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Intra-operative Hand-offs and Postoperative Complications among Patients Undergoing Gynecologic Oncology Operations

Kemi M. Doll, MD^{1,2}, Jessica A. Lavery, MS³, Anna C. Snaveley, PhD⁴, and Paola A. Gehrig, MD¹

¹ Division of Gynecologic Oncology, Lineberger Comprehensive Cancer Center, University of North Carolina, Chapel Hill, NC

² Division of Health Policy and Management, Gillings School of Global Public Health, University of North Carolina, Chapel Hill, NC

³ Department of Obstetrics and Gynecology, College of Physicians and Surgeons, Columbia University, New York, NY

⁴ PDstat, Chapel Hill, NC

Abstract

There is evidence that systems-based factors influence surgical outcomes of intraoperative and postoperative morbidity. The goal of this study was to provide an exploratory analysis of systems-based variables and their associations with surgical outcomes in gynecologic oncology patients. We merged electronic records from operating room software with billing claims from major surgeries performed from 2011 – 2013, at a tertiary care academic medical center. Univariate and bivariate analyses were performed to evaluate the relationship between baseline demographic and clinical covariates (age, comorbidity, procedure type, surgeon volume), the main exposure variables (case start time, case order, and personnel hand-offs) and the primary outcome of 30-day postoperative complications. Multiple logistic regression models were created to analyze the contributing effect of each systemic variable on post-operative complications. The overall rate of postoperative complications among patients was 31.4% (n=182). Although, traditional risk factors of comorbidity, procedure type, and case length were the strongest primary drivers of complication risk, there was a significant relationship between hand-offs among surgical scrub technicians and postoperative complications (OR 2.12 95%CI: 1.00 – 4.47). As a novel finding in surgical quality and safety research, this supports greater efforts into integrating key staffing information into studies of systemic variables and surgical outcomes.

Keywords

surgical complications; Personnel Staffing and Scheduling; Risk Factors; gynecologic oncology

Corresponding Author Kemi M. Doll, MD, Division of Gynecologic Oncology, University of North Carolina at Chapel Hill, Physicians Office Building, 101 Manning Drive, Campus Box 7572, Chapel Hill, NC 27599, kmdoll@med.unc.edu, P: 919-428-8435, F: 919-843-5387.

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Introduction

There is evidence that provider and systems-based factors influence surgical outcomes of intraoperative and postoperative morbidity (Akingba, Deniseiko-Sanses, Melick, Ellerkmann, & Matsuo, 2008; Kelz et al., 2009; Lonze et al., 2010; McKenney et al., 2009; Prystowsky, Bordage, & Feinglass, 2002; M. C. Wright et al., 2006; Wurtz, Wittrock, Lavin, & Zawacki, 2001). Surgical complication rates are becoming quality indicators, with a call for increased data collection and greater transparency of provider-specific metrics analysis (Pierce & Allen, 2015). In cancer care, these outcomes are especially important, as prolonged recovery from surgery may result in delays and omissions of recommended adjuvant therapy (J. D. Wright, Lewin, Deutsch, Burke, Sun, Neugut, et al., 2011).

Systematic factors including surgical case start time and length (Akingba et al., 2008; Kelz et al., 2009; Lonze et al., 2010; J. D. Wright, Lewin, Deutsch, Burke, Sun, Neugut, et al., 2011), case order (Gruskay, Kepler, Smith, Radcliff, & Vaccaro, 2012), surgeon volume (Finks, Osborne, & Birkmeyer, 2011; McArdle & Hole, 2004; Prystowsky, 2005), and personnel hand-offs (Talsma, Anderson, Geun, Guo, & Campbell, 2013) have been associated with post-operative outcomes. Later surgical case start times have been correlated with increased overall perioperative morbidity (Kelz et al., 2009), with greatest association with wound complications and infections (Lonze et al., 2010; J. D. Wright, Lewin, Deutsch, Burke, Sun, Neugut, et al., 2011). Within gynecological cancer, longer operative time was associated with 30-day postoperative complications after laparoscopic and robotic hysterectomies (Catanzarite, Saha, Pilecki, Kim, & Milad, 2015). Similarly, higher surgical case order in a given operating room (OR) was associated with increased infection rates in patients that underwent lumbar decompression procedures, with an odds ratio (OR) of 1.88 (95%CI: 1.2-2.9) (Gruskay et al., 2012). A single study addressing surgical start time found an association between early morning start time and increased extent of optimal surgical tumor reduction in ovarian cancer debulking procedures (Tanner et al., 2012). Surgeon case volume has been linked to increased perioperative morbidity in the performance of hysterectomy for endometrial and cervical cancers (J. D. Wright, Lewin, Deutsch, Burke, Sun, & Herzog, 2011; J. D. Wright, Lewin, Deutsch, Burke, Sun, Neugut, et al., 2011). After a comprehensive literature review, we found no other research focused on other systems-based factors and surgical outcomes in gynecologic oncology.

