

Implementation of an acute care emergency surgical service: a cost analysis from the surgeon's perspective

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Background: Acute care surgical services provide comprehensive emergency general surgical care while potentially using health care resources more efficiently. We assessed the volume and distribution of emergency general surgery (EGS) procedures before and after the implementation of the Acute Care and Emergency Surgery Service (ACCESS) at a Canadian tertiary care hospital and its effect on surgeon billings.

Methods: This single-centre retrospective case-control study compared adult patients who underwent EGS procedures between July and December 2009 (pre-ACCESS), to those who had surgery between July and December 2010 (post-ACCESS). Case distribution was compared between day (7 am to 3 pm), evening (3 pm to 11 pm) and night (11 pm to 7 am). Frequencies were compared using the χ^2 test.

Results: Pre-ACCESS, 366 EGS procedures were performed: 24% during the day, 55% in the evening and 21% at night. Post-ACCESS, 463 operations were performed: 55% during the day, 36% in the evening and 9% at night. Reductions in night-time and evening EGS were 57% and 36% respectively ($p < 0.001$). Total surgeon billings for operations pre- and post-ACCESS were \$281 066 and \$287 075, respectively: remuneration was \$6008 higher post-ACCESS for an additional 97 cases ($p = 0.003$). Using cost-modelling analysis, post-ACCESS surgeon billing for appendectomies, segmental colectomies, laparotomies and cholecystectomies all declined by \$67 190, \$125 215, \$66 362, and \$84 913, respectively ($p < 0.001$).

Conclusion: Acute care surgical services have dramatically shifted EGS from nighttime to daytime. Cost-modelling analysis demonstrates that these services have cost-savings potential for the health care system without reducing overall surgeon billing.

Contexte : La mise sur pied d'un service d'urgences chirurgicales permet d'offrir des soins de chirurgie générale d'urgence complets, tout en assurant une utilisation potentiellement plus efficiente des ressources en soins de santé. Nous avons évalué le volume et la distribution des interventions de chirurgie générale d'urgence (CGU) avant et après la mise sur pied d'un service de soins chirurgicaux d'urgence (SSCU) dans un hôpital de soins tertiaires canadien et mesuré son effet sur la facturation émise par les chirurgiens.

Méthodes : Cette étude rétrospective cas-témoins réalisée dans un seul centre a comparé des patients adultes soumis à des interventions de CGU entre juillet et décembre 2009 (pré-SSCU) à ceux qui avaient subi une intervention chirurgicale entre juillet et décembre 2010 (post-SSCU). Nous avons comparé la distribution des cas entre les quarts de jour (de 7 heures à 15 heures), de soir (de 15 heures à 23 heures) et de nuit (de 23 heures à 7 heures). Nous avons utilisé le test χ^2 pour comparer les fréquences.

Résultats : Pendant la période pré-SSCU, 366 interventions de CGU ont été effectuées : 24 % durant le jour, 55 % durant la soirée et 21 % durant la nuit. Après la mise en place du SSCU, 463 opérations ont été effectuées : 55 % durant le jour, 36 % durant la soirée et 9 % durant la nuit. Les réductions observées au plan des CGU réalisées durant la nuit et la soirée ont été de 57 % et 36 %, respectivement ($p < 0,001$). La facturation totale soumise par les chirurgiens pour les interventions réalisées avant et après la mise en place du SSCU a été respectivement de 281 066 \$ et de 287 075 \$: la rémunération a été de 6008 \$ supérieure après la mise en place du SSCU, pour 97 cas additionnels ($p = 0,003$). L'analyse de modélisation des coûts a révélé qu'après la mise en place du SSCU, la facturation soumise par les chirurgiens pour les appendicectomies, les colectomies segmentaires, les laparotomies et les cholécystectomies a diminué de 67 190 \$, 125 215 \$, 66 362 \$ et 84 913 \$, respectivement ($p < 0,001$).

Conclusion : Les services de soins chirurgicaux d'urgence ont considérablement modifié les interventions de CGU, les faisant passer des quarts de travail de nuit à ceux du jour. L'analyse de modélisation des coûts démontre que le SSCU recèle un potentiel d'économies pour le système de soins de santé sans réduire la facturation totale émise par les chirurgiens.

