          | 115 (22.5)     | < 0.001 |
| ASA Class|                   |                 |                     |                | < 0.001 |
| 1        | 190 (2.7)         | 92 (3.1)        | 97 (9.4)            | 9 (1.8)        |         |
| 2        | 3345 (47.5)       | 1304 (43.9)     | 614 (59.5)          | 217 (42.5)     |         |
| 3        | 3282 (46.6)       | 164 (49.3)      | 308 (29.8)          | 263 (51.5)     |         |
| 4        | 224 (3.2)         | 107 (3.6)       | 12 (1.2)            | 20 (3.9)       |         |
| 5        | 1 (0.0)           | 2 (0.1)         | 1 (0.1)             | 2 (0.4)        |         |
| Missing data | 5 (0.1) | 2 (0.1) | 1 (0.1) | 2 (0.4) |         |
| Functional Status Pre-Surgery |         |                 |                     |                | 0.047   |
| Independent | 6873 (97.5)  | 2885 (97.1)     | 1017 (98.5)         | 492 (96.3)     |         |
| Partially Dependent | 141 (2) | 71 (2.4) | 10 (1) | 17 (3.3) |         |
| Totally Dependent | 22 (0.3) | 14 (0.5) | 3 (0.3) | 2 (0.4) |         |
| Unknown | 11 (0.2)          | 1 (0)           | 2 (0.2)             | 0 (0)          |         |
| Surgical Procedure |     |                 |                     |                | < 0.001 |
| TAH      | 2109 (29.9)       | 1506 (50.7)     | 182 (17.6)          | 55 (10.8)      |         |
| TLH      | 1982 (28.1)       | 92 (3.1)        | 99 (9.6)            | 3 (0.6)        |         |
| VH       | 139 (2.0)         | 2 (0.1)         | 39 (3.8)            | 1 (0.2)        |         |
| LASH     | 65 (0.9)          | 19 (0.6)        | 5 (0.5)             | 0 (0)          |         |
| LAVH     | 910 (12.9)        | 41 (1.4)        | 64 (6.2)            | 1 (0.2)        |         |
| Radical Hysterectomy | 1488 (21.1) | 154 (5.2) | 505 (48.9) | 4 (0.8) |         |
| Lymphadenectomy | 93 (1.3) | 44 (1.5) | 49 (4.7) | 24 (4.7) |         |
| Other    | 238 (3.4)         | 993 (33.4)      | 83 (8.0)            | 421 (82.4)     |         |

A total of 94935 patients underwent gynecologic surgery during the time period queried. 87.8% (n = 83374) were benign cases and the remaining 12.2% (n = 11561) were performed for cancer. Among cancer subtypes, uterine cancer patients comprised the majority of the sample (n = 7047).

Demographics

Benign vs Oncologic

The median age for benign patients was significantly lower than oncologic patients 46 [39-54] vs 61 [53-70] years, (p < 0.001). Racial distributions also differed: 12.5% of benign patients were black, compared to 10% or less for uterine, ovarian, cervical and other cancer patients, (p < 0.001). BMI differed between those with benign versus oncologic gynecologic conditions. The median BMI for benign patients was 27.8 kg/m^2 [24-33], compared to 29.7 kg/m^2 [25-37] for oncologic patients (p < 0.001). Oncologic patients were 2.8 and 5 times more likely than benign patients to have ASA class of 3 and 4 respectively (p < 0.001) (Table 1).

Cancer Types

Among cancer types, median age ranged from 46 – 66 years. Cervical cancer patients were significantly younger than all other oncology patients (p < 0.001). Racially, cancer patients were overwhelmingly white, and black race accounted for less than 10% of any group. Median BMI was also significantly different across cancer types: uterine cancer patients had highest median BMI at 32.0kg/m^2, while the remaining cancer types had median BMI between 26.6 kg/m^2 and 27.9 kg/m^2. Among cancer types, most patients were ASA class 2 or 3. Ovarian and other cancer patients had the highest proportion of ASA class 3 at 49.3% and 51.5% respectively. Endometrial cancer patients were com-
Comorbidity Profiles

Entire Cohort

For all patients undergoing gynecologic surgery, hypertension (29%) was the most common comorbid condition, followed by diabetes (7.9%). Pulmonary, cardiovascular, and neurologic disease were less common: overall prevalences were 5%, 1.3%, and 1.3% respectively (Table 3).

