

# Beyond just the operating room: characterizing the complete caseload of a tertiary acute care surgery service

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**Background:** Most studies evaluating acute care surgery (ACS) models of care for patients with emergency general surgery (EGS) conditions have focused on patients who undergo surgery while admitted under the care of the ACS service. The purpose of this study was to prospectively examine the case-mix of admissions and consultations to an ACS service at a tertiary centre to identify the frequency and distribution of both operatively and nonoperatively managed EGS conditions.

**Methods:** In this prospective cohort study, we evaluated consecutive patients assessed by the ACS team between July 1 and Aug. 31, 2015, at a large Canadian tertiary care centre. This included all consultations and outside hospital transfers. Diagnoses, demographic characteristics, comorbidities, intervention(s), complications, readmission and in-hospital death were captured.

**Results:** The ACS team was involved in the care of 359 patients, 176 (49.0%) of whom were admitted under the direct care of the ACS team. Nonoperative care was indicated in 82 patients (46.6%) admitted to the ACS service and 151 (82.5%) of those admitted to a non-ACS service ( $p < 0.001$ ). Bowel obstruction (37 patients [21.0%]) was the most common reason for admission, followed by wound/abscess (24 [13.6%]), biliary disease (24 [13.6%]) and appendiceal disease (23 [13.1%]). Rates of 30-day return to the emergency department and readmission were 17.0% and 9.1%, respectively, and the in-hospital mortality rate was 1.7%.

**Conclusion:** Acute care surgery teams care for a wide breadth of disease, a considerable amount of which is managed nonoperatively.

**Contexte :** La plupart des études qui ont évalué les modèles de soins chirurgicaux aigus (SCA) chez des patients souffrant de problèmes de santé nécessitant un traitement de chirurgie générale (TCG) d'urgence ont porté sur des patients ayant subi une intervention lors de leur admission dans un service de SCA. Le but de cette étude était d'analyser de manière prospective la clientèle admise ou vue en consultation dans le service de SCA d'un centre de soins tertiaires pour connaître la fréquence et la distribution des problèmes de santé nécessitant un TCG d'urgence effectivement traités chirurgicalement ou autrement.

**Méthodes :** Dans cette étude de cohorte prospective, nous avons évalué des patients consécutifs vus par l'équipe de SCA entre le 1<sup>er</sup> juillet et le 31 août 2015 dans un grand centre canadien de soins tertiaires. Cela incluait toutes les consultations et les transferts en provenance d'autres hôpitaux. Nous avons noté les diagnostics, les caractéristiques démographiques, les comorbidités, les interventions, les complications, réadmissions et les décès en cours d'hospitalisation.

**Résultats :** L'équipe de SCA a assuré les soins de 359 patients, dont 176 (49,0%) avaient été admis directement au service de SCA. Des soins non chirurgicaux étaient indiqués chez 82 patients (46,6%) admis au service de SCA et chez 151 (82,5%) patients admis dans d'autres services ( $p < 0,001$ ). L'obstruction intestinale (37 patients [21,0%]) a été la raison la plus fréquente des admissions, suivie de blessure ou d'abcès (24 patients [13,6%]), maladie biliaire (24 patients [13,6%]) et maladie appendiculaire (23 patients [13,1%]). Les taux de retour aux urgences et de réadmission dans les 30 jours ont été de 17,0% et de 9,1%, respectivement, et le taux de mortalité en cours d'hospitalisation a été de 1,7%.

**Conclusion :** Les équipes de soins chirurgicaux aigus prennent en charge un vaste éventail de pathologies, dont une part importante est gérée de manière non chirurgicale.

Acute care surgery (ACS) services provide a framework of care for the management of emergency general surgery (EGS) patients, and many institutions around the world are now implementing such services.<sup>1-4</sup> Many ACS models follow a “surgeon-of-the-week” format, with the surgeon suspending his or her elective practice for 1 week to lead a team of house staff in the management of all emergency and acutely ill general surgery consultations and inpatients.<sup>4-6</sup> Although several investigators have examined the surgical management of EGS cases by ACS services,<sup>1-7</sup> few have examined the non-operative roles of ACS services.<sup>8</sup> Benefits of the ACS model, including decreased length of stay, reduced postoperative complication rates, lower readmission rates and reduced cost, have consistently been shown for a range of EGS operative cases.<sup>1,3,5,7</sup> To our knowledge, a similar impact assessment for patients who do not require operation has not been completed.