Operating room teams consist of circulating nursing, scrub technicians, anesthesia personnel and the surgical team. The absolute number of staff in a surgical case has been weakly correlated with postoperative infection (Talsma et al., 2013). Change in health-care personnel (hand-offs) during the procedures and the correlation with outcomes has not been explicitly studied.

The goal of this study is to provide an exploratory analysis of systems-based variables and their associations with surgical outcomes in gynecologic oncology patients. Identification of the factors that impact surgical risk will provide modifiable targets to continue to improve surgical care and outcomes across many cancer and surgical disciplines.

Methods

Study Design and Data Collection

This was a single-institution retrospective cohort study of major gynecologic oncology procedures at a tertiary care academic center, from October 2011 – October 2013 using merged data sets from operating room documentation and billing claims. This was approved by the North Carolina Institutional Review Board 13-3390. All cases performed by gynecologic oncologists were identified via the electronic operating room software records (n=1,861) and a third (N=666) were selected at random for analysis. The data was limited to major cases by identification of Current Procedural Terminology (CPT) coding (See Appendix 1 – list of codes). In addition, all cases with duration < 30 minutes were excluded. Cases were then linked to inpatient and outpatient billing claims via the Carolina Data Warehouse for Health (CDW), a central data repository containing clinical, research, and administrative data sourced from the UNC Health Care System. A merged database was then created linking each case to all billing claims filed between 0 – 30 days after the procedure.

Systemic variables of case type, case start time, case length, case order of the day, personnel hand-offs, and anesthesia team staffing were included in each case record. CPT coding was used to separate case types into two groups: laparotomy and minimally invasive surgery. Case start time was dichotomized into AM vs PM by those before and after 12:00. Case order of the day was limited to order within a specific operating room, and not by surgeon. Number of personnel hand-offs was defined as 1 minus the number of personnel attributed to the specific role (i.e. scrub technician) for the surgical case record. High volume surgeons were defined as those with > 100 cases/year within the dataset. Patient age was also included in each case record.

The claims data was then used to identify baseline comorbidity and the occurrence of post-operative complications in the 30-day post-operative window. All diagnostic codes filed within the 30-day window, in both inpatient and outpatient settings, were assessed. Disease conditions (e.g. diabetes, hypertension, obesity) were delineated from post-operative morbidity (e.g. wound infection, anemia) by *International Classification of Disease-9* (ICD-9) code description. ICD-9 codes that were ambiguous (e.g. atrial fibrillation that could be present at baseline or newly occurring post-op) were adjudicated with medical record review by an independent reviewer (B.G., acknowledgements) not privy to the outcome data. There were 207 of such cases, for which 148 were classified as comorbidity and 59 as postoperative complications.

Statistical Analysis

Univariate and bivariate analyses using Student's t-test and chi square tests were performed to evaluate the relationship between covariates, the main exposure variables and the primary outcome of postoperative complications. Covariates included age, case length, procedure type, high volume surgeon, and comorbidity count. Main exposure variables included start time, anesthesia hand-offs, case order, and scrub tech hand offs. Multiple logistic regression models were created to analyze the contributing effect of each systemic variable on post-

operative complications. Stratification by case length time was used to account for correlation between case length time and hand-offs.

Results

The study population included 666 patients, 579 of whom had major procedures over 30 minutes in length. Of these, 47% (n=272) were done via laparotomy, 53% (n=303) were minimally invasive surgeries, and 1% (n=4) were groin surgery. Procedures included major gynecologic and gynecologic oncology cases (Supplemental Table). Mean case length was 146 minutes with a range from 30 – 508 minutes. The median age of subjects was 60.2 years old (SD 14), with a range of 18 – 91. The median number of comorbidities per patient was 4 (Interquartile Range: 2-6) with cardiac conditions, neuropsychiatric diagnoses, and diabetes being most common (Supplemental Table.) There were 11 surgeons, 4 of whom were high-volume, and performed 371 (64%) of the cases. Nearly two-thirds of cases were first starts (n=385, 66%). The majority of cases had a single associated anesthesiologist (n=405, 70%), and 53% of cases had at least 1 scrub tech change (Table 1).

