

Impact of the acute care surgery model on resident operative experience in emergency general surgery

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Background: The acute care surgery (ACS) model has been shown to improve patient, hospital and surgeon-specific outcomes. To date, however, little has been published on its impact on residency training. Our study compared the emergency general surgery (EGS) operative experiences of residents assigned to ACS versus elective surgical rotations.

Methods: Resident-reported EGS case logs were prospectively collected over a 9-month period across 3 teaching hospitals. Descriptive statistics were tabulated and group comparisons were made using χ^2 statistics for categorical data and t tests for continuous data.

Results: Overall, 1061 cases were reported. Resident participation exceeded 90%. Appendiceal and biliary disease accounted for 49.7% of EGS cases. Residents on ACS rotations reported participating in twice as many EGS cases per block as residents on elective rotations (12.64 v. 6.30 cases, $p < 0.01$). Most cases occurred after hours while residents were on call rather than during daytime ACS hours (78.8% v. 21.1%, $p < 0.01$). Senior residents were more likely than junior residents to report having a primary operator role (71.3% v. 32.0%, $p < 0.01$). Although the timing of cases made no difference in the operative role of senior residents, junior residents assumed the primary operator role more often during the daytime than after hours (50.0% v. 33.1%, $p = 0.01$).

Conclusion: Despite implementation of the ACS model, residents in our program obtained most of their EGS operative experience after hours while on call. Although further research is needed, our study suggests that improved daytime access to the operating room may represent an opportunity to improve the quantity and quality of the EGS operative experience at our academic network.

Contexte : Il a été prouvé que le modèle de chirurgie en soins actifs (CSA) améliore les résultats pour le patient, l'hôpital et le chirurgien. Pour le moment, peu de publications s'intéressent aux effets de ce modèle sur les résidents. Notre étude compare l'expérience des chirurgies générales d'urgence (CGU) chez les résidents effectuant un stage en CSA et chez les résidents effectuant un stage optionnel en chirurgie.

Méthodes : Les cas de CGU rapportés par les résidents ont été recueillis de manière prospective pendant 9 mois dans 3 hôpitaux universitaires. Les statistiques descriptives ont été compilées, et les 2 groupes ont été comparés à l'aide du test du χ^2 pour les variables catégorielles et du test t pour les variables continues.

Résultats : En tout, 1061 cas ont été rapportés (la participation des résidents était de plus de 90 %). Les atteintes de l'appendice et de la vésicule biliaire représentaient 49,7 % des CGU. Les résidents en CSA ont indiqué participer à 2 fois plus de CGU que les résidents en stage optionnel (12,64 c. 6,30 cas, $p < 0,01$). La plupart des CGU se sont produites en dehors des heures normales, alors que les résidents étaient de garde, plutôt que pendant les heures de CSA (78,8 % c. 21,1 %, $p < 0,01$). Les médecins résidents finissants étaient plus susceptibles d'indiquer avoir tenu le rôle de chirurgien principal que les résidents en début de parcours (71,3 % c. 32,0 %, $p < 0,01$). Le moment des chirurgies ne faisait aucune différence pour ce qui est du rôle des résidents finissants, mais les résidents en début de parcours ont davantage assumé le rôle de chirurgien principal pendant les heures de CSA que pendant les périodes de garde (50,0 % c. 33,1 %, $p < 0,01$).

Conclusion : Malgré l'adoption du modèle de CSA, les résidents de notre programme ont acquis la majorité de leur expérience en CGU en dehors des heures normales, alors qu'ils étaient de garde. Bien que d'autres études soient nécessaires, notre étude laisse croire qu'un meilleur accès aux salles d'opération pendant le jour pourrait augmenter la quantité et la qualité de l'expérience en CGU dans le réseau universitaire.

Since the introduction of the acute care surgery (ACS) model by the American Association for the Surgery of Trauma in 2003, the concept of emergency general surgery (EGS) delivery has been rapidly evolving.^{1,2} Indeed, in 2009 the Canadian Association of General Surgeons endorsed the ACS model, which has since been implemented in most academic and many large community hospitals across Canada.³⁻⁵ Nevertheless, the service structure and case mix of each ACS service varies across the country.³

The benefits of the ACS model have been well documented in the literature. These include improved patient outcomes for common EGS conditions such as biliary and appendiceal disease⁶⁻¹⁰ and substantial cost savings for hospitals and health care systems when compared with traditional models of care.¹¹⁻¹⁴ A positive impact on the surgeon has also been demonstrated, with studies suggesting increased productivity and job satisfaction following ACS implementation.¹⁵⁻¹⁷