Some of the most common EGS conditions such as bowel obstruction, trauma and pancreatitis are managed nonoperatively.<sup>9-12</sup> Even conditions once thought to be unassailable bastions of surgical management are now being treated nonoperatively, including the management of acute appendicitis solely with antibiotics.<sup>13</sup> Restricting the literature on the emerging field of ACS to operative cases tells only part of the story. An understanding of the complete workload undertaken by ACS services managing EGS patients is warranted.

The primary objective of this study was to prospectively document the complete case-mix of an ACS service at a tertiary care centre to identify the frequency and distribution of operatively versus nonoperatively managed EGS conditions. Secondary outcomes, including complications, length of stay, return to the emergency department, readmission rates and in-hospital death, were also captured and described for the complete population managed by the ACS service. We hypothesized that a large number of patients assessed by the ACS service would be managed nonoperatively.

## METHODS

### Setting

We conducted a prospective cohort study at the Victoria Hospital campus of the London Health Sciences Centre, London, Ontario. The London Health Sciences Centre is a tertiary care academic centre with 3 hospital campuses and a catchment area of about 1.6 million people and is associated with Western University’s Schulich School of Medicine & Dentistry. Victoria Hospital is the largest of the centre’s 3 campuses.

Victoria Hospital adopted an ACS service in July 2010. The ACS team consists of 1 staff surgeon, 1 senior resident, 1 intermediate resident, 2 junior residents, 2–3 medical students and 1 nurse practitioner. The ACS surgeon suspends

his or her elective practice for 1 week to lead the team. The service has 7 daytime hours of dedicated operating room time, Monday to Friday. The ACS team’s only obligation is the care of all EGS patients and consultations both via the emergency department and in hospital. In addition to twice-daily handover of patients, all patients still undergoing treatment at the end of the duty period are formally handed over between the ACS and call teams. Overnight call is covered by the ACS surgeon of the week for 4 of 7 nights and by other ACS surgeons not on the ACS service that week for 3 of 7 nights. Trauma patients are admitted and managed by a separate traumatology service with a different attending physician. The ACS team attends all trauma activations, and operative management of general-surgery-related injuries is performed by the ACS service.

### Data collection

Data for all consecutive patients assessed by the ACS team between July 1 and Aug. 31, 2015, were prospectively collected by trained investigators (T.J.V. and P.B.M.) who attended daily clinical duties with the ACS team. All consultations and outside hospital transfers were included. Data collected included demographic characteristics, admission type (direct to general surgery, intensive care unit consultation, inpatient consultation, outside transfer, service transfer, via emergency department), diagnosis, comorbidities, interventions performed, length of stay, complications (as classified by Dindo and colleagues<sup>14</sup>), in-hospital death, disposition, and rates of return to the emergency department and of readmission within 30 days. Readmission within 30 days was assessed for any hospital within the catchment area through an integrated electronic medical record system. Patient comorbidities were captured to calculate a Charlson Comorbidity Index score for each patient as a measure of complexity of the patient’s condition and risk of death.<sup>15</sup>

### Statistical analysis

Demographic and descriptive variables were reported as means with standard deviations, medians with interquartile ranges (IQRs) or frequencies with associated percentages where appropriate. Patients were classified into those admitted directly to the ACS service and inpatient consultations admitted to another hospital service. Patients seen in consultation in the emergency department and then discharged were also considered separately. We compared patient characteristics (age, body mass index, sex, diagnosis, comorbidities, admission type) and outcomes (length of stay, intervention, complications, Clavien–Dindo score, discharge disposition, death) between groups using independent *t* tests, the Mann–Whitney test and the  $\chi^2$  test where appropriate. To identify the independent contribution of age, complications and Charlson Comorbidity Index score

on the probability of re-presentation, we completed multivariate logistic regression analysis on a composite outcome of 30-day return to the emergency department and 30-day readmission among patients admitted under the ACS service. We conducted all analyses using SPSS v.23.0 (IBM). A  $p$  value  $< 0.05$  was considered significant. Ethics approval for this study was obtained from our research ethics board.