The overall rate of postoperative complications among patients was 31.4% (n=182). Of the 182 patients with complications, 84 (46%) had 1 complication reported, 63 (35%) had two, and 35 (19%) had three or more complication codes. Complications included surgical and medical morbidity (Table 2.) There were notable differences in characteristics between patients who did and did not experience postoperative complications on bivariate analysis. Those with postoperative complications had longer mean case length (163 vs 146 min, $p=0.002$), more laparotomies (68% vs 38%, $p<.0001$), more pre-operative comorbidities (6.7 vs 3.5, $p<.0001$) and had a lower percentage of cases done by a high volume surgeon (58% vs 67%, $p=0.047$) (Table 1). Significantly higher postoperative complications were seen based on increasing number of scrub tech handoffs (1 handoff: 60% vs 50%, $p=.021$). No differences in case start time (AM vs PM) or the number of handoffs were found between those patients who did and did not have complications.

On initial multivariable logistic regression with all covariates, laparotomy, comorbidity count, and case length remained significantly associated with the occurrence of complication. Case length and scrub-tech hand-offs were found to be moderately correlated ($r=0.4$), and therefore models stratified by time were constructed. Scrub tech handoffs were significantly associated with complications in surgical cases up to 120 minutes duration (OR 2.12 95%CI: 1.00 – 4.47) (Table 3).

Discussion

In this study, most surgical system variables including anesthesia and nursing personnel changes, case order of the day, and case start time, were not associated with postoperative patient outcomes. Interestingly, for major gynecologic cases up to 2 hours in length, there was a significant relationship between hand-offs among surgical scrub technicians and complications, a novel finding in surgical quality and safety research. Traditional risk factors of comorbidity, procedure type, and case length were the strongest primary drivers of complication rates.

As an exploratory analysis of secondary data, our finding regarding scrub tech hand-offs is hypothesis generating and should be further studied. For the vast majority of cases, the surgical scrub tech would be the only member of the surgical team in direct contact with the operative field who is moving in and out of the operating room. In our data the most common complications were infections. This may point to an etiology related to operative field sterilization during exchanges or to re-sterilization procedures upon return to the operating room. Team dynamics may also play a role in explaining this relationship. The introduction of a new team member to the core operating team may be fertile ground for communication errors or delays. These errors and/or delays, in turn, may lead to intra-operative variances that contribute to higher blood loss, mild organ compromise, or longer operating times. Each of these events can be associated with higher post-operative complication rates (Catanzarite et al., 2015), making surgery team personnel changes a potential mediator of operative outcomes.

The paucity of studies investigating intraoperative personnel hand-offs likely reflects a deficit in the current data available. Major, high quality, data sources such as the National Surgical Quality Improvement Program (NSQIP), are incredibly detailed for capture of surgical complications and laboratory values, but do not contain granular information on the staffing details we investigate here. We feel these results support greater efforts into integrating key staffing information into studies of systemic variables and surgical outcomes.

Our study is limited by its single-institution data within a single surgical division. Importantly, the institution is an active participant in Surgical Care Improvement (SCIP) guidelines for antibiotic prophylaxis and venous thromboembolism prevention, making an ideal setting to measure factors beyond these metrics as potential causes of increased morbidity. As data from an academic institution, the involvement of surgical trainees may have impacted the effect of high volume surgeons in unmeasured ways. We do not have data on the movement of medical students in and out of the operative field. We do assume that movement of higher level trainees would be minimal given the structure of surgical training. Although we did conduct medical record review to resolve vague billing codes into appropriate comorbidity or post-operative complication status, we are limited by the accuracy of claims data, which is well documented.

We are strengthened by our unique data set, in which we were able to merge detailed operative room records with comprehensive billings claim data, to capture both inpatient and outpatient events. By focusing on a relatively narrow set of procedures, we minimized the variability inherently associated with different surgeries and were able to account for minimally invasive versus laparotomy procedures. We note that traditional risk factors of patient comorbidity, procedure type, and surgeon volume were the most significant drivers of post-operative complications. Given the consistent relationship reported between medical personnel hand-offs and outcomes in intensive care settings, combined with our findings, the area of surgical personnel handoffs warrants further study.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Biographical Sketch

Doll: Kemi Doll, MD is currently a post-doctoral research fellow in the Cancer Care Quality Training Program, part of the Division of Health Policy and Management at the University of North Carolina at Chapel Hill, in Chapel Hill NC. She is a board-eligible gynecologic oncologist whose research interest focus on surgical quality and outcomes.