Acute surgical emergencies represent some of the most common reasons for hospital admission. Acute care surgery (ACS) can be defined as the urgent assessment and treatment of nontrauma general surgical emergencies in adults, with the intention of optimally treating intra-abdominal surgical crises.¹ This includes a diverse number of conditions, such as acute appendicitis, cholecystitis, diverticulitis, pancreatitis, bowel obstruction, intestinal ischemia, intra-abdominal sepsis, incarcerated or strangulated hernias and perforated viscus.

Until recently, the most common delivery model for the care of these patients revolved around a surgeon who was required to manage all surgical emergencies for a 12- to 24-hour interval while concurrently working within the demands of a scheduled clinical practice. This system has multiple limitations: interference with and required time away from a busy “scheduled” subspecialty practice, providing emergency surgery coverage throughout the night with the high likelihood of still needing to engage in patient care during a busy “post-call” day, and a potential lack of coordinated and current academic expertise within the specific focus of ACS. In response to these limitations, the concept of ACS has recently evolved in Canada.

The delivery of an ACS model requires a dedicated hospital-based service that provides comprehensive care for all general surgical emergencies over a defined period of time (usually 7-day intervals). The potential benefits of this approach to acute surgical care include predictable scheduling for busy surgeons, predictable administration of operating suite resources, improved patient access and potentially improved patient care. Overall cost savings can also be substantial because of a reduction in night-time operating and additional staffing requirements. Beginning in Halifax in 1997, a number of Canadian centres have naturally evolved into this model of providing emergent surgical care. As of 2011, there were 16 fully functioning ACS programs across Canada^{1,2}.

The Acute Care and Emergency Surgery Service (ACCESS) at Victoria Hospital in the London Health Sciences Centre (LHSC) was established in July 2010, when our Division of General Surgery recognized the growing need for organized emergency general surgery (EGS) coverage. Prior to the implementation of ACCESS, there was no structured system for performing EGS cases during the daytime. Emergency patients would usually have their operations in the evening or night, after the completion of a surgeon's elective daytime caseload; alternatively, patients would stay in the hospital — sometimes for days — before a surgeon was able to perform an operation during the elective schedule. The goal of ACCESS, therefore, was to shift EGS night-time operating to the daytime, without necessarily increasing the overall general surgery operating volume. Establishing a separate service was justified provided that it had a defined scope of practice and would not materially affect the other divisions in the department of surgery.

Unfortunately, the academic advancement of the ACS concept, and therefore evidence-based improvements in outcomes after emergency surgical care, has been historically limited by an inability to capture and synthesize even basic patient data. The ability to improve patient outcomes through evidence-based research is particularly crucial because the emergency care of surgical patients is the common denominator among all general surgeons. Furthermore, there has been a historical absence of a dedicated group willing to advocate for evidence-based improvements in the care of those with general surgical emergencies.

Regardless of professional interests, clinical load or working environment, the list of general surgical emergencies is common to every general surgeon in Canada who participates in a call schedule. It also involves a patient cohort that is unique from subspecialty nonemergent patients from both a physiologic and surgical perspective. As a result, the emerging organization of ACS as a distinct entity is aimed at improving the care and experience of surgically ill patients in their most dire time of need. The purpose of this study was to evaluate the implementation of an ACS service in London, Ont., with attention to the volume and distribution of EGS cases, its economic viability on the basis of surgeon remuneration as well as its impact on hospital resources.

METHODS

All clinical activity reviewed occurred at Victoria Hospital in London, Ont., which serves as a regional level 1 trauma centre for Southwestern Ontario. Victoria Hospital also serves as one of the primary teaching hospitals for the Schulich School of Medicine and Dentistry at Western University. The primary clinical mission of ACCESS is to provide all general surgical coverage of the level 1 trauma centre, the inpatient and emergency department general surgical consults and the outpatient follow-up general surgery clinic for patients who receive surgery from or are assessed by ACCESS.

