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Surgical Apgar Score and prediction of morbidity in women undergoing hysterectomy for malignancy

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HIGHLIGHTS

- Peri-operative complications increase as SAS decreases.
- SAS cannot predict post-operative complications.

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ABSTRACT

Objective. To validate whether Surgical Apgar Score can predict post-operative morbidity in patients undergoing hysterectomies for malignancies.

Methods. We conducted a retrospective cohort study of consecutive hysterectomies performed for cancer at a single academic institution between 2008 and 2010. The Surgical Apgar Score (SAS) was derived as previously reported. Peri-operative complications were as outlined by the American Board for Obstetrics and Gynecology, and then further subdivided into intra-operative and post-operative events. Univariate and multivariate logistic regressions were utilized.

Results. A total of 632 patients were identified. Of our cohort, 64% underwent surgery for cancer arising in the uterus, followed by ovary at 28.6% and cervix at 4%. Median patient age was 60 years old with a mean American Society of Anesthesiologists Physical Status Classification System (ASA) score of 2.5 and a median body mass index of 29. Average Surgical Apgar Score was 7.6. As SAS decreased, the risk of peri-operative complications increased ($p < 0.01$). On univariate analysis SAS could predict for both intra-operative and post-operative complications. However, on multivariate analyses SAS could not independently predict for any post-operative complications (OR 1.02, CI 0.47–2.17). In a multivariable model incorporating age, ASA class, SAS <4, disease site, bowel resection and laparotomy, only ASA class and laparotomy were able to predict for postoperative complication events.

Conclusions. Low Surgical Apgar Score significantly associates with morbidity in women undergoing hysterectomy for malignancy, but is unable to predict which patients will have postoperative complications. This renders the SAS less helpful for the creation of peri-operative metrics to guide post-operative care.

Introduction

The neonatal Apgar score was developed in 1953 by Virginia Apgar in an attempt to elucidate which infants were at risk for neonatal morbidity and mortality [1]. The score was quick and easy to calculate, but predictive of 28 day mortality for any given infant [2,3]. This simple scoring system revolutionized obstetrics, and today is utilized not just as a quality of care metric, but as a tool to triage at-risk infants to more intensive observation or aggressive care.

Identifying surgical patients at increased risk of morbidity and mortality has been a challenge in a modern era of increasingly complex procedures. Postoperative decisions are commonly based on the surgeon's assessment of a patient's pre-operative health status as well as a subjective perception of how well the patient tolerated the surgery. Interestingly, post-operative conversations regarding surgical outcome with patients and their family have been shown to be based on similar subjective impressions [4]. Attempts to promote data driven practice have included various tools for risk stratification such as the American Society of Anesthesiologists Physical Status Classification System

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(ASA Classification), the Physiologic and Operative Severity Score for the enUmeration of Mortality and Morbidity (POSSUM), and the Acute Physiology and Chronic Health Evaluation (APACHE) [28]. Unfortunately, while ASA classification may accurately stratify intrinsic patient risk due to pre-operative characteristics, it places no weight on patient age, surgery to be performed, length of surgery or other intra-operative variables. APACHE score utilizes laboratory and clinical data to calculate a score associated with mortality in critically ill patients, and the POSSUM score was developed to audit surgical outcomes in a general surgery population. While both scores have been validated prospectively to predict morbidity, APACHE was not intended to guide care in non-critically ill patients, and the POSSUM score requires over 18 variables in a complex algorithm based on data not routinely gathered in the operating room. These limitations decrease their utility as tools for immediate postoperative assessment of the surgical patient [5–7].

Due to increasing interest in a metric that describes both the surgical procedure and a patient's physiologic tolerance of that procedure, Gawande et al. developed a simple surgical outcome score based on easily obtainable intra-operative data named the Surgical Apgar Score (SAS) [8]. The SAS was scaled from 0 to 10 and based on three intra-operative variables: estimated blood loss (EBL), lowest mean arterial pressure (MAP) and lowest heart rate (HR). In a general and vascular surgery population, this score was an independent predictor of major complication or death within 30 days of surgery. This same finding was seen in a large national retrospective analysis of general surgery patients as well as national and international prospective cohort studies [9–12]. Currently, the SAS is being studied prospectively in some institutions as a triage tool for postoperative care [13].

Despite the interest in the SAS by both administrators and physicians, ancillary studies have been conflicting. Studies in neurosurgical, oncology, gastrointestinal, vascular, urologic and colorectal surgery populations have confirmed the SAS's predictive ability for peri-operative morbidity [11,12,14–16]. Other studies in gastrectomy, neurosurgery and orthopedic patients were unable to confirm this association [17–19].

