



## Early postoperative death in extreme-risk patients: A perspective on surgical futility

Alexander S. Chiu, MD, MPH<sup>a,\*</sup>, Raymond A. Jean, MD<sup>a</sup>, Benjamin Resio, MD<sup>a</sup>, Kevin Y. Pei, MD<sup>b</sup>

<sup>a</sup> Department of Surgery, Yale School of Medicine, New Haven, CT

<sup>b</sup> Department of Surgery, Texas Tech School of Medicine, Lubbock, TX

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### ABSTRACT

**Background:** Surgical futility is poorly defined. However, there are patients with extremely high pre-operative risk who still undergo surgery and ultimately die, suggesting futile care. To further explore surgical futility, we examined the incidence and factors associated with extreme-risk patients undergoing major emergency general surgery with early death.

**Methods:** The American College of Surgeons National Surgical Quality Improvement Program database was reviewed for all adults undergoing colectomy, small bowel resection, control of bleeding ulcer, lysis of adhesion, and exploratory laparotomy between 2007 and 2015. Extreme-risk was defined as having an estimated mortality risk  $\geq 75\%$  using the National Surgical Quality Improvement Program mortality-risk calculator. Futile care was defined as extreme-risk patients who died within 48 hours of an operation. The incidence of, and clinical factors associated with, futile surgery were identified.

**Results:** Of 94,350 emergency general surgery patients, 1.9% were extreme-risk. Among extreme-risk patients, 30-day mortality was 71.2%; 31.6% of extreme-risk patients died within 48 hours, representing futile care. Only 5.5% of extreme-risk patients were discharged home. Patients who were  $>80$  years (odds ratio [OR] 6.25 vs 40–64; 95% confidence interval [CI], 4.51–8.66), septic (OR 4.63; 95% CI, 3.38–6.34), or had a dependent functional status (OR 2.50 vs independent; 95% CI, 1.83–3.43) had higher odds of having a futile operation.

**Conclusion:** A significant number of emergency general surgery operations were on extreme-risk patients who suffered early death, which may indicate futile care. Surgeons face numerous conflicting pressures when asked to perform potentially futile surgery. Additional research in the decision-making process in these cases is needed to understand why surgeons operate in such dire circumstances and whether they should.

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The decision of when to operate is one of the most difficult in surgery. This is especially challenging when a patient presents with significant comorbidities, increasing their odds of a poor operative outcome and potentially early death. However, data suggests that even in cases where patients are near the end of their life, surgery is still common. One study showed that nearly a quarter of Medicare beneficiaries undergo a surgical procedure within the past 3 months of their life, and  $\sim 10\%$  have a surgical procedure during their last week.<sup>1</sup>

\* Reprint requests: Alexander S. Chiu, MD, MPH, Department of Surgery, Yale School of Medicine, General Surgery Resident, 330 Cedar St, FMB 116, New Haven CT 06515.

E-mail address: [alex.chiu@yale.edu](mailto:alex.chiu@yale.edu) (A.S. Chiu).

Risk of mortality is a factor that many surgeons incorporate into their decision of whether to offer an operation, but each surgeon likely has their own threshold and aversion level for risk.<sup>2</sup> Despite significant variability, most surgeons will encounter a clinical scenario where they feel the odds of successfully improving a patient's life are vastly outweighed by the risk of significant morbidity or mortality.

The concept of futility is an incredibly controversial topic in surgery. Even the definition of futility in surgery has been thoroughly debated. Many have proposed frameworks, including the concept of physiologic futility (a complete lack of benefit), extreme rare success (has not been successful in the last 100 similar cases), and qualitative futility (even if lifesaving, the result would be an unacceptable functional status).<sup>3,4</sup> Although defining futility prospectively can be difficult, to gain insight into actual practice, we

aimed to look retrospectively at when and how often surgeons operate on patients with extreme risk and how often these cases ended in early mortality. With the benefit of hindsight, we hope to gain perspective on operations that ultimately did not meaningfully add to the lives of those receiving them.