All 8 general surgeons at Victoria Hospital were involved with ACCESS during the study period. Division faculty members provided all on-call coverage in 7-day intervals, working from 8 am to 5 pm Monday–Thursday and working from 8 am Friday to 8 am the following Monday. Between 5 pm and 8 am on weeknights, all general surgeons participated in a rotating call schedule. Surgeons would suspend their elective practice while covering ACCESS, and their allotted weekly operating room (OR) time for elective cases (15 h) would be subsumed into the daily dedicated OR time for ACCESS. Funding for an additional 13 hours of operating time was provided by a one-time regional project grant to address long wait times in the emergency department. After the project year, funding continued to be provided by the hospital because ACCESS was such a successful program. Because of the high volume of cases at our tertiary-care trauma centre, 2 fully staffed ORs

continued to run between 6 pm and 11 pm, and 1 OR continued to run from 11 pm to 8 am. The distribution of OR time for ACCESS throughout the week was as follows: 7 hours each on Monday and Friday, 6 hours on Wednesday and 4 hours each on Tuesday and Thursday. During the weekends (8 am Saturday to 8 am Monday), there was no dedicated ACCESS OR time; all surgical specialties had an equal opportunity to book and perform operations based on their level of urgency. The ACCESS clinics were also scheduled twice weekly to follow patients who were managed by the service. Other care providers for ACCESS included senior and junior general surgery residents, non-surgical residents, medical students and a nurse practitioner.

The Western University Department of Surgery includes approximately 82 other surgeons housed in 8 divisions, including general, vascular, plastic/reconstructive, cardiac, thoracic, urologic and pediatric surgery. The Division of General Surgery includes colorectal, hepatobiliary, transplant, surgical oncology, trauma and minimally invasive surgical specialists, many of whom practise primarily at Victoria Hospital. Other surgical practices at Victoria Hospital include vascular, thoracic, urologic, plastic, neurosurgery, orthopedic, anesthesiology and critical care services.

This was a single-centre, retrospective case-control study. The LHSC operative database was queried for all EGS procedures performed during the study periods (pre-ACCESS: July–December 2009; post-ACCESS: July–December 2010). Emergency procedures were defined as procedures booked on the nonelective operative list. All were booked according to their respective level of urgency: A (operation within 0–2 h), B (within 2–8 h), C1 (within 8–12 h) or C2 (within 12–48 h). We compared procedures before and after the implementation of ACCESS. We collected data only for general surgery patients from their electronic medical records. Operations initiated between 7 am and 3 pm were considered to be daytime surgeries, those performed between 3 pm and 11 pm were considered evening surgeries, and those performed between 11 pm and 7 am were considered night-time surgeries.

We compared continuous variables using the Mann-Whitney *U* test and categorical variables using χ^2 or Fisher exact tests, as appropriate. We considered results to be significant at $p < 0.05$. To be included in our analysis, patients had to be 18 years of age or older and had to have undergone an emergency operative intervention at Victoria Hospital during the pre-ACCESS or post-ACCESS study periods. Exclusion criteria were age younger than 18 years, and surgery performed by the pediatric general surgical service at Victoria Hospital. We also excluded patients who underwent elective general surgery, defined as cases that were booked in regular operative time and did not present through the emergency department. We also excluded patients who were operated on as priority A cases on the assumption that these cases would go to the OR promptly regardless of time of day.

Surgeons working on ACCESS were paid by fee-for-service, regardless of the time of day, and did not receive any further stipends or alternative funding from the hospital. To perform cost-modelling analysis using the well-established χ^2 method,³⁻⁵ we first calculated the average number of patients undergoing EGS operations per study period. Then, based on the observed distribution of EGS cases pre- and post-ACCESS, we calculated the corrected distribution of EGS cases for each timeframe using the Pearson χ^2 statistic. Using billing codes obtained from the 2011 Ontario Health Insurance Plan (OHIP) Schedule of Benefits and applying the appropriate premiums for after-hours cases (50% of the procedural fee for evenings and 75% of the procedural fee for nights), we calculated remuneration for EGS procedures based on the corrected distributions to determine differences in billing cost for EGS operations pre- and post-ACCESS.

RESULTS

Pre-ACCESS, 366 EGS procedures were performed: 24% occurred in the daytime, 55% occurred in the evening and 21% occurred at night-time (Table 1). Post-ACCESS, 463 EGS operations were conducted: 55% were performed in the daytime, 36% were performed in the evening and 9% were conducted at night. There was a 57% and 36% reduction in night-time and evening EGS operating, respectively ($\chi^2 = 86.51$, $p < 0.001$) post-ACCESS and a concomitant 132% increase in daytime EGS operations ($\chi^2 = 86.51$, $p < 0.001$).