Gehrig: Paola A. Gehrig, MD is a gynecologic oncologist and current Director of the Division of Gynecologic Oncology at the Lineberger Comprehensive Cancer Center at UNC Hospitals. She serves on the UNC Hospital's Quality Improvement Task Force and has multiple peer-reviewed publications in the surgical management of gynecologic cancers.

Lavery: Jessica A. Lavery, MS is a Biostatistician at Columbia University Medical Center, New York, NY. Her current role is focused on the Merck for Mothers Safe Motherhood Initiative, a project seeking to reduce maternal morbidity and mortality in New York State. Other areas of research include gestational diabetes and hypertensive disorders of pregnancy.

Snaveley: Anna C. Snaveley, PhD is a biostatistician who is currently the co-owner of PDstat, a clinical trials consulting business based in Chapel Hill, NC. She previously served as a faculty biostatistician at the UNC Lineberger Comprehensive Cancer Center.

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Table 1

Overall Characteristics and Bivariate Relationships to Post-Operative Morbidity

Variable		All N=579 (100%)	Post-Op Morbidity No N = 397 (69%)	Post-op Morbidity Yes N = 182 (31%)	p-value
Age ^a	Mean (SD)	60.2 yrs (14)	60 yrs (14)	61 yrs (14)	0.28
Case Length ^a	Mean (SD)	151 min (SD 60)	146 min (53)	163 min (70)	0.0018
Procedure Type	MIS ^b	303 (53)	245 (62)	58 (32)	<.0001
	Laparotomy	272 (47)	150 (38)	122 (68)	
High Volume Surgeon	No	208 (36)	132 (33)	76 (42)	0.047
	Yes	371 (64)	265 (67)	106 (58)	
Comorbidity Count ^a		4.5 (4.0)	3.5 (3.0)	6.7 (5.2)	<.0001
Case Start Time	AM	385 (66)	267 (67)	118 (65)	0.57
	PM	194 (34)	130 (33)	64 (35)	
Case Order	1	419 (72)	285 (72)	134 (74)	0.79
	2	133 (23)	92 (23)	41 (22)	
	3	27 (5)	20 (5)	7 (4)	
Hand Offs - Anesthesia	0	405 (70)	280 (71)	125 (67)	0.87
	1	115 (20)	78 (20)	37 (20)	
	2	59 (10)	39 (10)	20 (11)	
Hand Offs - Scrub Tech	0	270 (47)	198 (50)	72 (40)	0.02
	1	309 (53)	199 (50)	110 (60)	

^aReported as Mean (SD)_^bMIS: minimally invasive surgery

Table 2

Distribution of Types of Post-Operative Complications

Post-operative Complication Description	Frequency	Percent (Fraction) of All Post-Op Complications (N=538) *
Infectious	97	24.94
GI	69	17.74
Organ injury/compromise **	52	13.37
Electrolyte/Nutrition	42	10.80
Hemorrhage/Anemia	42	10.80
Wound	23	5.91
Renal	13	3.34
Pressure Ulcer, Debility	13	3.34
Conversion	12	3.08
Cardiac	11	2.83
Thrombosis	7	1.8
CNS	4	1.03
Respiratory	4	1.03

* Several patients had more than one complication.

** Includes incisional hernia, hydrourter, fistula, GI/GU intraoperative injury, including enterotomy

Table 3

Multivariate Modeling of Systems-Factors and Postoperative Outcomes in Gynecologic Oncology Patients

	Model 1: All cases (N=579)	p-value	Model 2: Cases up to 120 minutes (N=227)	p-value
AM vs. PM Start	1.14 (0.68 – 1.93)	0.62	1.59 (0.74 – 3.43)	0.24
Case Order	0.96 (0.58 – 1.65)	0.37	0.74 (0.40 – 1.40)	0.36
Anesthesia Hand Offs	0.83 (0.49 – 1.43)	0.72	0.55 (0.20 – 1.52)	0.46
Scrub Tech Hand Offs	1.44 (0.93 – 2.24)	0.10	2.12 (1.00 – 4.47)	0.05
Laparotomy vs. MIS	4.8 (3.04 – 7.57)	<.0001	4.14 (1.70 – 10.1)	0.002
Comorbidity	1.21 (1.14 – 1.27)	<.0001	1.30 (1.18 – 1.44)	<.0001
Case Length (min)	1.01 (1.00 – 1.01)	<0.001	--	--
Age (yr)	1.01 (0.99 – 1.02)	0.40	1.02 (1.00 – 1.04)	0.13