Benign versus Oncologic

Prevalence of common comorbidities differed significantly when benign patients were compared to oncology patients: 28% vs 51.8% of patients had any comorbidity. Hypertension and diabetes remained the most common comorbidities and were approximately 2 times more prevalent in the oncologic group than the benign group (Table 3). When a comorbidity score was calculated, patients who underwent surgery for oncologic conditions had 2-3 times more comorbidities, in number, than their benign counterparts ($p < 0.001$) (Figure 1).

Cancer Types

Among cancer types, significant differences were found in the prevalence and distributions of comorbid conditions. Uterine cancer patients had the highest prevalence of hypertension and diabetes, while other cancer patients had highest prevalence of cardiovascular, pulmonary and neurologic comorbidities, $p < 0.001$. Cervical cancer patients had the lowest prevalence of all analyzed comorbidities (Table 3).

When a comorbidity score was calculated and compared across cancer sites, uterine and other cancer groups had the highest proportion of patients with 2 or more comorbidities at 7% and 8% respectively; ovarian and cervical cancer followed at 5.7% and 3.3% respectively (Figure 1).

After adjusting for age, we found that oncology patients were 1.3 times more likely to have a higher comorbidity score compared to benign patients (OR 1.31, 95% CI 1.25-1.37). Further, oncology patients were 28% more likely to have 1 or more comorbidities when compared to benign (OR 1.28, 95% CI 1.22-1.33) (data not shown).

Table 3. — Comorbidity profiles by diagnosis.

| Comorbidities | Benign (n = 83374) | Malignant (n = 11561) | $p$-Value | Uterine (n = 7047) | Ovary (n = 2971) | Cervical (n = 1032) | Other (511) | $p$-Value |
|---------------|------------------|----------------------|-----------|------------------|-----------------|------------------|------------|-----------|
| Congestive Heart Failure | 31 (0.0) | 41 (0.4) | < 0.001 | 25 (0.4) | 11 (0.4) | 0 (0.0) | 5 (1.0) | 0.025 |
| Diabetes mellitus | 5641 (6.8) | 1882 (16.3) | < 0.001 | 1431 (20.3) | 302 (10.2) | 70 (6.8) | 79 (15.5) | < 0.001 |
| Dyspnea | 3031 (3.6) | 926 (8.0) | < 0.001 | 555 (7.9) | 295 (9.9) | 34 (3.3) | 42 (8.2) | < 0.001 |
| Severe COPD | 969 (1.2) | 322 (2.8) | < 0.001 | 196 (2.8) | 74 (2.5) | 21 (2.0) | 31 (6.1) | < 0.001 |
| Hypertension | 21832 (26.2) | 5727 (49.5) | < .001 | 3947 (56.0) | 1232 (41.5) | 260 (25.2) | 288 (56.4) | < 0.001 |
| Steroid use | 876 (1.1) | 211 (1.8) | < 0.001 | 89 (1.3) | 92 (3.1) | 15 (1.5) | 15 (2.9) | < 0.001 |
| Cardiovascular disease | 949 (1.1) | 288 (2.5) | < 0.001 | 179 (2.5) | 74 (2.5) | 8 (0.8) | 27 (5.3) | < 0.001 |
| Pulmonary disease | 3676 (4.4) | 1106 (9.6) | < 0.001 | 659 (9.4) | 340 (11.4) | 46 (4.5) | 61 (11.9) | < 0.001 |
| Neurologic disease | 984 (1.2) | 247 (2.1) | < 0.001 | 149 (2.1) | 62 (2.1) | 10 (1.0) | 26 (5.1) | < 0.001 |
| Comorbidity Score | < 0.001 | | | | | | | |
| 0 | 60285 (72.3) | 5567 (48.2) | 2961 (42.0) | 1650 (55.5) | 753 (73.0) | 203 (39.7) |
| 1 | 21240 (25.5) | 5247 (45.4) | 3583 (50.8) | 1152 (38.8) | 245 (23.7) | 267 (52.3) |
| 2 | 1737 (2.1) | 682 (5.9) | 454 (6.4) | 162 (5.5) | 31 (3.0) | 35 (6.8) |
| 3 | 102 (0.1) | 60 (0.5) | 46 (0.7) | 6 (0.2) | 3 (0.3) | 5 (1.0) |
| 4 | 9 (0.0) | 5 (0.0) | 3 (0.0) | 1 (0.0) | 0 (0.0) | 1 (0.2) |
| 5 | 1 (0.0) | 0 (0.0) | | | | |

parable at 46.6% ASA class 3. Cervical cancer patients had the lowest proportion of ASA class 4 at 1.2% (Table 2).