**Methods**

*Data source*

The National Surgical Quality Improvement Program (NSQIP) was utilized for this study. NSQIP is compiled by the American College of Surgeons and is multi-institutional program that collects surgical outcomes database compiled by expert reviewers. It is based on in-depth chart reviews that gathers clinical information, rather than relying on insurance claims. In addition to patient demographics and operation performed, NSQIP also provides detailed information on patient comorbidities and functional status.

*Study population*

The NSQIP database was queried between 2007 and 2015 for patients  $\geq 18$ , who underwent 1 of 5 burdensome general surgery procedures (burdensome being defined previously by a combination of operation frequency and risk of mortality and morbidity).<sup>5</sup> The 5 procedures included colectomy, small bowel resection, control of bleeding ulcer, lysis of adhesion, and exploratory laparotomy. Operations were selected for emergent operations only, as the decision to operate were presumably made quickly and is different than decisions that are made with time for continued discussion with patients and family. “Emergency operation” is a variable within NSQIP and is defined as an operation “performed within a short interval of time between patient diagnosis or the onset of related preoperative symptomatology. It is implied that the patient’s well-being and outcome is potentially threatened by unnecessary delay and the patient’s status could deteriorate unpredictably or rapidly.”<sup>6</sup>

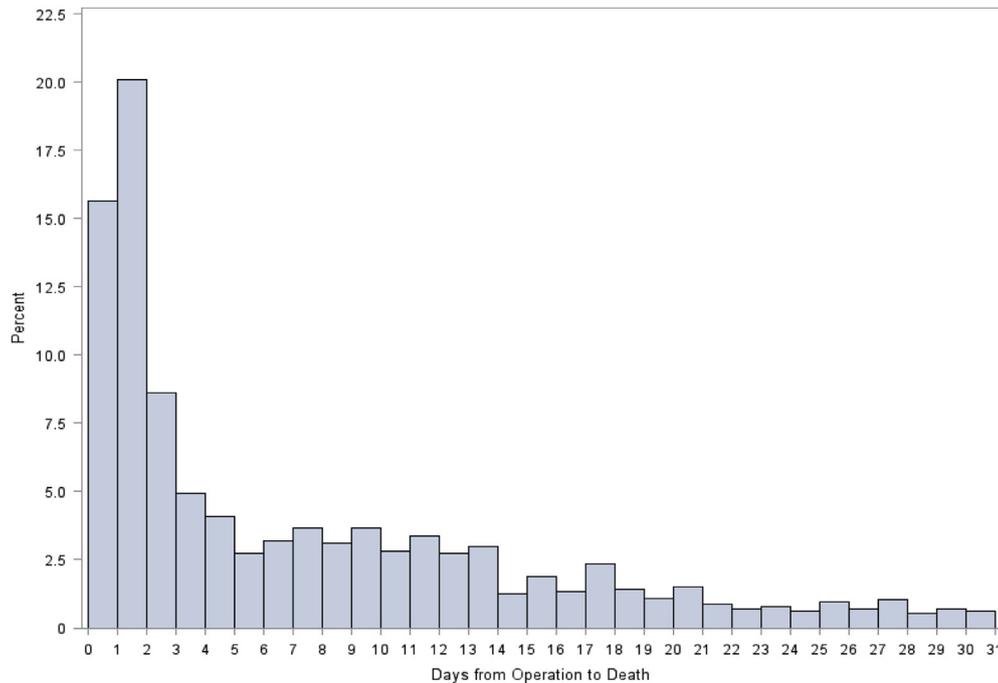
*Defining extreme risk*

To aid with operative decision making, the American College of Surgeons has created a risk calculator that estimates a unique mortality risk for each patient based on their specific comorbid factors and the operation they are undergoing.<sup>7</sup> NSQIP provides this estimated mortality risk variable for each patient in its database. This variable is an estimate between 0% and 100% of that specific patient’s risk of procedure related death within 30 days. Risk calculations are derived yearly from a logistic regression of all general surgery patients in the database.<sup>6</sup>

We sought to find a population for whom an operation was more likely to end in death than not. For the purposes of our study, we defined patients as extreme risk if their estimated mortality was  $\geq 75\%$ . There is no standard definition of extreme risk, and this percentage was decided upon after informal discussions and surveys of surgeons at our institution on what mortality risk threshold they would generally deem too risky to offer an operation.

