Predisposed to failure? The challenge of rescue in the medical intensive care unit

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The authors have nothing to disclose.

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BACKGROUND: Medical intensive care unit (MICU) patients develop acute surgical processes that require operative intervention. There are limited data addressing outcomes of emergency general surgery (EGS) in this population. The aim of our study was to characterize the breadth of surgical consults from the MICU and assess mortality after abdominal EGS cases.

METHODS: All MICU patients with an EGS consult in an academic medical center between January 2010 and 2016 were identified from an electronic medical record-based registry. Charts were reviewed to determine reason for consult, procedures performed, and to obtain additional clinical data. A multivariate logistic regression was used to determine patient factors associated with patient mortality.

RESULTS: Of 911 MICU patients seen by our service, 411(45%) required operative intervention, with 186 patients undergoing an abdominal operation. The postoperative mortality rate after abdominal operations was 37% (69/186), significantly higher than the mortality of 16% (1833/11192) for all patients admitted to the MICU over the same period ($p < 0.05$). Damage-control procedures were performed in 64 (34%) patients, with 46% mortality in this group. The most common procedures were bowel resections, with mortality of 42% (28/66) and procedures for severe clostridium difficile, mortality of 38% (9/24). Twenty-seven patients met our definition of surgical rescue, requiring intervention for complications of prior procedures, with mortality of 48%. Need for surgical rescue was associated with increased admission mortality (odds ratio, 13.07; 95% confidence interval, 2.86–59.77). Twenty-six patients had pathology amenable to surgical intervention but did not undergo operation, with 100% mortality. In patients with abdominal pathology at the time of operation, in-hospital delay was associated with increased mortality (odds ratio, 5.13; 95% confidence interval, 1.11–23.77).

CONCLUSION: Twenty percent of EGS consults from the MICU had an abdominal process requiring an operative intervention. While the MICU population as a whole has a high baseline mortality, patients requiring abdominal surgical intervention are an even higher risk. (*J Trauma Acute Care Surg.* 2019;87: 774–781. Copyright © 2019 American Association for the Surgery of Trauma.)

LEVEL OF EVIDENCE: Prognostic and epidemiological, level III
KEY WORDS: Medical intensive care unit; emergency general surgery; surgical rescue.

Acute abdominal pathology requiring operative management occurs in 1% to 4% of patients in the Medical intensive care unit (MICU).[1,2] Commonly encountered diagnoses in this population include clostridium difficile colitis, bowel obstruction, ischemic bowel, ulcer disease, pancreatitis, and cholecystitis. Other pathologies in the MICU include abdominal compartment syndrome, acute gastrointestinal bleeding, and postprocedural complications.[1–3] The surgical service is often called to evaluate patients with abdominal pain, sepsis of unclear etiology, unexplained laboratory abnormalities, or vasopressor requirements in the MICU. In this setting, surgeons serve as a rapid response team to aid with diagnosis, provide additional guidance for medical management, and to determine when patients require operative management.[4]

Prior studies of the MICU population have demonstrated significant postoperative mortality after abdominal operations. This literature has small patient cohorts and has not been updated in the last 15 years.[1,2] However, there have been numerous studies that describe the increased morbidity and mortality in the emergency general surgery (EGS) population compared to the elective surgical population.[5–9] The aim of this study was to determine the frequency and breadth of EGS consults from the MICU and to establish the postoperative outcomes of MICU patients undergoing emergent abdominal procedures. We hypothesized that MICU patients requiring abdominal EGS procedures would have significant in-hospital mortality, despite evolution in operative management and critical care over the last few decades.

