

# Failure to rescue in emergency general surgery in Canada

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**Background:** The risk of death after a postoperative complication — known as failure to rescue (FTR) — has been proposed to be superior to traditional benchmarking outcomes, such as complication and mortality rates, as a measure of system quality. The purpose of this study was to identify the current FTR rate in emergency general surgery (EGS) centres across Canada. We hypothesized that substantial variability exists in FTR rates across centres.

**Methods:** In this multicentre retrospective cohort study, we performed a secondary analysis of data from a previous study designed to evaluate operative intervention for nonappendiceal, nonbiliary disease by 6 EGS services across Canada (1 in British Columbia, 1 in Alberta, 3 in Ontario and 1 in Nova Scotia). Patients underwent surgery between Jan. 1 and Dec. 31, 2014. We conducted univariate analyses to compare patients with and without complications. We performed a sensitivity analysis examining the mortality rate after serious complications (Clavien–Dindo score 3 or 4) that required a surgical intervention or specialized care (e.g., admission to intensive care unit).

**Results:** A total of 2595 patients were included in the study cohort. Of the 206 patients who died within 30 days, 145 (70.4%) experienced a complication before their death. Overall, the mortality rate after any surgical complication (i.e., FTR) was 16.0%. Ranking of sites by the traditional outcomes of complication and mortality rates differed from the ranking when FTR rate was included in the assessment.

**Conclusion:** There was variability in FTR rates across EGS services in Canada, which suggests that there is opportunity for ongoing quality-improvement efforts. This study provides FTR benchmarking data for Canadian EGS services.

**Contexte :** On a proposé que le risque de décès après une complication postopératoire — appelé « échec de sauvetage » — pourrait s'avérer une mesure plus pertinente de la qualité du système de santé que les indicateurs comparatifs traditionnels, comme les taux de complications et de mortalité. Cette étude visait à déterminer le taux réel d'échec de sauvetage dans les centres de chirurgies générales d'urgence (CGU) au Canada. Notre hypothèse était que ce taux varie grandement d'un centre à l'autre.

**Méthodes :** Dans le cadre de cette étude de cohorte rétrospective multicentrique, nous avons réalisé une analyse secondaire des données issues d'une étude antérieure, dont l'objectif était d'évaluer les interventions chirurgicales relatives à des atteintes ne touchant ni l'appendice ni la vésicule biliaire effectuées par 6 centres de CGU au Canada (1 en Colombie-Britannique, 1 en Alberta, 3 en Ontario et 1 en Nouvelle-Écosse). Ces interventions ont eu lieu du 1<sup>er</sup> janvier au 31 décembre 2014. Nous avons comparé les 2 catégories de patients — avec complications et sans complications — au moyen d'analyses univariées. Nous avons aussi mené une analyse de sensibilité concernant le taux de mortalité après des complications graves (3 ou 4 selon la classification de Clavien–Dindo) qui ont nécessité une intervention chirurgicale ou des soins spécialisés (par exemple, une admission en soins intensifs).

**Résultats :** L'étude a porté sur un total de 2595 patients. Sur les 206 patients décédés dans les 30 jours, 145 (70,4%) ont eu une complication avant leur décès. Globalement, le taux de mortalité après une complication postopératoire (soit le taux d'échec de sauvetage) était de 16,0%. Le classement des centres avec les indicateurs traditionnels (taux de complications et de mortalité) n'était pas le même une fois pris en compte le taux d'échec de sauvetage.

**Conclusion :** Le taux d'échec de sauvetage varie d'un centre de CGU à l'autre au pays, ce qui laisse croire qu'une amélioration continue de la qualité reste possible. Cette étude fournit des données de référence sur les taux d'échec de sauvetage aux centres de CGU au Canada.