*Defining futile care*

For the purposes of our study, we defined a futile operation as one where a patient had extreme-risk ( $>75\%$  risk of mortality) and died within 48 hours of their operation. Although the NSQIP calculator is based on risk of 30-day mortality, our main outcome of interest was 48-hour mortality. Death within 48 hours was used for a number of reasons. For one, within 48 hours, death may be attributable to the operation itself. Secondly, even if it was not directly related to the operation, death within this time suggests that that life was not meaningfully prolonged and surgery did not significantly improve the patient’s clinical course. This also suggests that a presumed attempt at a life-saving operation was unsuccessful. Finally, when evaluating time from surgery to death in the extreme risk group, a large percentage of mortalities were noted to occur within 48 hours (Fig 1), making this a high yield population.



**Fig 1.** Distribution of days from operation to death among extreme risk patients.

**Table 1**  
Patient demographics by risk class

Characteristic	Nonextreme risk patients		Extreme risk patients		Total		P value
	N	%	N	%	N	%	
Age group							<.01
18–39	12,130	13.1	89	5.0	12,219	13.0	
40–64	36,654	39.6	329	18.3	36,983	39.2	
65–79	28,933	31.3	818	45.6	29,751	31.5	
>80	14,839	16.0	558	31.1	15,397	16.3	
Sex							<.01
Female	50,440	54.5	859	47.9	51,299	54.4	
Male	41,997	45.4	931	51.9	42,928	45.5	
Missing	119	0.1	4	0.2	123	0.1	
Race/ethnicity							<.01
White	59,241	64.0	1,217	67.8	60,458	64.1	
Black	9,980	10.8	151	8.4	10,131	10.7	
Hispanic	4,755	5.1	79	4.4	4,834	5.1	
Asian	2,513	2.7	37	2.1	2,550	2.7	
Other	9,690	10.5	177	9.9	9,867	10.5	
Missing	6,377	6.9	133	7.4	6,510	6.9	
BMI							<.01
Underweight	4,804	5.2	184	10.3	4,988	5.3	
Normal weight	30,796	33.3	544	30.3	31,340	33.2	
Overweight	24,762	26.8	425	23.7	25,187	26.7	
Obese	24,847	26.9	491	27.4	25,338	26.9	
Missing	7,347	7.9	150	8.4	7,497	7.9	
ASA Class							<.01
1 = no disturb	2,681	2.9	—	—	2,681	2.8	
2 = mild disturb	21,265	23.0	—	—	21,265	22.5	
3 = severe disturb	39,412	42.6	25	1.4	39,437	41.8	
4 = life threat	25,983	28.1	1077	60.0	27,060	28.7	
5 = moribund	3,057	3.3	687	38.3	3,744	4.0	
Missing/none assigned	158	0.17	5	0.28	163	0.2	
Functional status							<.01
Independent	76,514	82.7	482	26.9	76,996	81.6	
Partially dependent	9,365	10.1	347	19.3	9,712	10.3	
Totally dependent	5,923	6.4	932	52.0	6,855	7.3	
Unknown	754	0.8	33	1.8	787	0.8	
Operation							<.01
Colectomy	45,477	49.1	1,014	56.5	46,491	49.3	
Small bowel resection	19,102	20.6	217	12.1	19,319	20.5	
Lysis of adhesion	12,134	13.1	21	1.2	12,155	12.9	
Exploratory laparotomy	9,395	10.2	431	24.0	9,826	10.4	
Control of bleeding ulcer	6,448	7.0	111	6.2	6,559	7.0	
Total	92,556	98.1	1,794	1.9	94,350	100.0	

ASA, American Society of Anesthesiologists; BMI, body mass index.