Submitted: Semptember 7, 2018, Revised: May 30, 2019, Accepted: June 1, 2019, Published online: June 13, 2019.
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Presentation: Oral Presentation at the 77th Annual Meeting of the American Association for the Surgery of Trauma, September, 2018 in San Diego, California.
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DOI: 10.1097/TA.0000000000002411

METHODS

Data Collection

The method for data collection into the patient database has been previously described.[3] Briefly, coding modifications were inserted into the electronic medical record at a single large urban referral center to prospectively identify and export all patient encounters involving EGS as an admitting or consulting service; this database has been expanded since its previous description to capture patient encounters from 2010 to 2016. The database was queried to identify all patients who received care in the MICU and had involvement of the EGS service, as confirmed by individual chart review. The reason for consultation was identified and classified as abdominal or nonabdominal. Operative procedures were verified between the database and the medical record and then classified based upon review of the operative note. Dates and times of consults were determined by time stamps on notes written in the medical record. Similarly, operative dates and times were determined by intraoperative records. The Glasgow Coma Scale and laboratory values closest to the time of operation and within 24 hours were used for analysis. The number of vasopressors in the 24 hours and 48 hours prior to the index operation were recorded. One year mortality was determined by crossreferencing patients in the database with social security death index records.

Any delay was defined as used in Kollef study with a cutoff of greater than 24 hours from onset of signs or symptoms of an intraabdominal process. This was determined through individual chart review of history and physical and consult notes, along with laboratory and radiographic data.

Signs and symptoms included abdominal pain, laboratory abnormalities, unexplained fever or vital sign abnormalities, or radiographic abnormalities. Delays were further classified into prehospital delay if documented time of onset to time of presentation to our hospital was greater than 24 hours, and in-hospital delay if time of onset to time of EGS consultation or operative procedure was greater than 24 hours. Prehospital delays were characterized as patient related if due to delay in presentation to medical care, outside hospital related, or facility (rehabilitation, skilled nursing facility, long-term acute care facility) related.

Postoperative surgical rescue was defined as any patient in whom the index operative intervention was required due to a complication from a prior procedure. This was determined via individual chart review to identify procedures prior to our index procedure. The indication for intervention was then analyzed to determine whether this represented management of a procedural complication. These were further classified as occurring in hospital or at an outside facility.

The primary endpoint in this study was hospital admission mortality. The secondary endpoint was 1 year mortality, obtained through social security death index records by name and date of birth matching. The Predictive OpTimal Trees in Emergency Surgery Risk (POTTER) calculator, a machine learning version of the Emergency Surgery Acuity Score (ESAS) used to estimate mortality, was used to calculate a score for each patient using the publicly available smartphone application.[10]

Statistical Analysis

Data analysis was performed using python, 3.6.1; pandas, 0.22.0; statsmodels, 0.8.0; numpy, 1.14.2; and scipy, 1.0.0. Clinically important patient characteristics and variables were selected based on clinical expertise. Medication reconciliation data were utilized to categorize admission medications into immunosuppressant, anticoagulant, antiplatelet, insulin, noninsulin hypoglycemic, and antibiotic categories. Laboratory values were obtained from the time of a surgical consultation or earlier for MICU patients. Laboratory values were excluded from analysis if there was greater than 25% missing data. The remaining missing values were imputed by the median. The number of vasopressors ordered 0 hour to 24 hours and 24 hours to 48 hours prior to surgical consultation were identified by the number of unique continuous vasopressor medications ordered during this period. Missing values for dichotomous variables were imputed to a negative value. A correlation matrix was used to identify and remove any variables with high correlation. Variance inflation factor (VIF) between each variable was also calculated to help detect multicollinearity. Variables with a VIF greater than 5 were considered to have high multicollinearity and were removed sequentially starting with the highest VIF score. A logistic regression was created for MICU admission mortality and MICU 1-year mortality.

RESULTS

Between 2010 and 2016, the EGS service consulted on 911 MICU patients, representing 8% (911 of 11,192) of the MICU population over that time. The consult question was related to a nonabdominal question in 333 (37%) of patients, with 68% (225 of 333) of these patients undergoing operative procedures. Nonabdominal interventions included access procedures, tracheostomy and/or feeding tube placement, and skin or soft tissue procedures. The majority of the consults (578 of 911,