The impact of the ACS model on residency training is not as well understood. In 2010, Wood and colleagues showed that implementation of an ACS service offloaded the burden of EGS from elective subspecialty teams, resulting in improved adherence to mandatory call limits and attendance at academic half days.¹⁸ Since then, a number of retrospective studies have compared resident case logs before and after ACS implementation, all concluding that case volumes were similar or increased without sacrificing case complexity.¹⁹⁻²³ However, none of these studies addressed the quality of the resident surgical experience.

To our knowledge, no studies have looked at specific factors involved in EGS delivery and their potential effect on residency training. In this study, we aimed to describe the impact of the ACS model on surgical residency training and to understand the differences in resident operative experience on ACS versus non-ACS rotations.

METHODS

Study design

This study was a prospective cohort study of general surgery residents' operative experience at a single academic network comprising 3 hospitals with varying approaches to EGS delivery. Our primary outcome was the proportion of cases in which residents performed the primary operator role. Comparisons were made between residents' assigned rotation (ACS v. elective service at the same hospital), operative timing (after hours vs. daytime), EGS case types and the involvement of fellows in the operating room. The study received full approval from the Hamilton Integrated Research Ethics Board.

Context

The provision of EGS services within our academic network is distributed across 3 teaching hospitals. Each EGS service varies in terms of access to operating rooms, patient populations served, burden of disease encountered, and resident and fellow staffing. All sites are staffed by residents. All staff surgeons participate regularly in ACS weeks (except 2 surgeons with practices focused on breast surgery and surgical oncology, who provide relief night coverage only). Each ACS service is assigned at least 1 general surgery resident; the resident complement varies by rotation and may include 1 senior general surgery resident and 1 or more junior residents. At the time of this study, sites 1 and 3 had shared access to emergency operating room time after 1 pm, while site 2 had dedicated operating room access from 8 am to 10 am on weekdays. Site 1 had a physician assistant (PA) on the ACS service during the daytime on weekdays, while sites 2 and 3 had no nonresident staffing. Site 1 is the highest volume bariatric centre in the province. Site 2 is the regional trauma centre. Site 3 specializes in hepatobiliary and general surgical oncology.

Study participants and data collection

No sample size calculation was completed for this descriptive, hypothesis-generating work. Residents in all postgraduate years were invited to participate. Those in postgraduate years 1 and 2 (PGY-1 and PGY-2) were considered junior residents, and those in years 3-5 (PGY-3, PGY-4, PGY-5) were considered senior residents. All participation was voluntary and there was no reward for participation. All participants provided informed consent for collection of their data.

General surgery residents prospectively recorded details of their EGS operative experience over the 9-block study period (1 block was equal to 4 weeks) between April and December 2017. Residents contributed to this study in 1 of 2 ways: as dedicated ACS residents participating in the daytime ACS and after-hours on-call workload or as elective residents assigned to subspecialty rotations (e.g., colorectal surgery, minimally invasive surgery, surgical oncology) during the day and participating only in the after-hours on-call EGS workload. A resident block was defined as a 4-week rotation during which a resident contributed to the EGS workload, either during the daytime while on an ACS rotation or after hours while on call. Daytime was defined as 8 am to 5 pm Monday to Friday, whereas after hours was defined as 5 pm to 8 am on weekdays and all day on weekends. These parameters were chosen to approximate the regular working hours versus on-call hours of a general surgery resident.

Data were collected prospectively by individual residents on their own cases using a standardized fillable Microsoft

Table 1. Resident-reported EGS operative experience

Characteristic	No. (%) of cases; rotation			p value
	ACS rotation n = 458*	Elective rotation n = 603*	All rotations n = 1061*	
EGS case type				0.54
Appendectomy	109 (23.8)	155 (25.7)	264 (24.9)	
Cholecystectomy	116 (25.3)	147 (24.4)	263 (24.9)	
Large bowel	57 (12.4)	80 (13.3)	137 (12.9)	
Small bowel	49 (10.7)	56 (9.3)	105 (9.9)	
Hernia	23 (5.0)	34 (5.6)	57 (5.4)	
Peptic ulcer disease	6 (1.3)	19 (3.2)	25 (2.4)	
Perianal disease	21 (4.6)	28 (4.6)	49 (4.6)	
Trauma	20 (4.4)	18 (3.0)	38 (4.0)	
Other	57 (12.4)	66 (10.9)	123 (11.2)	
Operative role				
Primary operator	313 (68.3)	323 (53.6)	636 (59.9)	< 0.01
Assistant	139 (30.3)	252 (41.8)	391 (36.8)	< 0.01
Observer	6 (1.3)	28 (4.6)	34 (3.2)	< 0.01
Operative timing†				
After hours	185 (48.7)	590 (97.8)	775 (78.8)	< 0.01
Daytime	195 (51.3)	13 (2.2)	208 (21.1)	