Additionally, even if a patient survives the initial operation, morbidity may be a debilitating outcome among extreme risk patients. Therefore, morbidity and discharge destination were examined as secondary outcomes. Morbidity was defined on having any postoperative complications, which were categorized into wound, infectious, respiratory, thromboembolic, renal, neurologic, cardiac, and bleeding complications. Discharge destinations were categorized as died during hospital stay, return home, return to long term facility, and discharged to rehab, acute care, or skilled nursing facility. Discharge destination is only known for patients from 2011 onward.

#### Statistical considerations

Descriptive analysis was performed to better understand the population of extreme risk patients receiving operations. All categorical comparisons were made utilizing  $\chi^2$  analysis and continuous variables using Student *t* test. Multivariable logistic regression was used to determine what demographic and clinical factors were most strongly associated with receiving futile care. All analysis was conducted using SAS (SAS Institute, Cary NC, version 9.4). This study was deemed exempt from full Institutional Review Board review by the institutional Human Investigations Committee.

## Results

### Cohort demographics

There was a total of 94,350 patients who underwent 1 of the 5 emergent operations of interest between 2007 and 2015. The most common operation was partial colectomy (49.3%), followed by lysis of adhesion (20.5%), and small bowel resection (12.9%; Table 1). Overall, the population was predominately female (54.4%), white (64.1%), and had an independent preoperative functional status (81.6%). The average mortality risk for the population was 13.4%, with a range from <0.1% to 98.9%.

### Demographics of extreme risk patients

Among the cohort, 1.9% ( $N = 1,794$ ) were extreme risk with a preoperative mortality risk of  $\geq 75\%$  (Table 1). The average calculated 30-day mortality risk for this group was 82.9% (standard deviation [SD] 5.5). The nonextreme risk group had an average calculated mortality probability of 12.1% (SD 16.6). Compared to the rest of the population, extreme risk patients were more likely to be male, (51.9% vs 45.4% of nonextreme risk,  $P < .01$ ) >80 years old

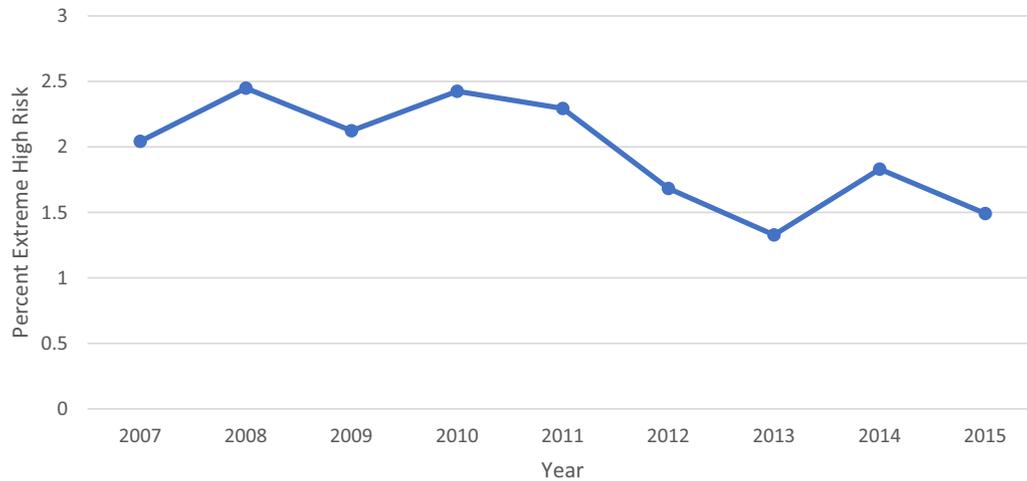


Fig 2. Percent of operative patients who are extreme risk by year.