TABLE 1. Clinical and Demographic Characteristics of the Patient Cohort

	MICU
	% or Value ± Standard Deviation
Age	59.6 ± 15.1
Male sex	53%
African American race	8%
White race	77%
Unknown race	15%
BMI	31.0 ± 18.7
GCS score	11.0 ± 4.3
Intubated at time of index procedure	48%
Hemodialysis at index procedure	8%
Tracheostomy	23%
Ventilator days	12.3 ± 16.2
Intensive care unit days	16.2 ± 18.1
Hospital days	25.7 ± 23.3
Medications	
Antibiotics	30%
Immunosuppressants	23%
Anticoagulants	18%
Antiplatelet agents	33%
Insulin	22%
Noninsulin diabetic medications	11%
No. vasopressors in 24 h prior to procedure	1.01 ± 1.47
No. vasopressors in 48 h prior to procedure	0.13 ± 0.66
Admission and disposition	
Admission via the emergency department	34%
Discharge to home	18%
Laboratory values	
ALT, unit/L	124.57 ± 473.97
Albumin, g/dL	2.51 ± 0.65
Alkaline phosphatase, unit/L	115.09 ± 112.89
Total bilirubin, mg/dL	1.79 ± 2.9
Creatinine, mg/dL	2.01 ± 1.49
Hemoglobin, g/dL	9.64 ± 2.21
INR	1.73 ± 0.85
Lactate, mmol/L	4.17 ± 4.97
Sodium, mmol/L	138.97 ± 5.17
PTT, s	45.41 ± 26.05
Platelet count, $\times 10^3/\mu L$	215.13 ± 121.58
WBC count, $\times 10^3/\mu L$]	18.05 ± 13.39
Procedures	
Damage control	34%
Surgical rescue	15%
Total number of procedures	2.3 ± 1.9
Mortality	
Admission mortality	37%
1 y Mortality	50%
Surgical rescue admission mortality	48%

BMI, body mass index; GCS, Glasgow Coma Scale; PTT, partial thromboplastin time; WBC, white blood cell; INR, International Normalized Ratio.

63%) were for an abdominal question. Operative intervention was required in 32% (186 of 578) of these patients, representing 20% of the consult population and 2% (186/11192) of the overall MICU population over this period.

The cohort of MICU patients requiring an abdominal operation was 53% male, with a mean age of 59.6 years (Table 1). Nearly half of patients (48%) were intubated at the time of the index procedure, and the majority (66%) were transfers from an outside facility. At baseline, 23% were on immunosuppressant medications, 51% were on anticoagulant or antiplatelet medications, and 32% were on diabetic medications. Thirty percent of patients were on antibiotics at the time of the index procedure. The most common procedures required were bowel resection (66 of 186, 36%), clostridium difficile procedures including loop ileostomy with lavage or colonic resection (24 of 186, 13%), and negative abdominal explorations (23 of 186, 12%) in which no intraabdominal pathology was found despite preoperative suspicion. Damage-control procedures were performed in 64 (34%) patients (Table 2).

Prehospital and In-hospital Delays

Delay to diagnosis and treatment was seen in 129 (60%) patients in the MICU cohort. The majority of these delays (94 of 129, 73%) were prehospital delays, with 44% related to outside hospital events, and 43% from the patient delaying presentation to the hospital. In a small number of patients, there was a combined delay between the patient and outside hospital, a delay in presentation from a facility (nursing facility, assisted living facility), or a combination of a facility and outside hospital. In one-third of cases (35 of 129, 33%), there was a delay in surgical involvement and operative management in the hospital. There were prehospital combined with further in-hospital delays in eight patients.

Surgical Rescue from Prior Procedural Complications

In the MICU, 27 (15%) patients required operative interventions due to complications from prior procedures. The index procedure was performed at an outside institution in the majority of these cases (70%). Mortality in this rescue population was 48% (13 of 27).

