Impact of acute care surgery on timeliness of care and patient outcomes: a systematic review of the literature

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Background: Dedicated emergency general surgery (EGS) service models were developed to improve efficiency of care and patient outcomes. The degree to which the EGS model delivers these benefits is debated. We performed a systematic review of the literature to identify whether the EGS service model is associated with greater efficiency and improved outcomes compared to the traditional model.

Methods: We searched MEDLINE, Embase, Scopus and Web of Science (Core Collection) databases from their earliest date of coverage through March 2017. Primary outcomes for efficiency of care were surgical response time, time to operation and total length of stay in hospital. The primary outcome for evaluating patient outcomes was total complication rate.

Results: The EGS service model generally improved efficiency of care and patient outcomes, but the outcome variables reported in the literature varied.

Conclusion: Development of standardized metrics and comprehensive EGS databases would support quality control and performance improvement in EGS systems.

Contexte : Des modèles dédiés de services de chirurgie générale d'urgence (CGU) ont été développés pour améliorer l'efficience des soins et les résultats chez les patients. On ne s'entend toutefois pas sur l'ampleur des bénéfices conférés par le modèle CGU. Nous avons procédé à une revue systématique de la littérature afin de vérifier si le modèle CGU est associé à une plus grande efficience et à de meilleurs résultats comparativement au modèle classique.

Méthodes : Nous avons interrogé les bases de données MEDLINE, Embase, Scopus et Web of Science (collection centrale) depuis la plus ancienne couverture du sujet et jusqu'à mars 2017. Les paramètres principaux pour l'efficience des soins étaient le temps de réponse, le délai avant l'intervention et la durée totale du séjour hospitalier. Le paramètre principal pour l'évaluation des résultats chez les patients était le taux de complications total.

Résultats : Le modèle de service CGU améliore généralement l'efficience des soins et les résultats chez les patients, mais dans la littérature, les paramètres mesurés varient.

Conclusion : Le développement de paramètres standardisés et de bases de données globales sur la CGU appuierait le contrôle de la qualité et l'amélioration du rendement des systèmes CGU.

Acute care surgery (ACS) encompasses trauma, surgical critical care and emergency general surgery (EGS). Emergency general surgery patients account for a substantial proportion of emergency department presentations and contribute to the increasing inability of hospitals to provide timely emergency care.[1] Currently, there are roughly 16.2 million emergency department visits in Canada, with 55% of these triaged as urgent or emergent. In the United States, more than 3 million patients are admitted to hospital each year with EGS conditions.[2]

In addition to representing an immense burden of disease, EGS patients are uniquely challenging to manage. Emergency general surgery encompasses a spectrum of illnesses with diverse pathology, including almost any diagnosis that can culminate in abdominal sepsis. The main uniting factor in

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this patient population is the urgency with which they require intervention. Preoperative evaluation and optimization are often limited, which leaves these patients particularly prone to poor outcomes. Many studies have shown an association between EGS and negative outcomes, including higher rates of major complications and death.[3–9] Compared to patients undergoing elective operations, those undergoing emergency open gastrointestinal surgery are up to 5 times more likely to die within 30 days of their operation; they also experience minor and major complications 3 times as often as their elective surgery counterparts.[9]

The traditional model of care for EGS patients was an "on-call" system. A surgeon managed all incoming surgical emergencies for 24 hours while simultaneously working within the demands of his or her scheduled elective practice. Potential delays in patient assessment, ordering of supplemental investigations and admission to hospital occurred, as the on-call surgeon would not necessarily be on site when consulted regarding a patient. Patients requiring an emergent operation would interrupt an elective slate, or their surgery would be delayed until a theatre became available. Evening and nighttime operating, although not ideal, was often preferable to cancelling elective cases. The traditional model required surgeons to simultaneously balance EGS on-call duties with the usual demands of scheduled surgery and clinics. These conflicting demands inevitably culminated in the provision of suboptimal care to EGS patients or delays in completion of work in an elective practice. It became increasingly clear that a new model of care was required to streamline the management of EGS patients, improve hospital efficiencies and enhance outcomes.