**Table II**  
Outcomes among extreme and nonextreme risk patients

Outcome	Nonextreme risk patients		Extreme risk patients		Total		P value
	N	%	N	%	N	%	
30-day mortality	11,108	11.8	1,278	71.2	12,386	13.1	<.01
48-hour mortality	3,470	3.8	567	31.6	4,037	4.3	<.01
Any complication within 30 days	44,046	47.6	1492	83.2	45,538	48.3	<.01
Specific complications							
Wound	14,342	15.5	177	9.9	14,519	15.4	<.01
Cardiac	3,565	3.9	255	14.2	3,820	4.1	<.01
Deep vein thrombosis	548	0.6	17	1.0	565	0.6	.05
Pulmonary Embolus	1,064	1.2	11	0.6	1,075	1.1	.03
Respiratory	20,226	21.9	1,014	56.5	21,240	22.5	<.01
Bleeding	14,813	16.0	824	45.9	15,637	16.6	<.01
Neurologic	880	1.0	58	3.2	938	1.0	<.01
Renal	3,676	4.0	255	14.2	3,931	4.2	<.01
Urinary tract infection	3,498	3.8	79	3.9	3,568	3.8	.79
Sepsis	18,805	20.3	667	37.2	19,472	20.5	<.01
Discharge destination*							<.01
Died during hospitalization	6,107	10.2	703	67.9	6,810	11.2	
Home	38,168	63.7	57	5.5	38,225	62.7	
Returned to facility admitted from	1,010	1.7	18	1.7	1,028	1.7	
Rehab/acute care/skilled care	14,263	23.8	250	24.1	14,513	23.8	
Unknown/missing	418	0.7	8	0.8	426	0.7	

\* Only available from 2011 onward.

(31.1% vs 16.0% for nonextreme risk,  $P < .01$ ) and have a totally dependent functional status (52.0% vs 6.4% for nonextreme risk,  $P < .01$ ). In particular, extreme risk patients were more likely to have congestive heart failure (21.6% vs 3.1% no extreme risk,  $P < .01$ ), to be on dialysis (24.1% vs 3.5% nonextreme risk,  $P < .01$ ), and have severe chronic obstructive pulmonary disease (33.3% vs 10.2% nonextreme risk,  $P < .01$ ; Supplemental Table 1). The percent of the operative population who is categorized as extreme risk has slowly decreased over time, from a high of 2.4% in 2008 to 1.5% in 2015 (Fig 2).

### Outcomes

Among extreme risk patients, 31.6% received futile care and died within 48 hours of surgery. In comparison, 3.8% for nonextreme risk patients died within 48 hours ( $P < .01$ ). Distribution of time from operation to death among extreme risk patients is presented in

Fig 1. Thirty-day mortality for extreme risk patients was 71.2% compared to 11.8% for nonextreme risk ( $P < .01$ ).

Extreme risk patients were nearly twice as likely to have at least one postoperative complication compared to the nonextreme risk group (83.2% vs 47.6%,  $P < .01$ ). In particular, extreme risk patients were more likely to have cardiac (14.2% vs 3.9%,  $P < .01$ ), respiratory (56.5% vs 21.9%,  $P < .01$ ), and bleeding (45.9% vs 16.0%,  $P < .01$ ) complications compared to nonextreme risk patients. Overall, 69.1% of extreme risk patients died in the hospital, and another 24.1% were discharged to a skilled care facility (Table II); while 63.7% of nonextreme risk patients eventually were discharged home, only 5.5% of extreme risk patients were ( $P < .01$ ).