Admission Mortality

Of the 186 MICU patients undergoing abdominal procedures, 69 (38%) died during hospital admission. Mean time to death was 20.6 days, with 23% of deaths occurring within 48 hours. Unadjusted mortality in the entire MICU population during this period was significantly lower at 16% (1,833 of 11,192, $p < 0.05$). Mortality rates for the most common procedures were 42% for bowel resection cases, 38% for clostridium difficile related procedures, and 30% with negative abdominal explorations. In patients undergoing damage-control procedures, mortality was 47% (30 of 64). High mortality rates were seen in operative procedures to treat complications from feeding tube placement (4 of 5, 80%) and decompressive laparotomies (4 of 7, 57%) though these were performed in only a small number of patients. In five patients, the abdominal process was found to be so severe that operative intervention was considered futile, and mortality in this group was 100%. In patients who died, the most common cause of death was multisystem organ failure at 28%. Mesenteric ischemia (13%) and ischemic colitis (10%) were the next most common causes of death in the overall population. Other causes of death included acute respiratory distress syndrome, hemorrhage, sepsis and septic shock, as well as other individual organ failures. In patients undergoing negative explorations, three died of multisystem organ failure, two of septic shock, one of heart failure, and one of a variceal hemorrhage (data not shown). POTTER scores were calculated for each

TABLE 2. Procedures Performed in the MICU

	MICU				
Procedure Type	**Cases (n)**	**Damage Control (n)**	**Damage Control (%)**	**Mortalities (n)**	**Mortality (%)**
Abscess drainage	5	0	0%	1	20%
Appendectomy	4	0	0%	0	0%
Bleeding control	3	2	100%	1	33%
Bowel resection	66	43	65%	28	42%
Clostridium difficile procedure	24	2	8%	9	38%
Cholecystectomy	9	1	11%	1	11%
Decompressive laparotomy	7	7	100%	4	57%
Diverting ostomy	4	0	0%	1	25%
Intervention for ulcer disease	10	2	20%	2	20%
Management of feeding tube complication	5	1	20%	4	80%
Hernia repair without bowel resection	3	1	33%	2	67%
Intraoperative findings of futility	5	0	0%	5	100%
Lysis of adhesions	2	0	0%	0	0%
Negative laparoscopy/laparotomy	23	0	0%	7	30%
Pancreatic drainage or debridement	3	3	100%	2	67%
Splenectomy	2	0	0%	0	0%
Other procedures	11	2	25%	2	25%
Total	186	64	34%	69	37%

TABLE 3A. Logistic Regression Analysis of Factors Associated With Admission Mortality in the MICU Population: All MICU Patients Undergoing Abdominal Procedures

Factors	OR	95% CI	*p*
Surgical rescue	13.07	2.86–59.77	0.001
Male sex	3.80	1.25–11.59	0.019
Total bilirubin	1.53	1.17–2.00	0.002
Lactate	1.19	1.04–1.36	0.010
Age	1.10	1.05–1.15	0.0001
Sodium	0.95	0.91–0.98	0.002
Prehospital delay: patient-associated	0.15	0.04–0.63	0.010

TABLE 4A. Logistic Regression Analysis of Factors Associated With 1-year Mortality in the MICU Population: All MICU Patients Undergoing Abdominal Procedures

Factor	OR	95% CI	*p*
Preoperative hemodialysis	20.38	2.58–161.15	0.004
Surgical rescue	5.95	1.59–22.32	0.008
Total bilirubin	1.51	1.15–1.97	0.003
Age	1.07	1.04–1.11	0.0001
Sodium	0.96	0.93–0.994	0.021
Total number of procedures	0.78	0.62–0.991	0.042
Albumin	0.46	0.22–0.96	0.040

patient in the cohort, and ranged from 4% to 71% estimated 30-day mortality, with a mean estimate of 33%. In survivors, the score was 29%, while in nonsurvivors the score was 43%.