Comorbidity Profiles

Figure 1. — Summed number of raw comorbidities.
Discussion

Our data confirms what many gynecologic oncologists have experienced: patients undergoing gynecologic surgery for malignant conditions have higher prevalence of comorbidities and poorer preoperative health status than their benign counterparts. Demographically, gynecologic oncology patients are significantly older, have higher BMI, and are racially different from benign patients. The comorbidity profiles of benign and oncology patients are also distinctly different, with the exception of cervical cancer patients who tend to be younger and with similar comorbidity profiles to benign patients. While age is an important factor in profiling, oncologic patients in our cohort remained more likely to have increased numbers of comorbidities after controlling for age, making them more medically complex than typical benign gynecology patients.

Comorbidity profiling of cancer patients to date has largely focused on the four most common cancers: lung, colorectal, breast and prostate. Several studies have shown that patients with breast and prostate cancer have comorbidity profiles similar to age matched populations without cancer. Conversely, lung cancer patients tend to have more comorbidities than their cancer free counterparts [6, 13, 14]. Our data is similar to that presented by Piccirillo et al which included all cancer sites and found that hypertension was the most common comorbidity among greater than 17000 patients (38%), and diabetes was third most common at 11% [6]. In the Annual Report to the Nation on the Status of Cancer (May 2014) Edwards et al profiled lung, colorectal, breast, and prostate cancer patients and compared them to age-matched Medicare beneficiaries. In this large-scale study, the most common comorbidity across cancer sites was diabetes (16%), and the proportion of cancer patients with diabetes was greater than that found in the average (non-cancer) population (16 vs 13%). While our data show gynecologic oncology patients to have similar types of comorbidities as other cancer sites, our data further suggest that the majority of gynecologic oncology patients have greater burden of comorbidity and therefore worse baseline health status than patients with cancers of other anatomic sites.

Multiple studies have explored the effect of comorbidities on outcomes for both benign and oncologic gynecology patients. In 2007, Aletti et al developed a prediction model for surgical complications in stage III and IV ovarian cancer patients that included baseline comorbidities. Not surprisingly, they showed that increased numbers of comorbidities were correlated with post-operative morbidity and mortality [15]. Multiple groups since that time have shown gynecologic oncology patients to have high rates of common comorbidities, as well as poorer outcomes [4, 5, 16]. Iyer et al used Great Britain’s National Health System (NHS) database to analyze complications associated with gynecologic oncology patients, and showed that post-operative complications were significantly associated with increasing comorbidities [3]. Dessources et al used the NSQIP database to analyze readmissions for all hysterectomies from 2011 to 2012. Their group found that higher ASA (American Society of Anesthesiologists) physical status scores and more comorbidities were associated with increased rates of readmission. Endometrial cancer patients in particular had 3-6% higher rates of readmission compared to their benign counterparts [11].

Given previously defined association of patient characteristics with outcomes, a portion of the literature has focused on development of risk calculators in an attempt to predict patients most at risk for complications. To date, only two groups have developed risk calculators specific to the gynecologic oncology population [17, 18]. The NSQIP database has been a popular source of data for creation of calculators in recent years [12, 19]. The American College of Surgeons created a Universal Risk Calculator (URC) which includes hypertension and diabetes but no other defined comorbidities. The URC has been tested and validated for some diagnoses, but has often performed poorly within the gynecologic oncology population. Multiple groups using the URC for gynecologic oncology patients found good sensitivity in predicting death, but varying ability of the tool to predict 30-day morbidity or minor complications [7-9]. While these calculators performed well in the sense of predicting morbidity and mortality, exclusion of most comorbidities in the models is limiting. We propose that more comprehensive calculators accounting for comorbidities will better guide reimbursement by informing risk not only for catastrophic outcomes but increased need for multidisciplinary physician involvement.

