의학석사 학위논문

응급수술팀 모델 도입이 응급수술 결과에 미치는 영향

Outcomes in emergency surgery following the implementation of an acute care surgery model: Retrospective observational study

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이 논문을 의학석사 학위 논문으로 제출함

2024 년 7 월

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Abstract

Background

Over the past three years, approximately 23,000 emergency surgeries were performed annually in South Korea, accounting for > 1% of all surgeries nationwide. With the growing necessity for treating these emergency cases with dedication and proficiency, acute care surgery (ACS) teams were appointed at various hospitals. Regarding the implications of the ACS team, many studies showed promising results with a shorter time from the emergency department (ED) to the operating room (OR), shorter length of stay, and fewer complications. This study aimed to demonstrate the overall effect of ACS implementation at a single institution in South Korea.

Methods

This was a single-center, retrospective observational study. Patients aged > 18 years who visited the ER and received emergency surgery between July 2014 and December 2016 (Pre-ACS) and between July 2017 and December 2019 (Post-ACS) were included.

Results

Among 958 patients, 497 were in the pre-ACS group and 461 in the post-ACS group. After propensity score matching by age, sex, underlying disease, and emergency surgery acuity score, 405 patients remained in each group. Although our analysis showed no significant differences in mortality between the pre-ACS and the post-ACS group (2.4% vs 3.4%, $P = 0.408$, respectively), it showed a reduction in time from ED presentation to operation (547.8 ± 401.0 vs. 476.6 ± 313.2 minutes, $P = 0.005$) and complication rates (24.7% vs. 16.8%, $P < 0.001$). There were no significant differences in total operation duration and length of hospital stay.

Conclusions

Although mortality was not reduced in the post-ACS group as expected, time from ED to OR and complication rates were significantly reduced in the post-ACS group. We can state that implementing an ACS team dedicated to emergency surgery provides safe and better clinical outcomes.

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INTRODUCTION

The Acute Care Surgery (ACS) model is heralded as a revolutionary step forward in acute surgical care compared with the traditional on-call (TOC) model. Although the quality of acute surgical care has improved over the years owing to the requirement for prompt initiation of treatment of acutely ill surgical patients, the TOC model had its limitations. This model involved a rotating pool of surgeons in charge of all emergency surgical caseloads in addition to their elective duties [1]. Consequently, the surgeon on call was often unavailable, delaying most emergency surgeries until the operating room was available after hours. Alternatively, patients were inevitably transferred to other facilities. In response to the lack of dedicated and well-organized service, the ACS model was developed in the early 2000s in the US and was quickly adopted in most institutions offering emergency surgical care [2]. This model involves a dedicated surgical team comprising surgeons, residents, and nursing staff not involved in other services. This focused set of resources and infrastructure aims to provide round-the-clock care for all surgical emergencies [3, 4].

The ACS model has been credited with improving access to care, reducing surgical complications, and improving patient outcomes [5]. In addition, ACS has been shown to reduce costs associated with caring for patients requiring urgent and emergent procedures [6]. The ACS model is associated with reducing the length of hospital stays and medical expenses [7]. Interestingly, one study analyzed the effects of handover on the quality of care in the ACS model and found no difference in complication rates or the lengths of hospital stay, thus assuring the safety of the patients in this model [8]. Alternatively, as the ACS model dictates multiple medical personnel working in shifts, work satisfaction was higher with minimal risk of patient hazard [9]. The ACS model with dedicated beds and operating rooms must be instrumental in changing the cultural aspect of the traditional notions regarding emergency surgeries [10]. Overall, this model has been shown to improve access to care and outcomes and reduce surgical complications while decreasing costs associated with emergency surgical care.