Dedicated EGS service models were developed in part as a response to growing concerns with the traditional model of EGS care. Emergency general surgery models are broadly defined as clinical service teams that are dedicated to the prompt, comprehensive and evidence-based care of acutely ill general surgery patients. This model represents a change in the organization and staffing of general surgery services across North America. Several common elements of an EGS service are agreed on, although local, regional and national variation exists. A consultant leads the EGS service for a defined period of time, generally 1 week. The consultant is on site and available to provide clinical support to all stages of general surgery patient care during this time. The consultant is generally relieved from elective duties while leading the service. There is complete separation of emergency and elective pathways, with most services having dedicated operating room (OR) time for emergency surgical cases. However, it is important to acknowledge that establishment of an EGS service is not equivalent to having OR time for these cases. In fact, surgeon availability and OR availability are 2 separate issues. This is a potential factor in showing the superiority of the EGS service. Many North American institutions face the challenge of dedicating OR time despite EGS surgeon availability.

The proposed benefits of the EGS service model are numerous. A well-organized, dedicated EGS team with continual on-site presence should increase efficiency in the delivery of care to EGS patients.[10–13] Specifically, this team-based approach should lead to faster assessments of surgical consultations, decreased time to hospital admission and improved throughput in the emergency department. With a dedicated EGS OR and surgeon, a patient's time to operation should also decrease. In addition, a dedicated OR should allow more emergency cases to be handled during daytime hours. Finally, improvements in the timeliness of patient care with EGS are proposed to translate into fewer patient complications and overall enhanced outcomes. A reduction in complications in addition to improved preoperative timeliness of care should result in decreased total hospital length of stay (LOS), with attendant cost benefits to the hospital and health care system. Despite this potential, the degree to which the EGS model can deliver these benefits continues to be debated in the literature.

We performed a systematic review of the literature with the objective to identify whether the EGS service model is associated with greater efficiency in delivery of care and improved outcomes compared to the traditional model. Where possible, we followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines in performing this review.

Methods

Search strategy

A health science librarian performed a systematic search of the literature across relevant databases (MEDLINE [Ovid], Embase [Ovid], Scopus and Web of Science [Core Collection]) from their earliest date of coverage through March 2017. No language restrictions were used in the search or study selection. Although searches varied in keeping with the options available within each database, a combination of controlled vocabulary and keyword queries were used in most cases. The title, abstract and subject heading (if applicable) fields were searched in all cases. Most commonly used subject headings included Emergency medical services; Emergency service, hospital; Triage; Specialties, surgical; Acute diseases; Appendicitis; Cholecystitis; and Intestinal obstruction. A series of keyword strategies were created to access literature focusing on the concept of emergency department (services) surgery, acute surgery, appendicitis, cholecystitis and bowel obstruction to ensure that all relevant studies were captured in the search. Although numerous other diseases (e.g., diverticulitis and perianal abscess) are diagnosed in

EGS patients, we specifically addressed appendicitis, cholecystitis and bowel obstruction because of their overwhelming prevalence in the EGS published literature. The reference lists of relevant articles were also searched for appropriate studies. A search for unpublished literature was not performed.

Study selection

Studies included in this review had to compare an EGS model with a preexisting or traditional model of care. Studies also had to include a quantitative outcome evaluation. Studies that featured outcomes for an EGS model with no comparator were excluded. Similarly, qualitative studies were excluded. Primary outcomes for evaluating efficiency of care were surgical response time, time to operation and total hospital LOS. The primary outcome for evaluating patient outcomes was total complication rate. Secondary outcomes included in this review were appendix perforation rate and operative time of day. We chose appendiceal perforation as a secondary outcome to assess whether perforation is more a function of a specific service model or access to care. Studies that reported on at least 1 of the primary outcomes were included in the review.

Possible studies for inclusion were identified from the abstracts of the initial search and were selected according to the inclusion criteria after the full text was read. Two reviewers (J.M. and S.E.S.) chose papers for inclusion independently. Once the studies for inclusion were chosen, the reviewers compared their choices and resolved discrepancies through consensus. A third reviewer (K.H.), the senior member of the research team, resolved outstanding discrepancies. The same 2 reviewers independently abstracted data from included studies using a standardized data extraction form based on the Cochrane Effective Practice and Organisation of Care data collection checklist. We reported results in a descriptive fashion, as substantial heterogeneity was present in which performance and outcome variables were reported as well as in their specific definitions. There is not a registered protocol for this systematic review.