Logistic regression analysis revealed factors associated with increased mortality in the MICU population included age (odds ratio [OR], 1.10; 95% confidence interval [CI], 1.05–1.15), total bilirubin (OR, 1.53; 95% CI, 1.17–2.00), lactate (OR, 1.19; 95% CI, 1.04–1.36), male sex (OR, 3.80; 95% CI, 1.25–11.59), and surgical rescue (OR, 13.07; 95% CI, 2.86–59.77) (Table 3A). Prehospital patient delay was the only type of delay associated with mortality, with an odds ratio of 0.15 (95% CI, 0.04–0.63). Plasma sodium was also associated with mortality with an odds ratio of 0.95 (95% CI, 0.91–0.98). Secondary analysis was performed after eliminating patients with negative explorations and yielded the expanded list of factors associated with mortality seen in Table 3B. The same factors listed above were again shown to be similarly associated with mortality in this population. New identified factors associated with increased mortality were creatinine (OR, 1.73; 95% CI, 1.05–2.83) and in-hospital delay (OR, 5.13; 95% CI, 1.11–23.77). Factors inversely associated with mortality included total number of procedures, anticoagulation use, cholecystectomy, interventions for ulcer disease, and African American race.

TABLE 3B. Logistic Regression Analysis of Factors Associated With Admission Mortality in the MICU Population: MICU Patients Undergoing Abdominal Procedures With Confirmed Pathology

Factor	OR	95% CI	*p*
Surgical rescue	17.33	2.41–124.61	0.005
In-hospital delay	5.13	1.11–23.77	0.037
Male sex	4.97	1.15–21.48	0.032
Creatinine	1.73	1.05–2.83	0.030
Total bilirubin	1.63	1.17–2.23	0.004
Lactate	1.28	1.08–1.51	0.004
Age	1.17	1.09–1.25	0.0000
Sodium	0.91	0.86–0.96	0.0002
Total number of procedures	0.76	0.58–0.997	0.047
Patient delay	0.07	0.009–0.54	0.010
Procedure: intervention for ulcer disease	0.07	0.005–0.97	0.048
Anticoagulation	0.06	0.009–0.43	0.005
African American race	0.02	0.001–0.35	0.009
Procedure: cholecystectomy	0.000	0.000–0.992	0.050

One year mortality was also analyzed as a secondary outcome postoperatively, with a 50% mortality (93 of 186) in the MICU population. Logistic regression analysis revealed significant associations with age (OR, 1.07; 95% CI, 1.04–1.11), total bilirubin (OR, 1.51; 95% CI, 1.15–1.97), surgical rescue (OR, 5.95; 95% CI, 1.59–22.32), and preoperative hemodialysis (OR, 20.38; 95% CI, 2.58–161.15). Serum albumin (OR, 0.46; 95% CI, 0.22–0.96), sodium (OR, 0.96; 95% CI, 0.93–0.994), and total number of procedures (OR, 0.78; 95% CI, 0.62–0.991) were associated with decreased mortality (Table 4A). In subanalysis of patients who had confirmed pathology on exploration, albumin and total procedures were no longer significantly associated with mortality, while the other variables remained the same. An additional association was seen between lactate level and increased mortality (OR, 1.15; 95% CI, 1.004–1.33) (Table 4B).

DISCUSSION

In this study, we demonstrate that 20% of EGS consults in the MICU require abdominal operations, with resultant high postoperative mortality. While multiple factors were associated with mortality, surgical rescue demonstrated the greatest increase in mortality both during admission and at 1 year. In-hospital delays to surgical care were associated with increased mortality in patients who were found to have intraabdominal pathology at the time of operation.

Few prior studies have focused on the management of abdominal pathology in the MICU population. A prospective observational study of 67 MICU patients with abdominal pathology by Kollef et al. noted a mortality of 25% in the patients who underwent surgery.[1] In a retrospective cohort study

TABLE 4B. Logistic Regression Analysis of Factors Associated With 1-year Mortality in the MICU Population: MICU Patients Undergoing Abdominal Procedures With Confirmed Pathology