ACS = acute care surgery; EGS = emergency general surgery.
 *Unless indicated otherwise.
 †Operative timing data were not recorded for 78 cases on ACS rotations (7.3% of all cases): 380 cases on ACS rotations, 603 cases on elective rotations and 983 cases in total were included in this analysis.

Excel spreadsheet and submitted using an anonymized study identifier. We included all EGS cases participated in by residents while on the ACS service or while covering call. Planned daytime operations performed as part of an elective service were excluded from data collection and analysis.

Statistical analysis

Continuous parameters were expressed as means with standard deviations (SDs) and compared using the independent samples Student *t* test. Categorical data were expressed as counts and percentages and compared using the χ^2 or Fisher exact test. For comparisons of the operating experience of junior and senior residents, PGY-2 residents were compared with PGY-4 residents to allow clear comparison, because PGY-1 and PGY-5 residents do not rotate through ACS services at our institution. All tests were 2-sided, and statistical significance was set at a threshold of *p* < 0.05. Analysis was conducted using R version 3.5 (R Foundation).

RESULTS

Resident-reported emergency general surgery operative experience

Resident participation

More than 90% of eligible residents (32 of 35) participated in the study in some capacity, with data submit-

ted for 66.1% of eligible resident blocks (119 of 180) over the 9-block study period. A total of 1061 EGS cases were reported during the 119 eligible resident blocks, for a mean of 8.92 cases per resident per block. Residents on ACS rotations contributed 458 cases (43.2%) over 31 resident blocks, for a mean of 12.64 (SD 4.58) cases per resident per block. Of these cases, 48.7% were performed after hours. Residents on elective rotations contributed 603 cases (56.8%) over 93 resident blocks, for a mean of 6.30 (SD 1.17) cases per resident per block. Of these cases, 97.8% were performed after hours.

Emergency general surgery case types

Appendectomy (24.9%) and cholecystectomy (24.8%) were most commonly reported and represented half of all cases. Large bowel (12.9%) and small bowel (9.9%) cases were the next most commonly reported (Table 1).

Resident operative role

Residents reported having a primary operator role in 59.9% of cases (Table 1). They reported having assistant and observer roles in 36.9% and 3.2% of cases, respectively. The frequency with which residents reported having a primary operator role increased with increasing PGY level (Figure 1), with senior residents (PGY-3 to PGY-5) reporting that they had a primary operator role more frequently than junior residents (PGY-1 and PGY-2) (71.3% v. 32.0%, respectively, *p* < 0.001).