Results

Study characteristics

The original search strategy yielded 3272 studies, of which 22 met the full criteria for inclusion (Fig. 1). Characteristics of the studies included in this systematic review are summarized in Table 1. All studies were retrospective in nature, with pre/post designs. Seven studies were from the US, 3 were from Canada, 11 were from Australia or New Zealand, and 1 was from Taiwan. Twelve studies evaluated patients with a diagnosis of acute appendicitis, 6 dealt exclusively with biliary disease, and 3 included patients with multiple diagnoses (a combination of biliary disease, acute appendicitis and small-bowel obstruction). One study evaluated all-comers without excluding patients based on diagnosis. Descriptive results of the included studies are summarized in Table 1.

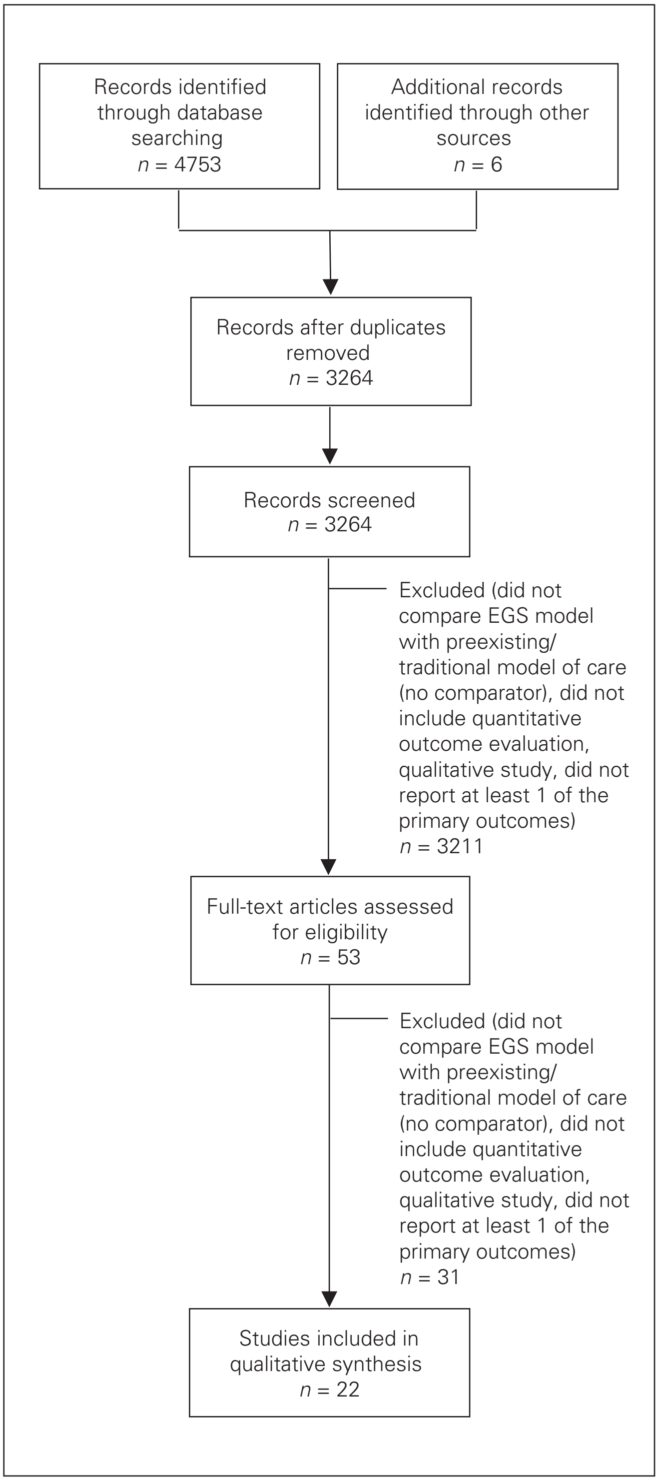

Fig. 1. Flow chart showing study selection. EGS = emergency general surgery.