### Factor associated with futile care

Those >80 were associated futile surgery (odds ratio [OR] 6.25 vs 40–64; 95% confidence interval [CI], 4.51–8.66), as were those who were partially (OR 2.50 vs independent; 95% CI, 1.83–3.43)

**Table III**  
Selected odds ratios of associations with futile care (being extreme risk and dying within 48 hours)

Variable	OR N	95% CI	
		%	N
Age group			
18–39	1.55	0.97	2.47
40–64	Ref	Ref	Ref
65–79	2.72	2.05	3.62
>80	6.25	4.51	8.66
Sex			
Female	0.98	0.80	1.21
Male	Ref	Ref	Ref
Race/ethnicity			
White	Ref	Ref	Ref
Black	0.77	0.54	1.09
Hispanic	1.12	0.72	1.75
Asian	1.14	0.60	2.14
Other/missing	0.70	0.46	1.05
BMI			
Underweight	0.67	0.51	0.87
Normal weight	Ref	Ref	Ref
Overweight	0.71	0.54	0.93
Obese	2.07	1.45	2.96
Functional status			
Independent	Ref	Ref	Ref
Partially dependent	2.50	1.83	3.43
Totally dependent	2.14	1.66	2.76
Unknown	1.66	0.67	4.08
Operation			
Colectomy	3.30	1.59	6.86
Small bowel resection	2.43	1.12	5.29
Lysis of adhesion	0.67	0.17	2.58
Exploratory laparotomy	9.27	4.44	19.34
Control of bleeding ulcer	Ref	Ref	Ref
Sepsis			
Yes	4.63	3.38	6.34
No	Ref	Ref	Ref
Comorbid conditions			
Bleeding disorder	1.70	1.37	2.11
Smoker	1.09	0.84	1.41
Chronic obstructive pulmonary disease	1.41	1.10	1.80
Ventilator dependent within 48 hours	12.77	9.65	16.90
Ascites	3.24	2.55	4.12
Hypertension	1.20	0.94	1.53
Congestive heart failure	1.37	1.03	1.82
Diabetes	1.06	0.83	1.35
Steroid use	1.59	1.21	2.09
Dialysis dependent	2.41	1.87	3.11

or totally dependent (OR 2.14 vs independent; 95% CI, 1.66–2.76; Table III). Those in septic shock on presentation were also associated with futile care (OR 4.63 vs not in shock; 95% CI, 3.38–6.34). Of comorbid conditions, those on a ventilator within 48 hours of their operation were most commonly associated with a futile outcome (OR 12.77 vs no ventilator need; 95% CI, 9.65–16.90). There was no significant association among sex, race, or ethnicity with being extreme-risk and dying within 48 hours.

## Discussion

Patients with extreme predicted mortality are frequently offered high risk procedures. Not surprisingly, these extreme risk patients had a correspondingly high mortality rate. Importantly, nearly a third of these patients died within 48 hours, suggesting that their operation may have been futile, as it likely did little to change their symptoms significantly, did not change the course of their disease progression and may have even precipitated death. Although the debate on defining futility in surgery rages on, with some even questioning the utility of the concept at all, this data makes clear that a

significant number of patients receive operations each year that add little value.<sup>8</sup>

Futile surgery was most commonly performed on the elderly with multiple comorbidities and who presented in extremis. In particular, age >80 years, sepsis, and ventilator dependence were key indicators that an operation was likely to be futile. This in itself may come as no surprise, but reinforces the fact that surgeons are continuing to decide to operate on an obviously extreme risk group. What is more unexpected is that more than half of these extreme risk patients had a totally dependent functional status on admission. It is not uncommon for surgeons to make value judgements when evaluating surgical risk, such as accepting higher risk for a pediatric patient than for an octogenarian.<sup>9</sup> Given the national attention on frailty, one would expect surgeons to be far more selective about offering emergent operations to this moribund group. In the face of these functional limitations and clear comorbidities, one must ask why surgeons continue to operate frequently on such a high-risk population.