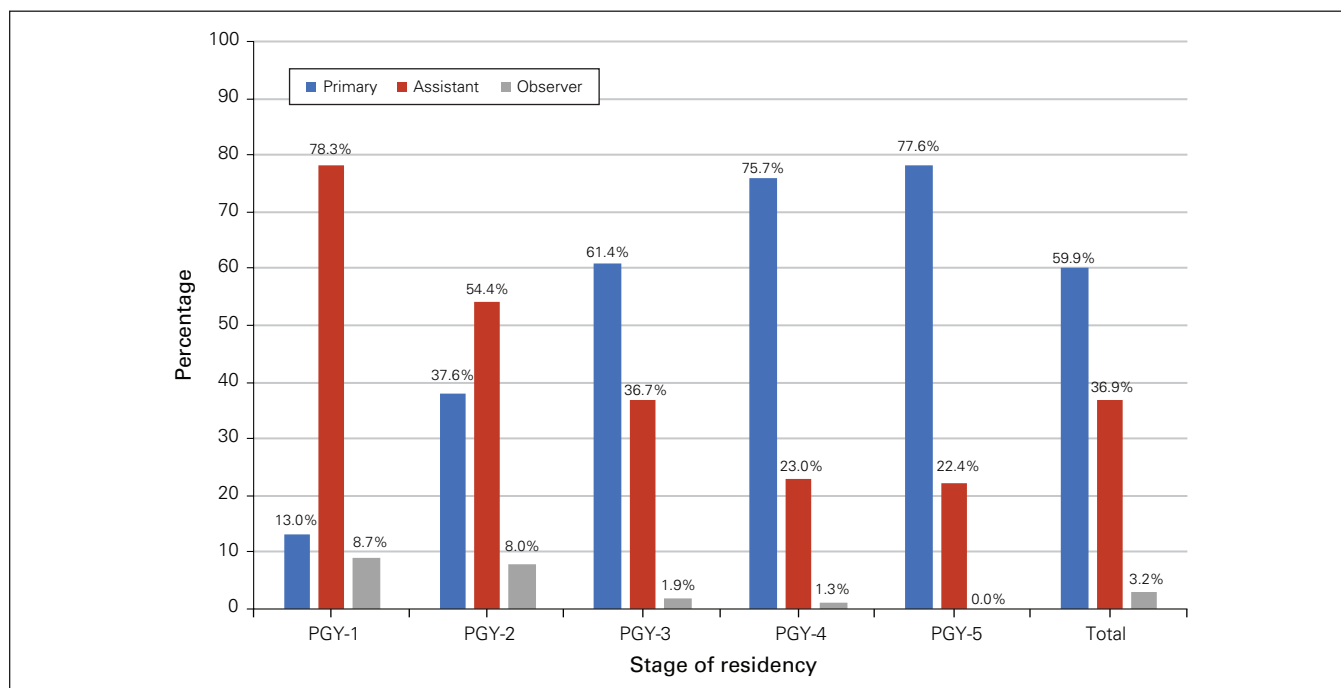


Fig. 1. Resident operative role by PGY level. PGY = postgraduate year.

Timing of resident operative experiences (after hours v. daytime)

Approximately 78.8% of reported cases occurred after hours while residents were on call; only 21.1% of the cases took place during daytime ACS hours. This observation remained unchanged when we stratified the results by case type (Appendix 1, Supplemental Table 1, available at canjsurg.ca/019619-a1). There was no difference in the case volume or proportion of after-hours versus daytime ACS cases on any given day of the week (Appendix 1, Supplemental Table 2).

Factors associated with emergency general surgery operative experience

Our analysis of the factors associated with residents' emergency general surgery operative experience is presented in Table 2. The factors included the type of rotation, the time of operation, the type of case and the presence or absence of fellows.

Acute care surgery versus elective rotations

Residents on ACS rotations reported a higher volume of EGS cases than those on elective rotations (mean 12.6 v. 6.3 cases per resident per block, $p = 0.02$). Nearly half of the EGS cases on ACS rotations occurred after hours while residents were on call (48.7%), compared with 97.8% of EGS cases on elective rotations. In addition, residents on ACS rotations were more likely to report having a primary operator role for EGS cases than those on elective rotations (68.3% v. 53.6%, $p < 0.01$) (Table 2, Figure 2).

After-hours versus daytime operating

Residents functioned as the primary operator more often during daytime EGS cases than during after-hours cases (68.3% v. 56.4%, $p < 0.01$) (Table 2). When we stratified the results by level of training, this difference was seen only for junior residents (PGY-2) (50.0% daytime v. 33.1% after hours, $p = 0.02$). The operative role of senior residents (PGY-4) was unaffected by case timing (76.1% daytime v. 73.3% after hours, $p = 0.54$) (Figure 3).

Emergency general surgery case types

Resident-reported operative roles varied considerably by EGS case type. Residents reported having the primary operator role most often for perianal cases (79.6%), appendectomy (76.5%) and cholecystectomy (68.1%) (Table 2). In contrast, residents reported having a primary operator role 40% of the time or less for large bowel, peptic ulcer disease and trauma cases (Table 2).