Hysterectomies are performed for treatment of both benign and malignant conditions, and it is important to understand the variation in baseline health of the two patient populations. While they may undergo the same procedure, their baseline comorbidities are often drastically different, lending to both surgically related and non-surgically related differences in outcomes. Because outcomes are so heavily emphasized, it is important to account for these baseline factors when designing payment reform strategies for surgical procedures. The goal of obtaining optimal outcomes with the least expenditure is the premise of value-based care, upon which recent initiatives such as the Medicare Access and CHIP Reauthorization Act (MACRA) initiative have been designed [20]. Reimbursement will be based on patient outcomes, a proxy for physician performance, rather than fee-for-service. As such, comorbidity profiles of gynecologic oncology patients inform the increased complexity of care for the gynecologic oncology patient and therefore are integral to creation of risk reimbursement models in the field.

Gynecologic oncology patients as a group lack characterization of baseline health status which has been previously shown as paramount to understanding outcomes in this population. As pay-for-performance replaces fee-for-service care in the US, payment models must consider comorbidity profiles of complex patient groups such as gynecologic oncology patients in order to adequately account for
expected outcomes. Additional risk models accounting for comorbidity factors and their potential impact on surgical and non-surgical health related outcomes in a perioperative period of care should be developed. Overall cost of care for varying degrees of medically complex patients undergoing hysterectomy should be examined.

**Author Contributions**

Lindsey Buckingham: primary author, data analysis, drafting, revision  
Lori Cory: drafting, revision  
Colleen Brensinger: final data analysis  
Xiaochen Zhang: data abstraction and preliminary analysis  
Robert Burger: drafting, revision  
Fiona Simpkins: drafting, revision  
Emily Ko: original concept, data analysis, drafting, revision

**Funding Sources**

Supported in part by Grant 124268-IRG-78-002-35-IRG from the American Cancer Society and by the George and Emily McMichael Harrison Fund, Penn Presbyterian Harrison Fund of the University of Pennsylvania Hospital Obstetrics and Gynecology Department.

**Ethics approval and consent to participate**

The current study was exempt from IRB approval as mandated by the University of Pennsylvania Health System (IRB# 820313).

**Acknowledgements**

The authors would like to acknowledge Mark A. Morgan MD, Robert Giuntoli MD, Nawar Latif MD, Sarah Kim MD, and Kathryn Schmitz PhD for their contributions to the conceptualization and editing of this project.

**Conflict of interest**

Contributing authors declare that they have no relevant conflicts of interest regarding this manuscript.

Submitted: June 13, 2019  
Accepted: August 29, 2019  
Published: June 15, 2020

**References**

[1] US department of health and human services. Strategic Plan Fiscal Years 2010 - 2010.10. Accessed December 15, 2018.

[2] Cohn D.E., Leitao M., Levenback C., Berkowitz R., Roman L., Lucci J., et al.: “Reporting of quality measures in gynecologic oncology programs at Prospective Payment System (PPS)-Exempt Cancer Hospitals: an early glimpse into a challenging initiative”. *Gynecol. Oncol.,* 2013, 130, 403.

[3] Iyer R., Gentry-Maharaj A., Nordin A., Burnell M., Liston R., Manchanda R., et al.: “Predictors of complications in gynaecological oncological surgery: a prospective multicentre study (UKGOSOC-UK gynaecological oncology surgical outcomes and complications)”. *Br. J. Cancer,* 2014, 112, 475.

[4] Mahdi H., Jernigan A.M., Aljbori Q., Lockhart D., Moslemi-Khebri M.: “The impact of obesity on the 30-day morbidity and mortality after surgery for endometrial cancer”. *J. Minz. Invasive. Gynecol.,* 2014, 22, 94.

[5] Suidan R.S., Leitia M.M., Jr., Zivanovi O., Gardner G.J., Long Roche K.C., Sonoda Y., et al.: “Predictive value of the Age-Adjusted Charlson Comorbidity Index on perioperative complications and survival in patients undergoing primary debulking surgery for advanced epithelial ovarian cancer”. *Gynecol. Oncol.,* 2015, 138, 946.

[6] Piccirillo J.F., Tierney R.M., Costas I., Grove L., Spitznagel E.L.: “Prognostic importance of comorbidity in a hospital-based cancer registry”. *JAMA,* 2004, 291, 2441.