The number of elective general surgery cases declined by 6.1% post-ACCESS, from 1061 to 996 cases, but this decrease was not significant ($\chi^2 = 2.19$, $p = 0.14$). The total number of general surgery cases (elective and emergent) also remained similar pre- and post-ACCESS (1427 v. 1459 cases, respectively, $\chi^2 = 2.19$, $p = 0.14$).

The number of emergent non-general surgery cases declined by 6% post-ACCESS (826 v. 877 cases pre-ACCESS), but this decrease was not significant ($\chi^2 = 2.60$, $p = 0.27$). The total number of non-general surgery cases also declined by 6% post-ACCESS (5159 v. 5472 cases

Table 1. Distribution of emergency and elective general surgery cases pre- and post-ACCESS

Case; time	Pre-ACCESS, no. (%)	Post-ACCESS, no. (%)	Difference, %	<i>p</i> value
Emergency				
Daytime	88 (24)	257 (55)	+132	< 0.001
Evening	203 (55)	165 (36)	-36	< 0.001
Night-time	75 (21)	41 (9)	-57	< 0.001
Total	366	463	+27	< 0.001
Elective	1061	996	-6	0.14
Total cases	1427	1459	+2	0.14

ACCESS = Acute Care and Emergency Surgical Service.

pre-ACCESS), but there was no statistical difference ($\chi^2 < 0.0001, p = 0.99$).

We reviewed EGS operations to identify the most common operations performed during the study periods (Appendix, Table S1, available at canjsurg.ca). The 4 most commonly performed operations pre- and post-ACCESS were laparotomy, appendectomy (laparoscopic or open), segmental colectomy and cholecystectomy (laparoscopic or open). While the proportion of laparotomies (29% v. 26% pre- and post-ACCESS, respectively), appendectomies (29% v. 26% pre- and post-ACCESS, respectively) and segmental colectomies (29% v. 26% pre- and post-ACCESS, respectively) were statistically unchanged ($p = 0.63$), the number of cholecystectomies increased significantly from 7% of all EGS surgeries pre-ACCESS to 16% post-ACCESS ($p = 0.001$).

Using the 2011 OHIP Schedule of Benefits, remuneration for performance of EGS operations pre- and post-ACCESS was calculated based on procedural codes (see the Appendix, Tables S2 and S3). After-hours premiums were applied to the operations based on the time of day during which they were performed. Total remuneration pre-ACCESS was \$281 066 for 366 EGS procedures, and total remuneration post-ACCESS was \$287 075 for 463 EGS procedures ($p = 0.003$). The average billing per case was \$767.94 pre-ACCESS and \$620.03 post-ACCESS ($p = 0.003$). To account for the difference in the number and distribution of EGS cases, the Pearson χ^2 statistic of 86.51 was used. The corrected distribution of EGS cases for each timeframe in the pre- and post-ACCESS groups was then calculated (Table 2). The cost of performing only appendectomies, laparotomies, segmental colectomies, and

cholecystectomies was then calculated to evaluate the difference in remuneration (Table 3). Remuneration for all 4 procedures was significantly reduced post-ACCESS ($\chi^2 = 52.9, p < 0.001$; Table 3).

DISCUSSION

Despite a growing consensus on the training requirements for acute care surgeons, the establishment of ACS practices has been much more varied. Several institutions have histories of ACS practices embedded in their medical staff structures, and in such cases the advent of ACS was little more than relabelling an existing professional model.¹

At many institutions, the practice of trauma surgery and surgical critical care diverged from nontrauma general surgery into distinct clinical divisions and service lines with little clinical overlap among the other general surgical disciplines.⁶ In such instances, establishing an ACS service entailed either re-expansion of the trauma surgeon's clinical and operative domain^{7,8} or the creation of an emergency surgery service that excluded care of trauma patients.⁹ In large community hospitals that do not serve as trauma centres, surgical hospitalist practices are emerging to meet the hospitals' emergency surgery coverage needs. These later models tend not to include surgical critical care.