Impact of fellows

Residents reported the presence of fellows in 15.0% of cases, with 97.5% of these cases occurring at a single site. At this site, fellows were involved in 155 of 429 reported cases (36.1%). When operating with fellows, residents reported having a primary operator role in only 41.5% of cases, compared with 63.2% of cases with no fellow ($p < 0.01$). When fellows were present they had assistant and observer roles in 49.1% and 9.4% of cases, respectively, compared with in 34.7% and 2.1% of cases without fellows, respectively ($p < 0.01$) (Table 2). Fellows were observed to be participating in daytime ACS cases with

Table 2. Factors influencing resident-reported EGS operative experience

Characteristic	No. (%) of cases;* resident-reported operative role			p value
	Primary operator	Assistant	Observer	
Resident rotation				
ACS	313 (68.3)	139 (30.4)	6 (1.3)	< 0.01
Elective	323 (53.6)	252 (41.8)	28 (4.6)	
Operative timing*				
After hours	437 (56.4)	308 (39.7)	30 (3.9)	0.15
Daytime	142 (68.3)	65 (31.2)	1 (0.5)	
Junior residents				
After hours	58 (33.1)	99 (56.6)	18 (10.3)	0.02
Daytime	31 (50.0)	30 (48.4)	1 (1.6)	
Senior residents				
After hours	148 (73.3)	50 (24.8)	4 (2.0)	0.54
Daytime	67 (76.1)	21 (23.9)	0 (0.0)	
EGS case type				
Appendectomy	202 (76.5)	54 (20.4)	8 (3.0)	
Cholecystectomy	179 (68.1)	80 (30.4)	4 (1.5)	
Large bowel	47 (34.3)	84 (61.3)	6 (4.4)	
Small bowel	54 (51.4)	44 (41.9)	7 (6.7)	
Hernia	31 (54.4)	25 (43.9)	1 (1.8)	
Peptic ulcer disease	39 (40.0)	9 (48.0)	1 (12.0)	
Perianal	16 (79.6)	24 (18.4)	2 (2.0)	
Trauma	10 (38.1)	12 (57.1)	3 (4.8)	
Other	56 (47.1)	61 (51.3)	2 (1.7)	
Fellows present in operating room				
Yes	66 (41.5)	78 (49.1)	15 (9.4)	< 0.01
No	570 (63.2)	313 (34.7)	19 (2.1)	

ACS = acute care surgery; EGS = emergency general surgery.
 *Unless indicated otherwise.
 †Operative timing data were not recorded for 78 cases on ACS rotations (7.3% of all cases).

the same frequency as they participated in after-hours cases (36.8% v. 40.7%, respectively, $p = 0.59$).

Differences in acute care surgery models

The proportion of cases performed after-hours varied between sites (87.0%, 74.8% and 71.4%, $p < 0.01$). EGS case types varied slightly between sites, with appendectomy and cholecystectomy representing 57.8%, 39.5% and 49.2% of the case mix by site ($p < 0.01$) (Table 3). The frequency with which residents reported having the primary operative role also differed between sites (55.0%, 59.9% and 67.0%, $p = 0.02$).

DISCUSSION

Implementation of ACS services has had a profound impact on the organization of resident training in EGS. In our training program, the adoption of ACS services has compartmentalized resident training between EGS and non-EGS rotations. Before this paradigm was introduced, residents gained EGS experience longitudinally through 5 years of training. In the current environment, ACS rotations concentrate EGS training into discrete blocks, with residents receiving only limited exposure on non-ACS rotations while on call. The potential benefits and drawbacks are worth considering.

The burden of EGS on resident workload is substantial. Redirecting the bulk of this workload to dedicated EGS teams during the day has the potential to reduce that burden for residents on non-EGS rotations.

Wood and colleagues demonstrated that the creation of EGS-focused services translated into fewer missed educational opportunities in the operating room or clinic while