Factor	OR	95% CI	*p*
Preoperative hemodialysis	28.84	2.05–405.93	0.013
Surgical rescue	4.37	1.03–18.59	0.046
Total bilirubin	1.47	1.10–1.95	0.008
Lactate	1.15	1.004–1.33	0.044
Age	1.09	1.05–1.14	0.0000
Sodium	0.94	0.91–0.98	0.002

of 77 MICU patients with "abdominal catastrophe," Gajic et al.[2] reported a mortality of 45% in patients undergoing operative intervention. Our 37% mortality is consistent with this prior literature, with the variation likely due to differences in the patient populations in these prior two studies compared with our cohort. In the two aforementioned studies, small cohorts of patients did not undergo abdominal operations despite their abdominal pathology, and the mortality in these groups was 100%. In our initial patient review, there were 26 MICU patients who had intraabdominal processes amenable to operative intervention, however due to the severity of illness and poor prognosis, procedures were not pursued. In this population, mortality was 100%, again consistent with the prior literature. It is important for surgeons to recognize the patients who are unlikely to be rescued to avoid nonbeneficial procedures while also maintaining a low threshold for early intervention in the population that has the potential for rescue.

Previous data from our institution demonstrated that patients who develop complications after procedures often require operative intervention and have higher morbidity and mortality than patients without complications.[3] Our current data reaffirm this finding for critically ill medical patients over a longer time interval, with a 48% mortality seen in surgical rescue patients from the MICU. The need for surgical rescue was associated with significantly increased odds of both admission and 1-year mortality in the MICU population. Patients who undergo outside procedures prior to MICU admission are often transferred for medical complications, such as respiratory failure, which may not prompt the primary team to investigate for procedural complications that would require intervention. This is supported by the finding that 22% of MICU rescue patients had an in-hospital delay. Given that these patients are at high risk for deterioration, surgical consultation should be obtained for any patient admitted to the MICU after an outside hospital procedure to evaluate for a surgical complication. After in-hospital procedures, any evidence of decompensation or complication should also prompt immediate surgical consultation. Patients found to have any postprocedural complication must be carefully managed both medically and surgically to optimize chances for rescue.

In contrast to prior studies, we did not find that delay to management increased mortality when examining the entire cohort. The time from admission to operative intervention also was not associated with mortality in our population. However, when the patients with negative explorations were eliminated from the cohort, in-hospital delay had a significant association with admission mortality. This demonstrates that timely diagnosis and involvement of the surgical team does affect outcomes in patients who have confirmed pathology, consistent with prior studies.[1,2,11] The finding that prehospital patient delay had an inverse relationship with mortality in both the entire MICU cohort and the cohort with pathology identified in the operating room may reflect a more indolent course in patients who delay presentation to the hospital, in contrast to patients who present earlier due to a precipitous decline at home.

The efforts are ongoing to develop preoperative risk assessment tools to predict outcomes in the EGS population based upon admission and preoperative characteristics.[12] The ESAS has 22 predictors associated with mortality and has been shown to correlate with complications, while another tool that is yet to be fully validated uses age, albumin, sepsis, BUN and nonindependent status to estimate mortality.[10,13–15] The machine learning tool derived from ESAS, called the POTTER score, is now a publicly available smartphone application.[10] Investigators have also developed a frailty score in EGS patients to help predict outcomes.[16] Analysis of our MICU population revealed that age was associated with increased odds of mortality, which is consistent with multiple risk calculators. Male sex was also found to increase odds of admission mortality. Prior studies have demonstrated an association between sex and postoperative morbidity in EGS patients; however, sex is included neither in the ESAS nor the five variable risk calculator.[7,12] The appearance of total bilirubin as a factor associated with both short- and long-term mortality could be related to the role of underlying liver dysfunction, as chronic liver disease has previously been shown to correlate with EGS outcomes.[17] While only a small subset of our patients were on hemodialysis at the time of the index procedure, this was associated with an increased odds of one-year mortality, consistent with prior studies of renal dysfunction and mortality in the EGS population.[18–20] In analyzing our cohort, we used the POTTER score to evaluate estimated mortality and found that it did appropriately estimate the overall cohort mortality, and there was a difference in POTTER scores between nonsurvivors and survivors.

It is important to consider the limitations of this study when evaluating our results. While much of the data was collected in this prospectively maintained database, additional data points were gathered via retrospective review of patient information. Incomplete and missing data do limit a full comparison between patients and cohorts. Lack of access to data on the entire MICU population limits comparisons of mortality between EGS and non-EGS patients in the MICU. There was no matched cohort of non-MICU patients used in this study to compare mortality in the MICU versus other hospital intensive care unit locations. Furthermore, the findings at our institution may not mirror those at other hospitals based on different patient populations or different approaches to abdominal pathology by intensivists and surgeons.