Our objective was to evaluate the implementation of an ACS service in an established academic surgical department at a university-affiliated teaching hospital. The general surgeons at our institution agreed to participate in ACCESS for several reasons: they would be provided with 28 hours of operating time per week, which was almost double their weekly allotted elective OR time; they would operate less at

Table 2. Corrected population distributions for remuneration model analysis using Pearson χ^2 analysis

Time	Pre-ACCESS cases, no. (%)	Post-ACCESS cases, no. (%)	<i>p</i> value
Daytime	47 (11)	259 (62)	< 0.001
Evening	262 (63)	127 (31)	< 0.001
Night-time	106 (26)	28 (7)	< 0.001
Total	415	414	—

ACCESS = Acute Care and Emergency Surgical Service.

Table 3. Remuneration model for appendectomies, segmental colectomies, laparotomies and cholecystectomies based on the Pearson χ^2 corrected population distributions pre- and post-ACCESS

Surgery	Pre-ACCESS, \$	Post-ACCESS, \$	Difference, \$	<i>p</i> value
Appendectomy	289 331	222 141	-67 190	< 0.001
Colectomy	578 213	452 998	-125 215	< 0.001
Laparotomy	285 213	218 850	-66 362	< 0.001
Cholecystectomy	377 565	292 653	-84 913	< 0.001
Total	1 530 322	1 186 642	-343 680	< 0.001

ACCESS = Acute Care and Emergency Surgical Service.

night because most emergency cases could be performed during the subsequent day; they would have substantial control over their billing during ACCESS because they were paid by fee-for-service; and, most importantly, they would be able to focus on their elective practices and academic pursuits when they were not covering ACCESS. With respect to the latter, all EGS patients were admitted to ACCESS, even if they received surgery by an on-call surgeon in the evening or night-time, thereby reducing the inpatient load for all non-ACCESS surgeons. It is clear that implementing ACCESS has significantly shifted the distribution of EGS to the daytime (from 21% to 9% post-ACCESS for night-time cases, a reduction of 57%), which correlates with other studies from around the world.¹⁰⁻¹² Britt and colleagues¹⁰ observed a decline in emergency procedures performed after 5:30 pm, from 44.6% to 30% after the implementation of an ACS service. Parasyn and colleagues¹¹ demonstrated that emergency theatre use during the day increased from 57% to 69%, with an 11% reduction in acute care operating after hours (5 pm); furthermore, 26% fewer emergency cases were handled between midnight and 8 am. Sorelli and colleagues¹² also observed a significant increase in daytime operating from 57% in 2004 to 74% in 2005, and a significant decline in after-hours operating from 43% to 26%. Because the beneficial effects of ACCESS on after-hours operating were almost immediate, surgeon satisfaction and, consequently, surgeon participation in ACCESS, remained excellent. While the trend of our data mirrors that of other centres, our data show a more significant reduction in after-hours operating likely because our daytime operating hours may be 1–2 hours shorter than in other centres (7 am to 3 pm instead of 8 am to 5 pm or 5:30 pm).

With daily dedicated OR resources, nonemergent but urgent cases that would otherwise have occurred at night-time are instead put on the board for the daytime. Although it was beyond the scope of our study to assess this, we feel such a strategy benefits health care delivery and resource management. There is decreased need for expensive night-time OR staff as well as a concomitant decreased use of night-time OR resources. Patients also receive surgery performed by presumably fresher, more alert staff in the morning rather than late at night. There is ample evidence to show ACS services benefit patients with biliary disease and appendicitis with shorter wait times in the emergency department,^{13,14} faster transition to the OR¹³ and shorter recovery times without increasing complication rates.¹³ When assessing ACS services for delivery of patient care, von Conrady and colleagues¹⁵ observed a 33% reduction in time from assessment in the emergency department to admission or operation. Preliminary analysis of wait times and health care outcomes at our institution suggests that the time to surgical consultation is shorter post-ACCESS for patients with biliary disease, although we hope to publish our observations in a separate study.

Our spectrum of operative care primarily involved procedures on the digestive tract. Most of these consisted of

operations on the colon, appendix, biliary tract and small bowel, which is consistent with most surgical emergencies. Laparotomies, appendectomies, segmental colectomies and cholecystectomies remained the 4 most frequently performed EGS operations at Victoria Hospital pre- and post-ACCESS. The proportion of cholecystectomies, however, rose dramatically from 7% pre-ACCESS to 16% post-ACCESS; 89% of post-ACCESS cholecystectomies were performed during the day, whereas only 34% of pre-ACCESS cholecystectomies were performed during the day. Austin and colleagues¹⁶ made a similar observation with respect to the increased numbers of appendectomies and cholecystectomies performed by general surgeons since the introduction of an ACS service. Surgeons may be more willing to operate on patients with acute cholecystitis and “hot” gallbladders when they have dedicated EGS operating time during the day, rather than operate late at night and potentially negatively affect their schedule the next day.