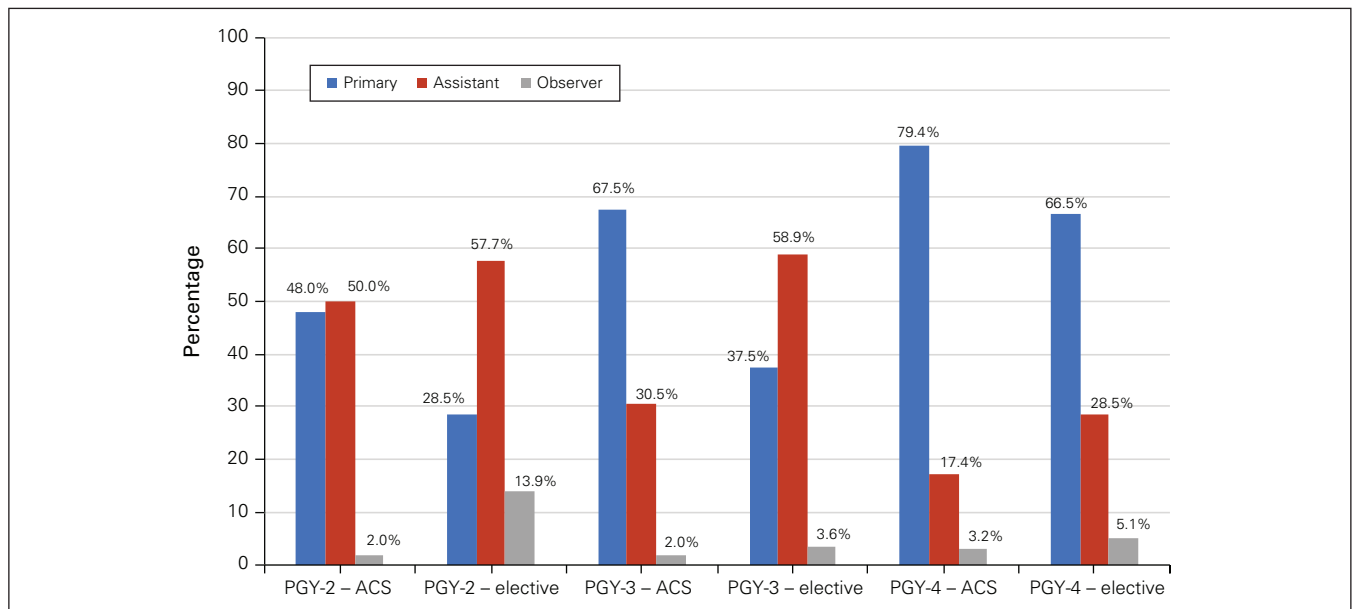


Fig. 2. Resident operative role by PGY level: ACS versus elective rotations. ACS = acute care surgery; PGY = postgraduate year.

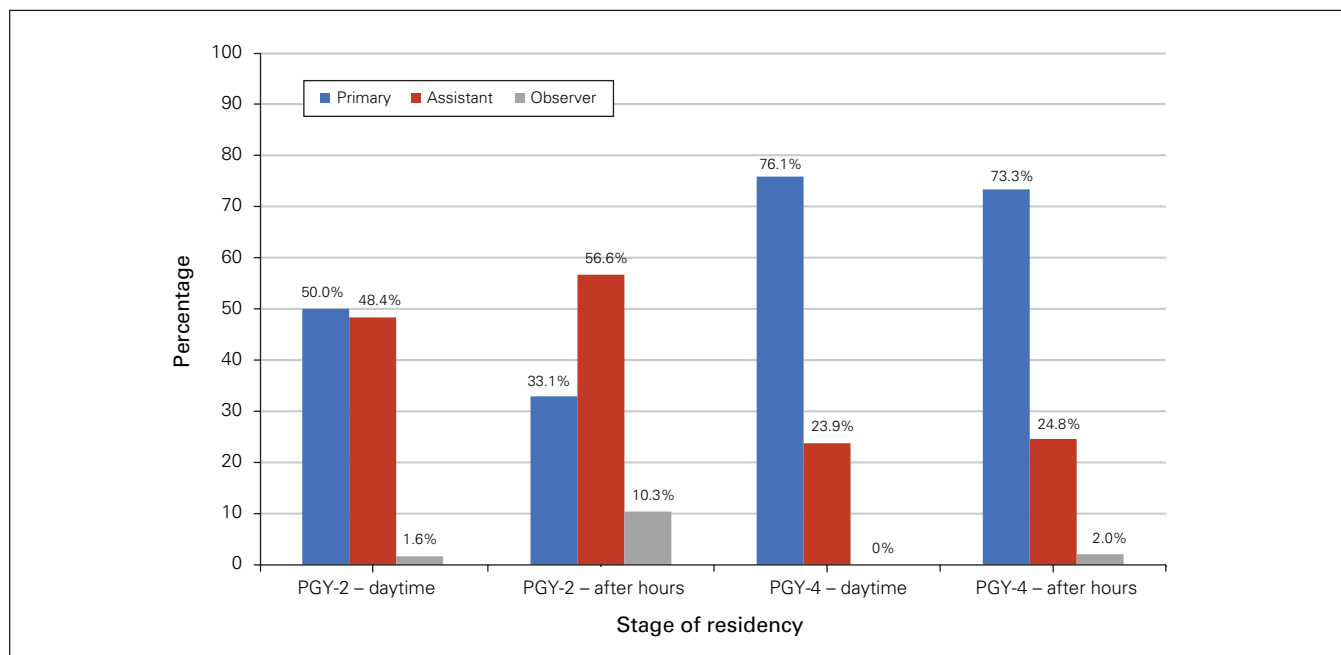


Fig. 3. Resident operative role by operative timing: junior (PGY-2) versus senior (PGY-4) residents. PGY = postgraduate year.