One determinant of offering surgery to extreme risk patients may be the surgeons themselves. For example, some surgeons may simply have a higher threshold for surgery and will operate at any chance of success. There is no standard definition of high-risk surgery and acceptable risk for one surgeon may be completely unacceptable for another.<sup>2,10</sup> Unfortunately, we do not have surgeon or hospital specific information to further evaluate if only a certain set of surgeons are performing operations on extreme risk patients, or if this is a more generalized phenomenon. Complicating matters is that surgeons have been shown to commonly misjudge mortality risk when evaluating patients; indeed, it may be that surgeons simply do not realize their patient has such a high risk.<sup>11</sup> Although it is far more common that surgeons overestimate risk rather than underestimate it, this still suggests that tools like the NSQIP risk calculator can be helpful adjuncts in the clinical decision-making process by adding objective information to a personal and emotional decision.

A stronger influence behind surgery on extreme risk patients likely comes from the desires of patients and their family. American medical culture has a prevailing sense of doing everything, and surgery is often seen as the last, best hope.<sup>9</sup> Additionally, medicine has moved away from a paternalistic framework to incorporate more patient-centered decision making, allowing patients and their families to guide decisions in these situations.<sup>12</sup> However, these are difficult decisions to be made by people who are often unready to make them and may not have a full understanding of the consequences of their decisions. One survey study of trauma surgeons showed that two-thirds rely on family members to make end-of-life decisions, but 80% feel that family members are rarely in an appropriate mental or emotional state to make such decisions.<sup>13</sup> Additionally, patients often frame the decision as one of life or death, without taking into consideration the morbidity involved in an operation, which for many emergency operations is quite significant.<sup>14,15</sup> Indeed, when patients are provided options of highly morbid treatments that would leave severe functional impairment, the vast majority would choose palliation.<sup>16</sup> Our data showed that among this extreme risk group, >80% had a complication, less than a third left the hospital, and only 5% returned home. This reinforces the necessity for surgeons to have in-depth conversations with families, even in acute settings, to truly explain not only the operation and prognosis, but what the long term functional status will be like.

We acknowledge that our definition of surgical futility (extreme risk with early postoperative death) is arbitrary. Our intention was simply to put objective data to what is an extremely subjective

topic and not to provide a definitive definition of futile care. We hope that this can help start a dialogue on how to quantify futility in surgery, provide an understanding of what current practices are, and develop a framework to discuss surgery at the end of life. Additionally, more detailed qualitative research is needed to truly understand what risk thresholds surgeons deem acceptable, and what mitigating circumstances are.

This study had a number of additional limitations. First, NSQIP does not have information on patients who did not receive an operation. Understanding when patients and surgeons decided not to proceed with an operation is another important aspect of this story, and would provide a more complete understanding of extreme risk patients. This illustrates the need for a comprehensive surgical database that captures not only operative patients, but also patients with the same diseases who are managed nonoperatively. Second, we do not have information on preoperative and postoperative diagnoses, and if discordant, may not fairly represent futile surgery; if a surgeon starts a case for a presumed pathology but finds a different one incompatible with life, it may not be fair to assess that operation as futile. Additionally, while it pulls data from around the country, NSQIP is not a nationally representative sample, and the results may not be generalizable to the population at large. Furthermore, this study relied heavily on the NSQIP risk calculator, which has often been criticized on accuracy; however, through consistent recalibrations, it has proven to be quite accurate on a population scale.<sup>17,18</sup>

Emergency surgery is performed frequently for patients whose risk of death is >75%. These patients commonly have multiple comorbidities and poor baseline functional status. This extreme risk population has predictably poor outcomes, and nearly a third die within 48 hours, suggesting that surgeons are frequently pursuing futile care. Additional study is needed to understand better what drives futile operations.

#### Conflict of interest

The authors have indicated that they have no conflict of interest regarding the content of this article.

#### Supplementary materials

Supplementary material associated with this article can be found, in the online version, at <https://doi.org/10.1016/j.surg.2019.05.002>.

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