## RESULTS

The ACS team assessed 359 patients during the study period, of whom 176 (49.0%) were admitted directly under ACS service care and 183 (51.0%) were assessed and/or managed as consultations under another service. Thirty-nine of the latter group (21.3% of consultations) were assessed and discharged directly from the emergency department. About half of all patients (176 [49.0%]) were female, the mean patient age was 54.1 years, and the

median body mass index was 26.6 (Table 1). There was no difference in demographic characteristics between patients admitted under or seen as consultations by the ACS team, except for intensive care unit admission and trauma status: significantly fewer patients admitted to the ACS service than seen as consultations by the ACS team required admission to the intensive care unit (9 [5.1%] v. 30 [16.4%],  $p = 0.001$ ) (Table 1).

The emergency department (116 patients [65.9%]) was the most common route of admission for patients assessed by the ACS team, with direct to general surgery (27 [15.3%]) and outside hospital transfers (21 [11.9%]) being the next most common. Most inpatient consultations were from trauma (65 patients [35.5%]), medicine (51 [27.9%]) and oncology (27 [14.8%]). The most common reasons for admission were bowel obstruction (37 patients [21.0%]), biliary disease (24 [13.6%]), wound/abscess (24 [13.6%]) and appendiceal disease (23 [13.1%]) (Table 2). For patients seen

**Table 1. Demographic and clinical characteristics of patients admitted to and seen in consultation by the acute care surgery service**

Characteristic	All patients $n = 359$	Admitted patients $n = 176$	Inpatient consultations $n = 183$	$p$ value	Emergency department discharge $n = 39$
Age, mean $\pm$ SD; yr	54.14 $\pm$ 19.3	55.69 $\pm$ 18.2	52.66 $\pm$ 20.2	0.1	44.13 $\pm$ 19.6
Female sex, no. (%) of patients	176 (49.0)	92 (52.3)	84 (45.9)	0.2	23 (59.0)
Body mass index, median (IQR)	26.57 (9.0)	26.83 (10.0)	26.42 (8.0)	0.3	25.52 (14.0)
Trauma patient, no. (%) of patients	50 (13.9)	0 (0.0)	50 (27.3)	$< 0.001$	1 (2.6)
Admission to intensive care unit, no. (%) of patients	39 (10.9)	9 (5.1)	30 (16.4)	0.001	0 (0.0)
Charlson Comorbidity Index score, mean $\pm$ SD	2.72 $\pm$ 2.9	2.64 $\pm$ 2.7	2.79 $\pm$ 3.1	0.6	1.41 $\pm$ 2.5

IQR = interquartile range; SD = standard deviation.

**Table 2. Diagnoses**

Diagnosis	No. (%) of patients			
	All patients $n = 359$	Admitted patients $n = 176$	Inpatient consultations $n = 183$	Emergency department discharge $n = 39$
Appendiceal disease	26 (7.2)	23 (13.1)	3 (1.6)	2 (5.1)
Biliary disease	36 (10.0)	24 (13.6)	12 (6.6)	3 (7.7)
Bowel obstruction	58 (16.2)	37 (21.0)	21 (11.5)	2 (5.1)
Inflammatory bowel disease/colitis	13 (3.6)	3 (1.7)	10 (5.5)	1 (2.6)
Wound/abscess	44 (12.2)	24 (13.6)	20 (10.9)	9 (23.1)
Hernia	17 (4.7)	11 (6.2)	6 (3.3)	2 (5.1)
Hepatic disease	1 (0.3)	1 (0.6)	0 (0.0)	0 (0.0)
Pancreatic disease	15 (4.2)	9 (5.1)	6 (3.3)	1 (2.6)
Trauma	49 (13.6)	0 (0.0)	49 (26.8)	1 (2.6)
Bleeding	11 (3.1)	3 (1.7)	8 (4.4)	2 (5.1)
Peptic ulcer disease	5 (1.4)	4 (2.3)	1 (0.5)	0 (0.0)
Diverticulitis	15 (4.2)	13 (7.4)	2 (1.1)	1 (2.6)
Abdominal pain (undiagnosed)	10 (2.8)	0 (0.0)	10 (5.5)	7 (17.9)
Breast disease	5 (1.4)	2 (1.1)	3 (1.6)	1 (2.6)
Other	54 (15.0)	22 (12.5)	32 (17.5)	7 (17.9)

in and discharged from the emergency department, the most common diagnosis was wound/abscess (9 [23.1%]).

A nonoperative management strategy was indicated and undertaken in 233 patients (64.9%) assessed by the ACS team and was more frequently used in patients admitted to a non-ACS service than in those admitted to the ACS service (151 [82.5%] v. 82 [46.6%],  $p < 0.001$ ) (Table 3). An interventional radiology procedure was performed in 30 patients (8.4%). Among admitted patients, operative management was nearly evenly split between open (44 [46.8%]) and laparoscopic (39 [41.5%]) surgery; 11 cases (11.7%) were extra-abdominal. Five (6.1%) of the admitted patients initially managed nonoperatively eventually required operation.