**E**mergency general surgery (EGS) conditions present a substantial health care burden, accounting for 7% of all hospital admissions in the United States.<sup>1</sup> About 25% of patients admitted with an EGS condition require an emergent operation and have nearly 3 times the rate of death and complications as their elective surgical counterparts.<sup>2-4</sup> In the Canadian context, previous work from the Canadian Collaborative on Urgent Care Surgery (CANUCS) group showed that EGS procedures have a mortality rate of up to 8% and an overall complication rate of 34%.<sup>5,6</sup>

Given the high complication rate, EGS procedures represent an ideal target for quality improvement, as even small improvements can result in substantial impacts. A cornerstone of quality improvement is the use of benchmarking to identify system processes that differ between the highest and lowest performers. However, benchmarking with traditional outcomes, such as complication and mortality rates, may be misleading and may reflect inherent differences in patient characteristics rather than system performance.<sup>7,8</sup> How centres respond to complications, or their ability to “pull a patient out of the fire,” may have a greater influence on mortality than the absolute rate of complications alone.<sup>9</sup> Consequently, the risk of death after a postoperative complication — otherwise known as failure to rescue (FTR) — has become a particularly attractive target for quality-improvement efforts.

Failure to rescue appears, in limited literature, to be more greatly influenced by structures and processes of care than by patient-level factors and, therefore, may be more easily subject to modification and standardization in emergency care.<sup>10,11</sup> It has been described across numerous surgical specialties and is believed to be an important factor contributing to variation in mortality across hospitals.<sup>12,13</sup> Because the way in which providers and the health care system react to complications may mean the difference between life and death, examining FTR rates may provide important insights into opportunities for improvement. Hatchimonji and colleagues<sup>4</sup> reported that up to 84% of patients who died after EGS had a preceding surgical complication, which suggests that FTR is likely to be a useful quality metric in this specialty. Furthermore, surgical rescue has been described as an essential component of EGS, since managing surgical complications accounts for about 10% of all procedures performed on an EGS service, with 50% of cases referred from other surgical services and 25% referred from outside centres.<sup>9</sup>

In Canada, EGS is a developing specialty that aims to improve patient care through national structured processes and frameworks. One of the most important first steps in quality improvement is to determine variability in outcomes and benchmarking. The purpose of this study was to identify the current rate of FTR in EGS centres across Canada. We hypothesized that considerable variability exists in FTR rates across these centres.

## METHODS

This multicentre retrospective cohort study used data from a previously conducted study designed to evaluate operative intervention for nonbiliary, nonappendiceal disease by EGS services across Canada.<sup>6</sup> The current study evaluated patients who underwent surgery at EGS services in 6 centres across Canada (Vancouver General Hospital; University of Alberta Hospital, Edmonton; London Health Sciences Centre, London, Ont.; Hamilton General Hospital, Hamilton, Ont.; William Osler Health System, Brampton and Etobicoke, Ont.; and Queen Elizabeth II Health Sciences Centre, Halifax) between Jan. 1 and Dec. 31, 2014. We deidentified the 6 sites by assigning them a designated letter from A to F. All adult (age  $\geq 18$  yr) patients who underwent urgent or emergent operative interventions were identified from local databases, as previously described,<sup>6</sup> for inclusion. Major operations included bowel resection, hernia repair, surgery in trauma cases and débridement of necrotizing soft tissue infection. All centres obtained institutional ethics board approval before commencement of the study.

Data were obtained through retrospective chart review by clinician investigators (S.M., M.T.M., R.N., F.S., S.W., P.T.E., E.J., N.G.P., P.B.M. and K.N.V.) and included demographic characteristics, diagnosis, procedure details, complications and in-hospital death. Outcomes (including any re-presentations to the same institutions) were captured for 30 days postoperatively or the duration of the hospital stay, whichever was longer. Complications were classified by the principal clinician investigator at each site using the Clavien–Dindo method<sup>14</sup> (Appendix 1, available at [www.canjsurg.ca/lookup/doi/10.1503/cjs.008820/tab-related-content](http://www.canjsurg.ca/lookup/doi/10.1503/cjs.008820/tab-related-content)).

## Outcome

The primary outcome was the frequency of death following any complication after emergency operation for nonbiliary, nonappendiceal conditions. We defined FTR as the mortality rate after any postoperative complication.

## Statistical analysis

We did not perform a sample size calculation; however, we determined a priori a convenience sample of at least 200 patients per site. We expressed continuous parameters as means with standard deviations or medians with interquartile ranges, as appropriate. We expressed categorical data as proportions. We conducted univariate analyses to compare patients with and without complications using the Student *t* test for continuous, normally distributed variables, the Mann–Whitney *U* test for continuous, non-normally distributed variables, and the  $\chi^2$  test for categorical variables.