Factor	Site 1	Site 2	Site 3	<i>p</i> value
ACS model characteristics				
Year established	2012	2017	2011	
Unique patient population	Bariatrics	Trauma	Hepatobiliary	
Presence of fellows on site	Yes (MIS)	No	No	
ACS-assigned physician adjunct	Yes (PA)	No	No	
Daytime OR resources	Shared emergency time after 1 pm	Dedicated ACS time 8–10 am	Shared emergency time after 1 pm	
No. of surgeons with ACS fellowship training	0	2	0	
No. of EGS cases per week*	~11	~7	~11	
Study outcomes				
Total case load	429	329	303	—
Cases done after hours, %	87.0	74.8	71.4	< 0.01
Appendectomy and cholecystectomy, %	57.8	39.5	49/2	< 0.01
Fellow presence in OR, %	36.2	0	0	—
Resident-reported primary operator role, %	55.0	59.9	67.0	0.02

ACS = acute care surgery; EGS = emergency general surgery; MIS = minimally invasive surgery; OR = operating room; PA = physician assistant.
*EGS case volumes represent the most accurate available estimates.⁴²

residents were on subspecialty rotations.¹⁸ Meanwhile, for residents on ACS rotations, a more concentrated, high-intensity EGS experience may be obtained.

The educational experience on an ACS service appears to be very dependent on its case mix, structure and access to dedicated OR time during the daytime. Residents in our program spend less than 10% of their overall clinical time on ACS rotations. To our knowledge, no comparative published data exist regarding EGS exposure at other general surgery residency program sites accredited by the Royal College of Physicians and Surgeons of Canada. Although residents may still gain substantial exposure after

hours while on call, concerns have been raised about continuity of care and the completeness of the learning experience when much of the work-up, management and postoperative care may be handed over to the ACS team in the morning.²⁴

With the ongoing trend toward subspecialization in general surgery, especially at academic centres,²⁵ adequate training in EGS and trauma is critical to ensuring the competency of the next generation of general surgeons in Canada.²⁶ With the widespread adoption of the ACS model, we have effectively changed the way residents are exposed to the provision of EGS and trauma care. Similar to concerns

recently raised about trauma exposure in Canada,²⁷ how can we be sure that exposure to EGS during a general surgery residency is adequate?

In this study, residents on ACS rotations reported an increased quality and quantity of EGS operative experience compared with residents on subspecialty rotations. Although we identified several contributing factors, the difference in daytime versus after-hours operative experience is of particular importance.

The benefits of daytime OR access and the risks associated with after-hours operating have been described.^{28–34} Despite this, the burden of EGS operating has traditionally been concentrated after hours or overnight, after the elective cases for the day have been completed. Where dedicated EGS teams are provided access to daytime OR resources, the ACS model has the potential to address this issue.³⁵ A recent meta-analysis by Murphy and colleagues found that the benefits of the ACS model are dependent on access to dedicated daytime OR resources.⁹ Unfortunately, this remains a major challenge for most Canadian institutions.³⁴

Improved resident operative experience during daytime operating may be explained by a number of factors. First, the scheduled nature of daytime operating may reduce time pressure, affording residents time to work through difficult cases that they might not receive after hours.³⁶ Second, dedicated OR access means the ACS team is not at risk of being displaced by other surgical emergencies. In addition to the benefits of lessened time pressure, this may allow planning for specific resident educational experiences. Third, operating with a single staff surgeon during the day for the entire week provides continuity and facilitates the development of trust, which may translate into more opportunity in the OR than when a resident has a more fragmented experience, potentially working with different staff surgeons on different call nights. In this study, we found this to be the case for junior but not senior residents, who may have a more consistent experience because of their seniority and existing skill set. Lastly, scheduled operating during the day may give residents time to better prepare for more complex EGS cases, as is typically afforded during subspecialty rotations, thereby fostering proactive versus reactive learning experiences.³⁷

Of the factors found to negatively influence resident operative experience in this study, the presence of fellows in the operating room is the most interesting. The impact of fellowship on general surgery residency training has been widely debated, but little has been published on the impact of fellows on EGS training specifically. In 2014, Dinan and colleagues published a retrospective review of chief resident case logs before and after ACS fellowship implementation and found that there was not a significant difference in case volume.³⁸ However, no mention was made of the resident operative experience in these cases.