Table 1. Characteristics and descriptive results of studies included in systematic review

Study	Study period, mo, traditional model/acute care surgery model	Diagnosis	No. of patients, traditional model/acute care surgery model	Change in surgical response time	Change in time to operating room	Change in length of stay	Change in total complication rate
Beardsley et al.,[11] 2014	3	Acute appendicitis	84/66	Decreased	Decreased	—	—
Britt et al.,[16] 2010	12/24	Acute cholecystitis	54/132	—	NS	NS	NS
Brockman et al.,[30] 2013	12	Acute appendicitis	351/357	—	—	NS	NS
Cubas et al.,[10] 2012	12	Acute appendicitis Acute cholecystitis	82/93 51/62	Decreased	Decreased	Decreased	NS
Earley et al.,[17] 2006	18	Acute appendicitis	127/167	—	Decreased	Decreased	Decreased
Ekeh et al.,[18] 2008	14	Acute appendicitis	273/279	—	NS	—	—
Faryniuk et al.,[12] 2013	3	Acute appendicitis, acute cholecystitis, small-bowel obstruction	67/142/127*	Decreased	NS	NS	—
Fu et al.,[15] 2014	12	Acute appendicitis	146/159	Decreased	Decreased	Decreased	NS
Gandy et al.,[19] 2010	12	Acute appendicitis	176/226	—	NS	NS	Decreased
Lancashire et al.,[14] 2014	12	Acute appendicitis	247/301	Decreased	NS	NS	NS
Lau et al.,[20] 2011	10/12	Acute cholecystitis	81/71	—	Decreased	NS	Decreased
Lehane et al.,[21] 2010	24	Acute cholecystitis	87/115	—	Decreased	Decreased	Decreased
Michailidou et al.,[22] 2014	12	Acute cholecystitis	94/234	—	Decreased	Decreased	Decreased
Milzman et al.,[23] 2010	18	Acute appendicitis	60/60	—	Decreased	NS	Decreased
Pepingco et al.,[24] 2012	24	Acute cholecystitis	114/157	—	Decreased	Decreased	—
Perry et al.,[31] 2010	14/10	Acute appendicitis, acute cholecystitis, small-bowel obstruction	5346/3836	—	—	Decreased	—
Pillai et al.,[25] 2013	29/31	Acute appendicitis	875/982	—	NS	Decreased	NS
Poh et al.,[26] 2013	12	Acute appendicitis	256/283	—	NS	NS	NS
Qureshi et al.,[13] 2011	18/12	Acute appendicitis	177/137	Decreased	NS	NS	—
Suen et al.,[27] 2014	18	Acute appendicitis	276/399	—	Increased	NS	—
Suhardja et al.,[29] 2015	12	Acute cholecystitis	179/163	—	Decreased	Decreased	—
Wanis et al.,[28] 2014	12	Acute appendicitis, acute cholecystitis, small-bowel obstruction	286/294	—	Decreased	—	—

Note: NS = nonsignificant difference.
*Traditional model/newly formed acute care surgery service model/established acute care surgery service model.

Efficiency of care

Of the 22 included studies, 6 evaluated surgical response time.[10–15] There was substantial heterogeneity in how this measure was defined. Beardsley and colleagues[11] and Cubas and colleagues[10] defined surgical response time as the interval between the patient's arrival at triage and evaluation by the surgical team; Beardsley and colleagues[11] additionally measured the time from emergency department assessment to surgical evaluation. Faryniuk and Hochman[12] evaluated the time from emergency department consultation to surgical assessment, whereas Qureshi and colleagues[13] measured the time from emergency department consultation to the time the surgical team decided to admit the patient. Lancashire and colleagues[14] and Fu and colleagues[15] defined surgical response time as the interval from emergency department registration to admission/decision to operate. Given this variation, we did not calculate a pooled result for surgical response time. Compared to the traditional model of care, the EGS service model was associated with significantly decreased surgical response time in all 6 studies (Table 2).