We performed a sensitivity analysis examining the mortality rate after serious complications (Clavien–Dindo score 3 or 4) that required a surgical intervention or specialized care (such as admission to the intensive care unit). This more restrictive definition of FTR was previously described by Peitzman and colleagues<sup>9</sup> and is felt to be more specific to a centre's ability to rescue after a major surgical complication.

We analyzed the data using SPSS version 23 (IBM Corp.), with a *p* value of < 0.05 considered significant.

## RESULTS

A total of 2595 patients who underwent nonbiliary, nonappendiceal operative intervention by the EGS service of the 6 participating sites were included in the study cohort. Individual sites contributed 208 (8.0%) to 704 (27.1%) patients, and cases were contributed by 90 different surgeons. Characteristics of the overall cohort and of patients who did (*n* = 907) and did not (*n* = 1729) have a complication are presented in Table 1.

**Table 1. Characteristics of patients who underwent nonbiliary, nonappendiceal operative interventions by the emergency general surgery service at the 6 participating sites**

Characteristic	No. (%) of patients*			<i>p</i> value
	Overall <i>n</i> = 2595	No complication <i>n</i> = 1688	Complication <i>n</i> = 907	
Age, median (IQR), yr	60 (46–73)	57 (44–70)	65 (52–77)	0.001
Male sex	1312 (50.7)	845 (50.2)	467 (51.5)	0.5
Comorbidities	1282 (49.4)	780 (46.2)	502 (55.3)	0.001
Diabetes	352 (13.6)	220 (13.0)	132 (14.6)	0.3
Chronic obstructive pulmonary disease	150 (5.8)	75 (4.4)	75 (8.3)	0.001
Congestive heart failure	85 (3.3)	37 (2.2)	48 (5.3)	< 0.001
Coronary artery disease	188 (7.2)	95 (5.6)	93 (10.3)	< 0.001
Hypertension	639 (24.6)	371 (22.0)	268 (29.5)	0.001
Steroid use	64 (2.5)	33 (1.9)	31 (3.6)	0.02
Bleeding disorder	52 (2.0)	31 (1.8)	21 (2.4)	0.3
Metastatic cancer	159 (6.1)	85 (5.0)	74 (8.2)	0.002
Dialysis	54 (2.1)	24 (1.4)	30 (3.4)	0.002
Smoking	296 (11.4)	194 (11.5)	102 (11.2)	0.9
Total no. of comorbidities, median (IQR)	0 (0–1)	0 (0–1)	1 (0–2)	< 0.001
3 most common diagnoses (%)	<ul style="list-style-type: none"> <li>• Small bowel obstruction (15.5)</li> <li>• Hernia (15.0)</li> <li>• Colonic neoplasm (9.2)</li> </ul>	<ul style="list-style-type: none"> <li>• Hernia (15.4)</li> <li>• Small bowel obstruction (15.2)</li> <li>• Perianal abscess (11.7)</li> </ul>	<ul style="list-style-type: none"> <li>• Small bowel obstruction (16.3)</li> <li>• Colonic neoplasm (12.4)</li> <li>• Hernia (9.4)</li> </ul>	—
Major operative procedure†	1936 (74.6)	1179 (68.2)	757 (83.5)	< 0.001
Urgency, h				
< 2	376 (14.5)	217 (12.8)	159 (17.5)	< 0.001
< 8	882 (34.0)	625 (37.0)	257 (28.3)	
< 24	542 (20.9)	381 (22.6)	161 (17.8)	
< 48	341 (13.1)	244 (14.4)	97 (10.7)	
Missing	454 (17.5)	221 (13.1)	233 (25.7)	
ASA grade				
1	143 (5.5)	121 (7.2)	22 (2.4)	< 0.001
2	464 (17.9)	362 (21.4)	102 (11.2)	
3	779 (30.0)	546 (32.3)	233 (25.7)	
4	582 (22.4)	332 (19.7)	250 (27.6)	
5	94 (3.6)	41 (2.4)	53 (5.8)	
Missing	533 (20.5)	286 (16.9)	247 (27.2)	
1–3	607 (23.4)	483 (28.7)	124 (13.7)	
4–5	1455 (56.1)	919 (54.4)	536 (59.1)	
Transferred from another centre	176 (9.5)	92 (7.3)	84 (13.9)	< 0.001
Procedure at another centre	37 (19.3)	16 (15.2)	21 (24.1)	0.1
Operation at another centre	27 (15.3)	10 (10.9)	17 (20.2)	0.08
Died	206 (7.9)	61 (3.6)	145 (16.0)	< 0.001

ASA = American Society of Anesthesiology; IQR = interquartile range.