While the focus of ACCESS was to perform EGS cases during the day, surgeons were also given the discretion to book elective cases during ACCESS OR time if there were no emergency cases on the board. This allowed the OR to function at full capacity without wasting valuable resources and provided the surgeons and anesthesiologists, who were also paid by fee-for-service, with a steady volume of patients. The need to use ACCESS OR time to the fullest extent required surgeons to maintain “standby lists” wherein patients who were booked for elective surgery (e.g., herniorrhaphy, cholecystectomy, hemorrhoidectomy) would be called into the hospital for their surgery on the same day; patients were made fully aware that their surgery could be delayed or postponed due to priority emergency cases. Overall, however, surgeons reported excellent patient satisfaction and did not experience considerable challenges when balancing the use of ACCESS OR resources for emergency and elective cases.

We found that ACCESS did not adversely affect emergency or elective operating for other surgical services. There was no statistical difference in non-general surgery cases (emergency or elective) post-ACCESS. Implementing an ACS service at our institution involved a redistribution of existing general surgery resources to maximize EGS patient care. Post-ACCESS, elective general surgery cases declined by 6.1%, but this decline was not significant. In addition, with the concomitant increase in EGS, the total number of cases (emergent and elective) remained relatively unchanged. While there is evidence to show that wait times for certain procedures (e.g., urgent outpatient cholecystectomies) decreased by 20% with the introduction of an ACS service,¹³ there is no North American data to demonstrate any adverse effect on elective surgery wait times by the introduction of an ACS service. This is a future avenue for investigation, as it is critical to balance acute EGS procedures without adversely affecting elective surgical care.

It is also clear that an ACS service is economically sustainable within the confines of our financially restricted, publicly funded health care system. In performing a remuneration model analysis,^{3,5} we demonstrated that ACCESS can help significantly reduce surgeon billing cost for individual cases by shifting operating from the night-time to the daytime. The biggest contributor to the cost reduction was the significant decrease in after-hours premium billing for each case: the average billing per case decreased by 19%, from \$767.94 pre-ACCESS to \$620.03 post-ACCESS. The total overall surgeon billing, however, increased post-ACCESS along with the number of EGS cases performed. Because individual surgeon income is a sensitive topic, the surgeons were reluctant to divulge exact billing information for their elective and emergent practices. For the few surgeons who did release billing information, their billings increased by approximately 13% in the first year post-ACCESS. This difference may not be solely due to the increase in emergency operating volume; participating surgeons reported that a greater number of days worked and an increase in fee schedules also contributed to their increased billings. Regardless, this study addresses the concern that the implementation of an ACS service would dramatically reduce surgeon income by reducing the premium billing; even though the remuneration for each additional case was only \$62 post-ACCESS, an ACS service may provide an opportunity for increased operating and improved income-earning potential while providing cost-effective service. While these values reflect surgeon billings, it was beyond the scope of this study to perform a cost-benefit analysis from the viewpoint of the hospital.

Our model is cost-effective because it involved a rearrangement of operating resources rather than creating more ORs or hiring new staff. In the United States, it is interesting to note that the implementation of an ACS service was felt to be financially unsustainable if it depended only on patients paying out-of-pocket; patient revenue covered only 73% of the total cost billed by surgeons for EGS procedures at a level 1 trauma centre in Miami.¹⁷ This is a reflection of the vastly different health care funding strategies between the 2 countries.

CONCLUSION

We have described the successful implementation of an ACS service in an established academic surgery department. We found that ACCESS has resulted in a significant shift from emergent night-time operating to daytime operating, and such an ACS service is a viable and sustainable economic model in our health care system.

Competing interests: None declared.

Contributors: All authors designed the study. R. Anantha, K. Vogt and V. Jain acquired and analyzed the data, which N. Parry also analyzed. R. Anantha and N. Parry wrote the article, which all authors reviewed and approved for publication.

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