The median length of stay for patients admitted to the ACS service was 3 days (IQR 2–6 d). Admitted patients were most often discharged home (162 [92.0%]) or to home hospitals (7 [4.0%]). The in-hospital complication rate among admitted patients was 13.6%, with 2 (1.1%) Clavien–Dindo grade I complications, 15 (8.5%) grade II complications and 7 (4.0%) grade IV complications (Table 4); the mortality rate was 1.7%. The most common in-hospital complications were the need for postoperative intubation, need for total parenteral nutrition and intensive care unit admission. Only 6 patients (4.8%) overall required an unplanned return to the operating room.

Within 30 days, 30 patients (17.0%) admitted to the ACS service returned to the emergency department, and 16 (9.1%) were readmitted to hospital (Table 4). Surgical

site infection was the most common reason for return to the emergency department, and the overall rate of this complication was 21.4% for both admitted patients and those seen in consultation. The most common initial primary diagnosis in these 16 readmitted patients was small-bowel obstruction (5 cases [31%]), followed by biliary and pancreatic pathology (4 [25%]). Of the 25 patients overall who were readmitted within 30 days, 6 (24%) had metastatic cancer. The in-hospital complication rate was significantly higher among patients managed operatively than among those managed nonoperatively (22.3% v. 3.6%,  $p < 0.001$ ), but the former had a lower 30-day readmission rate (4.2% v. 14.6%,  $p = 0.02$ ). Fourteen admitted patients (17%) managed nonoperatively returned to the emergency department within 30 days, 3 of whom (21%) needed an operation on readmission.

For ACS service consultations, the in-hospital complication rate was 8.7% (Table 4). Rates of 30-day return to the emergency department and readmission were 9.3% and 4.9%, respectively. The mortality rate was 5.5%.

The overall mortality rate among all patients was 3.6%.

In multivariate regression analysis, age (odds ratio [OR] 0.99, 95% confidence interval [CI] 0.97–1.02), Charlson Comorbidity Index score (OR 1.09, 95% CI 0.92–1.29) and complications (OR 2.26, 95% CI 0.83–6.19) were not significantly associated with the composite outcome of 30-day return to the emergency department and 30-day readmission.

**Table 3. Interventions**

Intervention	No. (%) of patients			<i>p</i> value
	All patients <i>n</i> = 359	Admitted patients <i>n</i> = 176	Inpatient consultations <i>n</i> = 183	
Operative management	126 (35.1)	94 (53.4)	32 (17.5)	< 0.001
Laparoscopic	43 (34.1)	39 (41.5)	4 (12.5)	< 0.001
Laparoscopic converted to open	4 (3.2)	3 (3.2)	1 (3.1)	0.4
Open	62 (49.2)	44 (46.8)	18 (56.2)	—
Extra-abdominal	21 (16.7)	11 (11.7)	10 (31.2)	—
Interventional radiology	30 (8.4)	18 (10.2)	12 (6.6)	0.2

**Table 4. Outcomes**

Outcome	No. (%) of patients					<i>p</i> value
	All patients <i>n</i> = 359	Inpatient consultations <i>n</i> = 183	Admitted patients <i>n</i> = 176	Admitted patients managed operatively <i>n</i> = 94	Admitted patients managed nonoperatively <i>n</i> = 82	
In-hospital complication	40 (11.1)	16 (8.7)	24 (13.6)	21 (22.3)	3 (3.6)	< 0.001
Surgical site infection	27/126 (21.4)	9/32 (28.1)	18/94 (19.1)	18 (19.1)	—	—
Reoperation	6/126 (4.8)	6/32 (18.8)	0/94 (0)	0 (0.0)	—	—
30-d return to emergency department	47 (13.1)	17 (9.3)	30 (17.0)	16 (17.0)	14 (17.1)	1.0
30-d readmission	25 (7.0)	9 (4.9)	16 (9.1)	4 (4.2)	12 (14.6)	0.02
In-hospital death	13 (3.6)	10 (5.5)	3 (1.7)	1 (1.1)	2 (2.4)	0.5

## DISCUSSION

We found that a single tertiary care ACS service saw a large number of patients and that a considerable amount of work was done outside the operating room involving patients who were not admitted directly to the ACS service. These results show the variety of the ACS workload as well as its importance as a consultation service for other medical teams. Although the most common reasons for admission to the ACS service were bowel obstruction, wound/abscess, and biliary and appendiceal disease, only about half of patients admitted were managed operatively.