[7] Szender J.B., Frederick P.J., Eng K.H., Akers S.N., Lede S.B., Odunsi K.: “Evaluation of the National Surgical Quality Improvement Program Universal Surgical Risk Calculator for a gynecologic oncology service”. *Int. J. Gynecol. Cancer,* 2015, 25, 512.

[8] Teoh D., Halloway R.N., Heim J., Vogel R.I., Rivard C.: “Evaluation of the American College of Surgeons National Surgical Quality Improvement Program Surgical Risk Calculator in Gynecologic Oncology Patients Undergoing Minimally Invasive Surgery”. *J. Minz. Invasive. Gynecol.,* 2016, 24, 48.

[9] Rivard C., Nahum R., Slagle E., Duninck M., Isakssson Vogel R., Teoh D.: “Evaluation of the performance of the ACS NSQIP surgical risk calculator in gynecologic oncology patients undergoing laparotomy”. *Gynecol. Oncol.,* 2016, 141, 281.

[10] Cory L., Latif N., Brensinger C., Zhang X., Giuntoli R.L., Burger R.A., et al.: “Readmission After Gynecologic Surgery: A Comparison of Procedures for Benign and Malignant Indications”. *Obstet. Gynecol.,* 2017, 130, 285.

[11] Dessources K., Hou J.Y., Tergas A.I., Burke W.M., Ananth C.V., Prendergast E., et al.: “Factors associated with 30-day hospital readmission after hysterectomy”. *Obstet. Gynecol.,* 2015, 125, 461.

[12] Bilimoria K.Y., Liu Y., Paruch J.L., Zhou L., Kmiecik T.E., Ko C.Y., et al.: “Development and evaluation of the universal ACS NSQIP surgical risk calculator: a decision aid and informed consent tool for patients and surgeons”. *J. Am. Coll. Surg.,* 2013, 217, 833.

[13] Edwards B.K., Noone A.M., Mariotto A.B., Sinard E.P., Boscoe F.P., Henley S.J., et al.: “Annual Report to the Nation on the status of cancer, 1975-2010, featuring prevalence of comorbidity and impact on survival among persons with lung, colorectal, breast, or prostate cancer”. *Cancer,* 2014, 129, 1290.

[14] Cho H., Mariotto A.B., Mann B.S., Klabunde C.N., Feuer E.J.: “Assessing non-cancer-related health status of US cancer patients: other-cause survival and comorbidity prevalence”. *Am. J. Epidemiol.,* 2013, 178, 339.

[15] Aletti G.D., Santillan A., Eisenhauer E.L., Hu J., Aletti G., Pordatz K.C., et al.: “A new frontier for quality of care in gynecologic oncology surgery: multi-institutional assessment of short-term outcomes for ovarian cancer using a risk-adjusted model”. *Gynecol. Oncol.,* 2007, 107, 99.

[16] Elshaiik A.M.A., Vance S., Kannal M., Burmeister C., Hanna R.K., Rasool N., et al.: “Influence of comorbidity on the risk of death: a single institution study of 1132 women with early-stage uterine cancer”. *Am. J. Clin. Oncol.,* 2014.

[17] Barber E.L., Rutstein S., Miller W.C., Gehrig P.A.: “A preoperative personalized risk assessment calculator for elderly ovarian cancer patients undergoing primary cytoreductive surgery”. *Gynecol. Oncol.,* 2015, 139, 401.

[18] Kohut A., Orfaneli T., Poggio J.L., Gibbon D., Buckley De Meri tens A., Richard S., et al.: “Morbidity and mortality risk assessment in gynecologic oncology surgery using the american college of surgeons national surgical quality improvement program database”. *Int. J. Gynecol. Cancer,* 2016, 28, 840.

[19] Mansmann U., Rieger A., Strahwald B., Crispin A.: “Risk calculators-methods, development, implementation, and validation”. *Int. J. Colorectal. Dis.*, 2016, 31, 1111.

[20] Cohn D.E., Ko E., Meyer L.A., Wright J.D., Tenkmin S.M., Footh J., et al.: “The “value” of value in gynecologic oncology practice in the United States: Society of Gynecologic Oncology evidence-based review and recommendations”. *Gynecol. Oncol.,* 2017, 145, 185.
Corresponding Author:
LINDSEY BUCKINGHAM, M.D.
Pennsylvania Hospital
800 Spruce St, 2 Pine West
Philadelphia, PA 19107 (USA)
linds.k.b@gmail.com