Time to OR was assessed in 20 studies.[10–29] This measure was also defined differently among these studies. The interval between triage registration and operative start was the most common definition, being used in 10 studies. The remainder of the studies used a variety of start times other than triage registration, including time of surgical consultation, surgical diagnosis, surgical evaluation, surgical decision, admission and booking request. Of note, Pepingco and colleagues[24] defined time to OR as median time to definitive procedure, which may include interventions such as endoscopic retrograde cholangiopancreatography rather than a surgical procedure. Compared to the traditional model of care, time to OR was significantly decreased with an EGS service in 11 studies and was significantly increased in 1 study[27] (Table 3).

Hospital LOS was assessed in 19 studies.[10,12–17,19–27,29–31] This measure was generally not clearly defined in these studies. Of the 8 studies that provided definitions, 4 looked at the time interval from inpatient admission to discharge, 3 considered the time from triage to discharge, and 1 measured emergency department arrival to discharge. Compared to the traditional model of care, hospital LOS was significantly decreased with an EGS service in 9 studies (Table 4). Nonsignificant differences in LOS were found in the remaining 10 studies. It should be noted that Faryniuk and Hochman[12] did not find a significant difference in hospital LOS when all diagnoses (appendicitis, acute cholecystitis and small-bowel obstruction) were considered. However, on subgroup analysis of only appendicitis and cholecystitis, LOS was significantly reduced with an EGS service (2.63 d v. 1.79 d, $p = 0.009$).

Table 2. Summary of surgical response time results

Study	Diagnosis	Mean surgical response time, h: Traditional model	Mean surgical response time, h: Acute care surgery model	Mean difference, h
Beardsley et al.[11]	Acute appendicitis	6.1	5.0	–1.1
Cubas et al.[10]	Acute appendicitis	6.6	4.4	–2.2
	Acute cholecystitis	12.0	6.0	–6.0
Faryniuk et al.[12]	Multiple diagnoses	1.7	0.8	–0.9
Fu et al.[15]	Acute appendicitis	4.7	2.8	–1.9
Lancashire et al.[14]	Acute appendicitis	7.2	5.8	–1.4
Qureshi et al.[13]	Acute appendicitis	5.6	3.2	–2.4

Table 3. Summary of time to operating room results

Study	Diagnosis	Mean time to operating room, h*: Traditional model	Mean time to operating room, h*: Acute care surgery model	Mean difference, h*
Beardsley et al.[11]	Acute appendicitis	26.5	24.5	–2.0
Cubas et al.[10]	Acute appendicitis	16.4	11.0	–5.4
	Acute cholecystitis	60.0	34.0	–26.0
Earley et al.[17]	Acute appendicitis	14.0	10.1	–3.9
Fu et al.[15]	Acute appendicitis	7.3	2.2	–5.1
Lau et al.[20]	Acute cholecystitis	35.0	24.6	–10.4
Lehane et al.[21]	Acute cholecystitis	48.0†	24.0†	–24.0
Michailidou et al.[22]	Acute cholecystitis	25.7	20.8	–4.9
Milzman et al.[23]	Acute appendicitis	1.6	0.6	–1.0
Pepingco et al.[24]	Acute cholecystitis	134.4†	50.4†	–84.0†
Suen et al.[27]	Acute appendicitis	15.0	18.0	3.0
Suhardja et al.[29]	Acute cholecystitis	32.4†	25.2†	–7.2
Wanis et al.[28]	Acute appendicitis, acute cholecystitis, small-bowel obstruction	3.7	3.2	–0.5

*Except where noted otherwise.
†Median.

Outcomes

Thirteen studies evaluated the difference in rate of postoperative complications between the traditional model of care and the EGS service model.[10,14–17,19–23,25,26,30] To enable comparison of patient outcomes between these studies, only data regarding total postoperative complication rate was abstracted for this review. Six of the included studies found that the total rate of postoperative complications was significantly decreased with an EGS service (Table 5). The remaining studies found no significant difference in the rate of complications between cohorts.