Acute care surgery services do much more than just operate in EGS patients, with only 35% of all patients seen managed operatively in our study. A recent study by Pottenger and colleagues<sup>9</sup> in a US centre where the ACS services also managed trauma and surgical critical care similarly showed that only 42% of the workload for ACS surgeons was procedural or surgical. Contrary to our belief that a service managing only EGS patients might operate more, we found that a large portion of the ACS workload consisted of medical or nonoperative management of patients. This should not come as a surprise, as there is much evidence to support the increasing role for nonoperative management in the treatment of many ACS conditions.<sup>10,11,13,16</sup> In fact, many of the most common conditions seen in patients admitted to our service, such as adhesive small-bowel obstructions, skin and soft-tissue infections, and trauma, have better outcomes with nonoperative management.<sup>2,8,16-23</sup> The current study suggests high rates of nonoperative management to be appropriate and expected for an ACS service.

Complications reported in our service were similar to those in the literature,<sup>24-29</sup> including a recent study by Zafar and colleagues,<sup>24</sup> who reported complication and mortality rates of 12.2% and 1.6%, respectively, for EGS patients treated at teaching hospitals. However, we found high rates of 30-day return to the emergency department (17.0%) and readmission (9.1%) among patients admitted to the ACS service. Havens and colleagues<sup>30</sup> reported a similar readmission rate (14%) for EGS patients undergoing abdominal surgery; however, they did not comment on patients who did not undergo operative interventions. Our high rates of return to the emergency department and readmission may suggest that ACS services manage acutely ill patients with complex medical conditions, who could be expected to return to hospital, a finding that is corroborated by our relatively high median comorbidity scores. Our regression analysis failed to show a single factor predictive of return to hospital. However, this leads us to hypothesize that, although baseline characteristics and complications may play a role, there are other factors that contribute to return to the emergency department and readmission. The high return and readmission rates also suggest a potential area for further study and quality improvement in the treatment of ACS patients.

In our study, patients managed operatively had a higher rate of in-hospital complications (22.3% v. 3.6%) and a lower rate of 30-day readmission (4.2% v. 14.6%) than did patients managed nonoperatively. One interpretation is that delaying operative intervention simply shifts complications from early in the patient's course, while in hospital, to later, with hospital readmission. This is partially seen in our finding that 21% of patients managed nonoperatively who were readmitted within 30 days required an operation. A second interpretation is that patients managed without surgery have problems that cannot be easily overcome with an operative intervention and that the complexity of their condition leads to higher readmission rates, even in the absence of signals from the Charlson Comorbidity Index. Given the prevalence of nonoperative care by ACS services in the current study, further work to determine the causes of these findings is warranted.

Finally, the fact that almost all of the literature in the ACS field focuses on operative outcomes suggests that the complete picture is not well described.<sup>1-7,31,32</sup> This lack of research into a sizeable proportion of the ACS workload prevents quality improvement and weakens the generalizability of results to the entire ACS patient population. Future work in this area needs to focus on both operatively and nonoperatively managed patient populations, and on both patients admitted to and seen in consultation by the ACS service to ensure relevant results and improved outcomes for all EGS patients.

## Limitations

Limitations of our study include our inability to capture patients readmitted to hospitals outside of the centre's catchment area, which may have resulted in higher representation rates that went undocumented. The use of the Clavien–Dindo classification to capture complications in EGS patients managed with and without surgery is a further limitation; however, we addressed this limitation by ensuring that all complications in patients managed nonoperatively were included.

## CONCLUSION

This comprehensive review of a Canadian ACS service shows that ACS services see a high volume of patients, many of whom are seen in consultation. Acute care surgery services do more than just operate on EGS patients, and the lack of literature on nonoperatively managed ACS patients suggests that future work is needed in this area to improve patient care.

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**Competing interests:** None declared.

**Contributors:** P. Murphy, L. Allen, N. Parry, K. Leslie and K. Vogt designed the study. T. van Zyl acquired and analyzed the data, which P. Murphy, L. Allen and K. Vogt also analyzed. T. van Zyl wrote the article, which all authors reviewed and approved for publication.

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