Patients undergoing hysterectomy for gynecologic malignancy represent a vast and diverse population. Procedures may vary from a simple hysterectomy performed vaginally, laparoscopically, robotically or abdominally to a hysterectomy that is part of a more radical procedure such as a debulking or exenteration. Multiple studies have commented on the complexity of this patient population, reporting up to a 16% readmission rate and a 32% complication rate for common procedures [20–23,27]. The aim of this investigation was to examine the SAS as a predictor of peri-operative morbidity in women undergoing hysterectomy for gynecologic malignancy.

Methods

After obtaining institutional approval from the Massachusetts General/Partners Healthcare review board, we identified all patients who underwent a hysterectomy for malignancy between January 2008 and December 2010. Inclusion into the study required the following: operative indication was malignancy and the patient had a hysterectomy performed as part of their surgery. Patients were excluded from analysis if operative or postoperative care occurred at another institution. Information regarding the patient's hospital stay, postoperative appointments, laboratories, discharge summaries and radiologic tests are all stored in the electronic medical record and were reviewed to examine each patient's postoperative course. Length of follow-up ranged from three to five years.

In regard to intraoperative data, surgical records are electronic at our institution and the anesthetic record is generated directly from data points obtained electronically during the case. Over 100 clinical variables were extracted for each patient by a single physician who created the database. Abstracted data included: age, comorbidities, ASA class, body mass index (BMI), surgeon, surgeon volume, disease site, use of regional anesthestic, preoperative albumin, blood counts and metabolic panels, prior abdominal/pelvic surgery, surgical modality, surgical procedures performed, estimated blood loss (EBL), the highest and lowest systolic blood pressure (SBP), the highest and lowest diastolic blood pressure (DBP), mean arterial blood pressure (MAP), the highest and lowest heart rate (HR), the lowest intra-operative temperature, urine output, intravenous pressor requirement, volume of resuscitative fluids, transfusions, length of surgery, epidural placement, length of stay, intra-operative complications, postoperative complications, intensive care unit (ICU) admission and readmission. Data were checked for accuracy by two other physicians who manually performed individual and random spot checks of patient information in order to ensure accuracy.

Peri-operative complications were defined by using the American Board of Obstetrics and Gynecology's reportable event parameters: estimated blood loss greater than 2 l, transfusion requiring more than 4 units of red blood cells, vascular injury, nerve injury, urinary injury, unplanned admission to intensive care unit, re-operation, fistula, anastomotic leak, length of hospital stay greater than 15 days and readmission within 30 days of index discharge. In addition, we added venous thrombotic event/pulmonary embolus as a complication.

Given our concern that SAS, which is based on EBL, is confounded by two peri-operative complication events (EBL > 2 l and transfusion greater than 4 units), we further stratified peri-operative complications into intra-operative and post-operative complications. Intra-operative complications were defined as the following: EBL greater than 2 l, transfusion requiring more than 4 units of red blood cells, vascular injury, nerve injury and urinary injury. Although the transfusion of four or more packs of red blood cells may have actually taken place several days after the index procedure, this was considered an intra-operative complication as it reflected the need to correct blood that was lost during the surgery or as a result of inadequate hemostasis at the conclusion of surgery.

Postoperative complications were defined as unplanned admission to ICU, re-operation, fistula, anastomotic leak, pulmonary embolus, death, length of hospital stay ≥ 15 days and readmission. Readmissions were defined as unplanned admission to the hospital within 30 days of index operation. The Apgar score was calculated using the previously described scoring system by Gawande et al. which utilizes the patient's EBL, lowest MAP, and lowest HR (Table 1).

Clinical variables were correlated utilizing Fisher's exact test, $\chi 2$, and Student's t-test as appropriate for univariate analysis. Significantly associated variables were then analyzed in linear and logistic regression models in order to determine independent variables associated with peri-operative morbidity and mortality. Statistical analysis was performed with Stata v10 (College Station, TX).

Results

A total of 632 patients were included in the analysis. The median age was 60 years old, mean ASA class was 2.5 and mean body mass index (BMI) was 29.2. Of our cohort, 64% underwent surgery for cancer arising in the uterus, followed by ovary at 28.6% and cervix at 4%. Infrequently patients underwent an exenterative procedure for vulvar/vaginal cancer which included a hysterectomy (n = 2, 0.03%) and another 3% of patients had a hysterectomy performed for non-gynecologic malignancy. Most commonly this was part of a combined, interdisciplinary

Table 1
The 10 point Surgical Apgar Score.

	0 points	1 point	2 points	3 points	4 points
Estimated blood loss (mL)	>1000	601–1000	101–600	≤100	
Lowest mean arterial pressure (mm Hg)	<40	40–54	55–69	≥70	
Lowest heart rate (beats per minute)	>85	76–85	66–75	56–65	≤55