Overall, we demonstrate that patients in the MICU requiring EGS procedures have significant mortality both during the index admission and extending to 1 year. Patients who have undergone prior procedures and have developed complications requiring operative intervention are at high risk for poor outcomes. In patients with pathology identified in the operating room, in-hospital delays were associated with increased hospital mortality, suggesting that early identification and diagnosis are important to outcomes. Given the vulnerability of this population, teamwork between the MICU and surgical services remains essential to identify and manage patients with abdominal pathology to optimize outcomes.

AUTHORSHIP

A.B. participated in the literature search, study design, data collection, data analysis, data interpretation, writing, critical revision. R.H. participated in the data collection, data analysis, data interpretation, writing, critical revision. M.K. participated in the data collection, critical revision. A.B.P. participated in the study design, data analysis, data interpretation, critical revision. R.M.F. participated in the study design, data analysis, data interpretation, writing, critical revision.

DISCLOSURE

The authors declare no funding or conflicts of interest.

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DISCUSSION

LENA NAPOLITANO, M.D. (Ann Arbor, Michigan): Good afternoon, everyone. Good afternoon, Dr. May, Dr. Knudson. I'd like to thank the Association for the opportunity to discuss this paper in an area that really is important and has been neglected, I think, in our area of acute care surgery in the last couple of decades.

Dr. Briggs and her colleagues from the University of Pittsburgh are to be congratulated for this important work. And the important finding that 20 percent of the EGS consults in the medical ICU required abdominal surgical intervention, again, is a very important finding.

This concept of surgical rescue was developed by their group and they showed that surgical rescue in the medical ICU was associated with high mortality but not in the surgical ICU.

So I have three questions for Dr. Briggs.

First, she showed that bowel resection was the most common procedure performed in both the MICU and SICU cohorts, in general. But you didn't tell us what was the most common operative procedure in the surgical rescue cohort. And, again, that's the cohort that had the very highest mortality risk.

She also showed us that surgical rescue was associated with a 13-fold increased hospital mortality risk and a 6-fold increased one-year mortality risk in the MICU cohort but that, again, surgical rescue, meaning surgery after a procedure, a complication of a procedure, was not a risk factor for increased mortality in the SICU cohort.

So in reading her paper, which is excellent and hopefully should be published soon, I want to really dive in and try to determine what are some potential modifiable risk factors that could potentially reduce the mortality of the surgical rescue, of the medical rescue patients' high mortality.

One of the questions that comes up as you look at your data is you have quite a large number of patients that get admitted to the medical ICU after procedures that then required laparotomy. Should those patients go to the surgical ICU? It seemed the surgical ICU outcomes were quite a bit better.

And, again, having the benefit of reading her wonderful manuscript the patients in the medical ICU seemed to have a much higher percentage of septic shock and multiple organ failure. And, again, would they be better managed in the surgical ICU?

And then, finally, many studies in the U.S. and worldwide have really confirmed that emergency laparotomy mortality rates are very high. But the reports mostly from the U.S. and the U.K. are about 10 to 15 percent.

Here in your study you're reporting mortality rates that are much higher – 42 percent for the emergency laparotomy group for bowel resection in the MICU; 22 percent for the emergency laparotomy cohort in the SICU. Again, that's double or triple the rates that are reported nationally and internationally.

And one of the ways that you can carefully review your data in clearly another risk-adjusted outcome measure would be to use the previously-evaluated scores for emergency laparotomy to risk-adjust outcomes.

And there are two widely used scores that I would advocate that you consider using in your study. One is the Emergency Surgery Score. And the second is the National Emergency Laparotomy Audit, the NELA score, that was developed in the U.K.

Both of those risk prediction models have been validated as scoring systems to really risk-adjust outcomes in emergency general surgery, particularly in emergency laparotomy.