\*Except where noted otherwise.

†Included bowel resection, hernia repair, surgery in trauma cases and débridement of necrotizing soft tissue infection.

**Table 2. Quality metrics for the 6 sites**

Metric	Overall	Site A	Site B	Site C	Site D*	Site E	Site F
Complication rate, %	35.0	2.9	38.0	32.7	42.8	36.6	37.0
Clavien–Dindo score; no. (%) of complications ( <i>n</i> = 553)							
1	100 (18.1)	(33.3)	(20.0)	(17.5)	—	(9.2)	(28.2)
2	134 (24.2)	(0.0)	(14.5)	(29.4)	—	(15.6)	(33.1)
3	142 (25.7)	(16.7)	(18.2)	(22.0)	—	(31.8)	(26.1)
4	177 (32.0)	(50.0)	(47.3)	(31.1)	—	(43.4)	(12.7)
Died, no. (%) of patients	206 (7.9)	(2.4)	(7.9)	(5.7)	(8.4)	(12.5)	(7.8)
Failure to rescue, %	16.0	33.3	12.3	13.5	15.9	23.7	11.9
Failure to rescue, Clavien–Dindo score 3–4, %	25.7	50.0	13.9	24.5	—	29.2	25.5

\*Did not report complications categorized by Clavien–Dindo score.

Of the 206 patients who died within 30 days, 145 (70.4%) experienced a complication before death. The rate of complications among patients who survived was 31.8% (*n* = 760) (*p* < 0.001). Overall, the mortality rate after any surgical complication (i.e., FTR) was 16.0%. The mortality rate among patients with a postoperative complication was significantly higher than that among patients who did not have a complication (16.0% v. 3.6%, *p* < 0.001). The mortality rate among patients with serious complications was 25.7%.

Table 2 shows the complication, death and FTR rates for each site. All but 1 site (site D) reported complications categorized by Clavien–Dindo scores. The number of patients contributed by each site is not included in the table to protect the anonymity of the participating sites. The ranking of the sites by complication, death and FTR rates is shown in Table 3. The metrics of FTR and FTR after a serious complication changed the ranking of site performance compared to the traditional metrics of mortality and complication rates.

Table 4 shows the site ranking by FTR, along with variables that may have affected site mortality rate, such as procedure type, American Society of Anesthesiologists grade and age.

**DISCUSSION**

There was considerable variation in FTR rates among EGS sites (12%–33%), and when we examined FTR rates after serious complications only, this variability increased (14%–50%). The ranking of sites by the traditional quality metrics of complication rate and mortality rate changed when FTR rates were included in the assessment. For example, with the quality metrics of postoperative complication rate and mortality rate, centre A would have concluded that they were providing the highest quality of care among the participating sites, with a complication rate of 2.9% and mortality rate of 2.4%. However, when we included their FTR rate

**Table 3. Site ranking by various quality metrics**

Quality ranking	Site: complication rate, %	Site: mortality rate, %	Site: failure to rescue rate, %	Site: failure to rescue rate with serious complications,* %
1	A: 2.9	A: 2.4	B: 12.3	B: 13.9
2	C: 32.7	C: 5.7	F: 11.9	C: 24.5
3	E: 36.6	F: 7.8	C: 13.5	E: 29.2
4	B: 38.0	B: 7.9	D: 15.9	F: 25.7
5	F: 37.0	D: 8.4	E: 23.7	A: 50.0
6	D: 42.8	E: 12.5	A: 33.3	—

\*Clavien–Dindo score 3–4.

**Table 4. Site ranking by failure to rescue rate and possible confounders**

Site: failure to rescue rate, %	Possible confounder; % of operations			
	Major operation	ASA grade > 2	ASA grade > 3	Patient age ≥ 80 yr
B: 12.3	62.4	60.9	20.8	10.0
F: 11.9	81.9	53.7	19.5	21.8
C: 13.5	75.0	40.9	10.3	10.6
D: 15.9	73.4	48.0	29.5	14.6
E: 23.7	81.1	78.7	44.0	16.7
A: 33.3	69.8	69.7	34.1	7.7

ASA = American Society of Anesthesiologists.