Table 4. Summary of hospital length of stay results

Study	Diagnosis	Mean hospital length of stay, d*: Traditional model	Mean hospital length of stay, d*: Acute care surgery model	Mean difference, d*
Cubas et al.[10]	Acute appendicitis	2.8	1.8	–1.0
	Acute cholecystitis	5.2	3.3	–1.9
Earley et al.[17]	Acute appendicitis	3.5	2.3	–1.2
Fu et al.[15]	Acute appendicitis	3.8	2.4	–1.4
Lehane et al.[21]	Acute cholecystitis	6.0†	4.0†	–2.0†
Michailidou et al.[22]	Acute cholecystitis	3.5	2.1	–1.4
Pepingco et al.[24]	Acute cholecystitis	4.9†	4.0†	–0.9†
Perry et al.[31]	Acute appendicitis, acute cholecystitis, small-bowel obstruction	2.6	2.0	–0.6
Pillai et al.[25]	Acute appendicitis	2.8	2.6	–0.2
Suhardja et al.[29]	Acute cholecystitis	4.0†	3.0†	–1.0†

*Except where noted otherwise.
†Median.

Table 5. Summary of complication rate results

Study	Diagnosis	Mean complication rate, %		Mean difference, %
		Traditional model	Acute care surgery model	
Earley et al.[17]	Acute appendicitis	17.4	7.7	–9.7
Gandy et al.[19]	Acute appendicitis	17.0	9.3	–7.7
Lau et al.[20]	Acute cholecystitis	18.5	7.0	–11.5
Lehane et al.[21]	Acute cholecystitis	17.2	8.7	–8.5
Michailidou et al.[22]	Acute cholecystitis	13.8	3.9	–9.9
Milzman et al.[23]	Acute appendicitis	14.0	5.0	–9.0

Secondary outcomes

The appendix perforation rate was documented in 10 studies.[13–15,17–19,25–27,30] There was no significant difference in appendix perforation rate between the traditional model of care and the EGS service model in 9 studies. Earley and colleagues[17] found a significantly decreased rate of appendix perforation with an EGS service (12.3% with ACS v. 23.3% with the traditional model, $p < 0.05$).

Operative time of day was reported in 13 studies.[14–17,19,20,24–30] Brockman and colleagues[30] found that significantly fewer nighttime emergency appendectomy operations occurred with an ACS model (4% v. 12% with the traditional model, $p = 0.005$). Similarly, 5 studies showed significantly decreased after-hours operating with an ACS service.[19,20,26–28] Complementing this finding, an increase in daytime operating with EGS service models was noted in 7 studies.[14,16,19,24,25,27,29] Conversely, Earley and colleagues[17] found that more than 40% of operations occurred in the evening (1600–2400) with the traditional model, whereas more than 40% of operations occurred between midnight and 0800 with an EGS service. Fu and colleagues[15] also noted that significantly more patients underwent appendectomy at night (1700–0800) with their EGS model than with the traditional model of care (73% v. 39%, $p < 0.001$).

Discussion

Multiple recent studies have evaluated the impact of an EGS service model on efficiency of care and patient outcomes. Substantial variability exists in which outcome variables are reported by each study and in the precise definition of these variables. In addition, there is currently no single accepted EGS model. International variation in the structure and organization of EGS models necessitates caution when generalizing the results of a study conducted in one country to an EGS model in another. With these limitations in mind, our systematic review of the available literature shows that an EGS service model generally results in significant improvements in surgical response time and time to operation and significant decreases in hospital LOS. A decrease in total complication rate is also realized with an EGS service.

In 1966, the National Academy of Sciences branded accidental injuries as "the neglected disease of modern society."[32] The academy's report highlighted the importance of reducing time between pathologic occurrence (injury) and the initiation of medical care. As a result, highly organized trauma systems have emerged that continue to have a major impact on patient mortality by systematically measuring outcomes, regionalizing delivery and establishing national standards through evidence-based metrics.[33–36]

Similar to the goals of trauma systems, EGS aims to streamline patient management, improve hospital efficiencies and enhance outcomes. This model has led to renewed interest in ACS fellowships, dedicated ACS conferences and research establishing evidence-based guidelines for the care of EGS patients. The implementation of the EGS model of care is a good initial step in unifying a previously fragmented patient population and improving the quality of their care. However, the development of trauma systems has shown that measurement of and feedback on performance is integral to the improvement of a system of care.