Since the MICU patients had much higher rates of septic shock and multiple organ failure and particularly renal failure, it would be wise to use one of those scoring systems or to develop your own in your cohort and validate those findings for risk-adjusted outcomes.

But I think your work is excellent. It's in an area that's really been avoided and we really haven't looked at carefully in the last couple of decades so congratulations on your work. I hope you continue to work in this area and present your data here at AAST.

Thank you.

JAY J. DOUCET, M.D. (San Diego, California): Excellent work. I agree with your conclusions. I think this is an important study for all intensivits.

Sitting on the our association's Health Care Economics Committee means I want to ask you about the money. Have you looked at the costs and charges involved here because you are saving money when you do this.

And more importantly, AHRQ or CMS calls failure to rescue Patient Safety Indicator Number 4. So if you do a good job on this statistic you save your hospital money as it doesn't get clawed back by CMS.

So if you do that cost-calculation make sure you throw that money in there, too, because you're going to make money twice. You're going to save the costs and you're going to also get money back from the government.

ROBERT G. SAWYER, M.D. (Kalamazoo, Michigan): Thank you very much. Why do you think the male sex was associated with a higher mortality?

ALEXANDRA BRIGGS, M.D. (Lebanon, New Hampshire): So first of all, thank you all very much for all of your thoughtful questions.

In order to address Dr. Napolitano's questions first, in terms of the rescue procedures in our cohort, in the MICU and the SICU, both, bowel resections were actually still the most common procedure for surgical rescue.

In terms of the other procedures, feeding tube-related complications were actually the next most common procedure in both. And those had significant mortality if there were problems after a feeding tube was placed.

The other more common one in the SICU was surgical rescue due to bleeding from an outside hospital procedure. Those were the most common.

In terms of the reason for rescue, I absolutely think that if a patient has had an outside hospital procedure that they should be managed in the SICU if they come to our institution.

I think the difficult thing is that sometimes referral patterns end up coming to the MICU instead. They know those providers well from transferring a lot of other patients and so often they're their first call.

And I think the other thing is it is often how the patients are billed. So patients have ARDS post-operatively and they say, oh, this is a medical problem and they send them to the MICU not realizing that it's because they have an anastomotic leak or some other intraabdominal process.

So I think certainly the referral pattern is something we need to work on. But I think that all patients who have had an outside procedure and have critical illness needs should go to a SICU.

I think part of it is also cognitive bias and anchoring bias so that when a patient is admitted from an outside hospital, billed as ARDS, they don't necessarily think about a possible intraabdominal process going on.

So you know these patients are probably still going to continue to be admitted to the MICU in which case I think mandating that a surgical consult be done if they have had an outside procedure is a way to get around that.

In terms of using the scoring systems, I think that's a great idea. The problem with our current data that we have with the ESS score, we don't have access to some of the functional data that that requires and then, also, the weight loss which I think is another aspect of the ESS score.

I have not really been familiar with the U.K. scoring system that you mentioned so that is something we can look into and see whether we can retrospectively apply that to this study.

Dr. Doucet, I appreciate your comments about cost. I agree with you that it's something that we should look at. It's not something I have done to date.

So it is certainly something that I would be interested in doing moving forward. And next steps of this are also going to be tracking some of the complications of readmission rates which I think also will lend to cost.

If the MICU patients are having further, you know, complications after their abdominal procedures and further readmissions then, again, that's a cost that we have to address.

In terms of the last question regarding male gender, there is not a lot of data out there regarding male gender and EGS outcomes. There are a couple of small studies in EGS suggesting that men do worse.

The pathways for that are not entirely clear. It's something that I was a little bit surprised by when that came out in our data and something that I think we need to look into further. I don't have a great explanation for it at this point.

One thing that I do want to look at is whether there are differences in delays in that population. Do they stay at home longer before they present? Do they have, you know, uncontrolled morbidities that they're not, you know, taking care of before they get into the hospital so their reserve is lower?

I don't have a good answer for that at this point but certainly something that we need to look at moving forward. So thank you for that question, as well.

Thank you.