(33%) and especially their FTR rate after a serious complication (50%) in the assessment, centre A went from the top performer to among the lowest. Using FTR in the analysis identified centre A as an outlier. This should motivate examination of their care processes to determine opportunities for quality improvement. Furthermore, the FTR rate of centre A does not appear to be secondary to a higher proportion of major procedures performed or of patients with a higher American Society of Anesthesiologists grade or advanced age. Although our study was not powered to perform multilevel

modelling to determine differences in FTR rate by site, adjusted for patient-level factors, the data in Table 4 suggest that the observed magnitude of the variability in FTR rates is unlikely explained by the variability in patient characteristics alone.

Since FTR is more reflective of modifiable systems of care than of the presenting patient population, it may be more informative than traditional quality metrics to determine the need for quality-improvement initiatives. The observed variability in FTR rates across sites suggests that there is also variability in Canadian EGS clinical care frameworks, which presents opportunities for standardization and quality improvement. There is a variety of EGS team compositions across Canada, with some centres having a surgeon of the week, some having multiple teams, and some dealing with trauma and EGS at the same time. The EGS services are also differently resourced in terms of protected operating room time. How these differences in EGS structure affect FTR rates are targets for future study.

The concept that focusing solely on complication prevention may be an ineffective approach to surgical quality improvement is not new. In 1997, Silber and colleagues<sup>15</sup> showed poor correlation when ranking hospitals based on complication, inpatient mortality and FTR rates. The present study builds on the expanding literature exploring EGS outcomes. The observed complication rate of 35.0% and mortality rate of 7.9% are consistent with previously reported rates (up to 50% and 12.5%, respectively<sup>2,16</sup>). The observed FTR rate of 16.0% is also similar to those in a previous report, with rates ranging from 24.5% for emergency exploratory laparotomy to 11.6% for lysis of adhesions.<sup>4</sup>

Our study provides new information regarding the utility of FTR rate as a quality measure in Canadian EGS. Current quality-improvement programs may benefit by shifting focus from the prevention of individual complications to designing and optimizing rescue pathways that can eliminate, or at least mitigate, the incremental risk associated with multiple, and in some cases specific, complications. For example, Wakeam and colleagues<sup>17</sup> showed that variation in mortality rates was associated with particular types of secondary complications, such as postoperative myocardial infarct, and proposed specific index complications as “pause points” to institute early rescue interventions to prevent additional secondary events.

Future research should examine the differences in system processes of care that exist between Canadian EGS centres with low FTR rates and those with the highest rates. The key processes and the optimal intervention points in the FTR pathway remain unknown. It is also unknown which quality-improvement efforts should be targeted in order to decrease certain key index complications and focus on the ability to effectively manage those

complications. Whether the emphasis should be on the prevention of secondary complications and what those key complications are needs to be explored. Additional study is urgently required to improve our understanding of how best to leverage FTR to inform ongoing quality-improvement efforts and provide hospitals with actionable data. For now, the FTR benchmark data provided by the present study allow hospitals across Canada to compare their FTR rates for EGS procedures and determine the need for quality-improvement or quality-assessment initiatives focused on EGS services.

Emergency general surgery is in a state of evolution, similar to the way trauma surgery was decades ago, before the development of prospective trauma databases. The data for this study were obtained through laborious chart review. In order for EGS to continue to progress, the development of a prospective national database focused on EGS should be considered.

### Limitations

Our study is subject to the inherent limitations of a retrospective design. One centre was unable to obtain any Clavien–Dindo scores, and another was able to provide data only for about half of their complications. Furthermore, it is reasonable to assume that underreporting of Clavien–Dindo 1 and 2 complications may be seen relative to Clavien–Dindo 3 and 4 complications, as the latter require surgical intervention or specialized care. In this case, site-specific FTR rates would be inflated. The case mix among centres was not reported, and the extent to which this affected the variability in FTR rates is not known. In addition, we could not control for case mix in our analysis. Specific index complications, the timeline between an initial complication and death, and failure to prevent a secondary complication have been described as factors associated with FTR,<sup>17,18</sup> and these were not reported in this study.

### CONCLUSION

There was variability in FTR rates across EGS services in Canada, which suggests that there is opportunity for ongoing quality-improvement efforts. This study provides FTR benchmarking data for Canadian EGS services.

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