We found that the presence of fellows in the OR diluted the resident-reported operative role, with residents

performing fewer cases as primary operator when a fellow was also present. It is important to note that at our institution, fellows are undergoing non-ACS subspecialty training and are expected to be involved in EGS operating after hours while on call. The impact of a dedicated ACS fellow available during daytime hours may be different;³⁸ this was not assessed by our study.

At the time of data collection, only 1 of the hospital sites had any nonlearner clinical staff assigned to the ACS services. The effect of this provider was not specifically addressed in our analysis.³⁹ However, the inclusion of advanced providers (physician assistants and nurse practitioners) is becoming more common in many centres and shows much promise in terms of optimizing the balance of patient care and the resident learning experience in teaching services.^{40,41}

The decision to establish an ACS service in our academic network was made on an individual basis by each site in different years, largely to improve the delivery of EGS patient care rather than to create optimal educational experiences for residency training. In our study, the ACS resident-reported case volumes averaged 12.6 cases per 4-week block, or approximately 3 cases per week. The combined operative volume of all 3 separate ACS services is approximately 1500 cases per year, with averages of 11 cases per week at site 1, 7 cases per week at site 2 and 11 cases per week at site 3, which would represent the absolute maximum number of operative cases available to the resident if they could attend every operation that week.⁴² Although comparative Canadian data are lacking, data from the ACS service in London, Ontario, indicated an average case volume of 14 cases per week, although logs of actual resident-attended operations were not reported.³⁵ Resident case log data from American training programs indicated that residents attended approximately 9 cases per week.¹⁹ Overall, the case volume reported by McMaster University general surgery residents is low, which raises concerns about the adequacy of their exposure to EGS operations while they are on ACS rotations. Potential solutions that could increase resident operative case exposure during their ACS rotation include increased daytime operations facilitated by dedicated ACS daytime OR time and increased case volume per ACS service facilitated by closure or consolidation of the existing 3 ACS services into 2 sites or a single site.

Limitations

Although this study attempts to address some important issues in the delivery of EGS training, our findings must be understood in light of certain limitations. While more than 90% of residents participated in this study in some capacity, no case log data were submitted for 47 of 166 eligible resident blocks during the study period. It is difficult to account for the bias this may introduce in our study, both in nature

and degree. This, and the variability with which residents report their role, is likely to affect any study of self-reported data or case logs. This could theoretically be addressed by randomly assigning residents to ACS or non-ACS rotations with third-party criteria-based data collection. First- and final-year residents do not complete ACS rotations in our program, so the data they contributed reflect only elective rotations and may have skewed the results slightly. This could have skewed the findings of elective service residents in a mixed manner, given that earned trust and competence are relatively lower for first-year residents, whereas these have peaked in the final year. Given the differences in EGS delivery models across our institution, a composite EGS operative experience is difficult to ascertain, limiting the generalizability of our findings. Finally, this study focused on operative experience, excluding consideration of potential benefits of the ACS model to aspects of residency training unrelated to the operative experience.

Nevertheless, to our knowledge this study is the first examining resident self-reported operative experience in EGS in Canada and includes more than 1000 cases occurring at 3 different sites within an established residency training site. We believe it represents an important first attempt to capture the educational impact of the advent and evolution of ACS in Canada.

CONCLUSION

Despite widespread implementation in Canada, the impact of the ACS model on residency training is poorly understood. Although our study results suggest that the resident experience is superior on ACS rotations (increased operative volumes and a higher percentage of cases in which the resident has a primary operative role), the majority of EGS operative exposure at our institution is still obtained after hours while on call. Improved access to daytime OR resources may improve the quality of ACS rotations from a surgical education standpoint. Further research is needed to determine the optimal ACS service characteristics for achieving EGS competency during general surgery residency training.

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Contributors: M. Meschino, R. Nenshi and M. Maraccio designed the study. M. Meschino acquired the data, which M. Meschino, A. Giles, P. Engels, T. Rice and R. Nenshi analyzed. M. Meschino and A. Giles wrote the article, which all authors critically revised. All authors agreed to be accountable for all aspects of the work.

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