The need for standardized quality metrics is apparent now that the EGS model has been created and adopted by multiple centres. Currently, a common set of clearly defined, evidence-based and broadly accepted performance measures for evaluating the quality of EGS as a part of, or independently from, ACS do not exist as robustly as they do for trauma systems or as defined by the American College of Surgeons National Surgical Quality Improvement Program. However, this program is not well suited for EGS owing to several factors, including nonoperative management of many EGS diagnoses and the relatively small proportion of EGS cases in the database, which contributes to concerns related to National Surgical Quality Improvement Program sampling methodology.[37] Multiple studies have evaluated the impact of EGS on the efficiency of hospital care and patient outcomes.[10–31] However, the substantial variability in specific outcome variables and their definitions makes it impossible to generalize or compare these results between centres.

A crucial step in developing standardized quality metrics is common agreement on and definition of outcome variables. The most commonly included measures are surgical response time, time to OR and hospital LOS. Part of the difficulty in establishing common definitions lies in the fact that EGS encompasses an array of heterogeneous diseases with sometimes very disparate hospital courses. However, acute appendicitis and biliary tract disease are the most common reasons for admission to an EGS service.[10] Patients with these diagnoses have fairly standard points of care along their hospital stays that are measurable. Establishing which point of care measures are important to monitor for the most common EGS conditions and establishing their precise definitions would aid in comparisons both within and between EGS models. To this end, a universal grading system of EGS disease severity has been developed by the American Association for the Surgery of Trauma[38] and has been applied to common diagnoses.[39]

With common definitions of disease, metrics can be established, and the development of comprehensive EGS databases or registries is possible. These registries could be an integral component in providing quality control and performance improvement in EGS systems; they could act as a database from which specific items could be evaluated, trends could be determined, and items could be linked to outcomes. Trends in EGS diagnoses, benchmarking data, and disease trends by age, geographic location and comorbidity could be readily delineated. Importantly, outcomes for a specific diagnosis could be monitored, providing data that could then be analyzed to evaluate the timeliness, appropriateness and quality of patient care. In addition to establishing benchmarks for care, comprehensive registries would allow hospitals to compare their performance to one another and to a national or international standard.

The value in tracking and improving outcomes underscores the academic potential of EGS models as standalone services or within the context of an ACS model that includes trauma and surgical critical care. Although somewhat beyond the scope of this review, the proliferation of ACS/EGS fellowships across North America is indicative of this. There are currently 22 sites approved for ACS fellowship training by the American Association for the Surgery of Trauma.[40] This suggests a need and desire to develop EGS as an area of focused competency within the specialty.

The view of ACS solely as a change in general surgery services whereby general surgeons who perform elective surgery now dedicate occasional weeks to the practice of ACS is a restricted one. Although this type of general surgeon is critical to the delivery of care that patients broadly receive, it is likely that specialists and leaders in this area are required to properly steward the potential of EGS.

Limitations

A limitation of this review is that, owing to the considerable heterogeneity with which performance and outcome variables were reported in the various studies and in their specific definitions, the results were reported in a descriptive fashion and could not be pooled. A second factor that may affect the applicability of the results stems from the diverse diseases encountered in EGS patients. A single review encompassing all potential EGS diagnoses is impractical until quality metrics are defined for this service model. This further underscores the importance of deriving common definitions and outcomes for EGS services.

Conclusion

Emergency general surgery services have the potential to substantially improve the quality of care EGS patients receive. However, a new model of care cannot be successfully implemented without establishing a means to measure performance and provide feedback to drive quality improvement. Standardized definitions of quality metrics for services would allow research results to be compared between centres. An acute care database would provide EGS centres objective, quantitative and consistent data for comparing patient outcomes and system processes. This would promote objective evaluations of care and quality assurance and would serve as a reference point to direct public policy, with the ultimate aim of delivering the highest-quality care possible.

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