The first ACS model was designed by the American Association for the Surgery of Trauma (AAST); many countries followed and adopted the aims provided by the AAST [2]. In many countries implementing the ACS model, the components comprise a dedicated surgical service covering all non-trauma emergency surgery, daytime on-site attending coverage, exemption from elective duties, and 24-hour emergency department (ED) coverage by dedicated residents. Round-the-clock on-site attending coverage is observed only in the USA and Taiwan, and exclusive ACS wards have been observed in the UK, Sweden, South Africa, and Singapore [11]. Although the ACS model is in demand in South Korea, only a handful of hospitals can afford to install and sustain it due to a lack of medical personnel, resources, systems, and insurance policies [12].

This study aimed to analyse whether the ACS model showed better clinical outcomes than the TOC model on implementation in a single institution in emergency general surgery.

METHODS

This was a retrospective cohort study including patients with acute surgical abdomen requiring emergency surgery at a single institution, Asan Medical Center (AMC). It is one of the biggest hospitals in South Korea, with > 2700 beds, > 100,000 patients presenting to the ED annually, and hosting > 60,000 surgeries every year. Patients were divided into the pre-ACS (between July 2014 and December 2016) and post-ACS groups (between July 2017 and December 2019). As the ACS model was implemented at our institution in January 2017, the first 6 months of 2017 were deemed a transition period and thus excluded. The inclusion criteria were patients ≥ 18 years of age who presented to the ED with acute surgical abdomen and had surgery immediately before being admitted to the ward. The exclusion criteria were following; patients < 18 years of age, those who underwent emergency surgery while admitted in departments other than surgery, those treated conservatively in the ward before deciding to undergo surgery, and patients who had previously undergone transplant (i.e., heart, lung, liver, kidney, or pancreas) or any type of vascular surgery. The types of surgery were not limited to any single surgery, so all types of emergency surgery due to acute surgical abdomen was included. The primary outcome was 28-day mortality rate and complication rates. The secondary outcomes were the time taken from the ED admission to the time of arrival at the operating room (OR), time taken from the ED admission to the decision for admission by the surgeon, length of hospital stay, length of intensive care unit stay, discharge route, reoperation during the hospital stay, readmission within 30 days after discharge. We excluded mortality from cancer progression or patients with a "do not resuscitate" (DNR) order. DNR orders were not premediated, rather taken with consent from patients' guardians when deemed hopeless in treatment. The time taken to get to the OR was measured based on the time recorded upon entering the OR from the time recorded upon presentation to the ED. Time from presentation to the ED to the decision of admission was measured based on the time recorded when a physician issued a confirmation of admission. The emergency surgery acuity score (ESAS) [13] was collected for the prediction of mortality, and postoperative complications were classified using the Clavien–Dindo classification system [14]. The data were obtained from the discharge summaries and progress notes.

Propensity score (PS)-matching analysis was performed to reduce the effect of selection bias and potential confounding between the two groups. To derive PS, the following variables were included in a multiple logistic regression: age, sex, operation type, operation time, causes of emergency surgery, diagnosis, Charlson comorbidity index, presence of cancer, sepsis or shock, and ESAS. One-to-one PS matching was performed by nearest neighbor matching with a calliper width of 0.1 multiplied by the SD of the linearly transformed PS. Standardized differences of less than 10.0% for a given covariate indicate a relatively small imbalance.

Statistical analysis

Chi-square test or Fisher's exact test was used for categorical data, and independent samples t-test and Mann–Whitney U test were used for continuous data. A *P*-value < 0.05 was considered statistically significant. Statistical analyses were conducted using R software (version 4.0.3; R Foundation for Statistical Computing, Vienna, Austria; http://www.R-project.org)

Ethics statement

The Institutional Review Board of the National Evidence-Based Healthcare Collaborating Agency approved this study (NECA-IRB number: NECAIRB22-004) and waived the requirement for informed consent. Electronic medical records were used to collect data retrospectively.

RESULTS

We identified total of 958 patients in this study, among whom 497 were in the pre-ACS group and 461 in the post-ACS group (Table 1). There were statistically significant differences between groups in age, ESAS, major organ involvement, cause of emergency surgery, and the department performing surgery. The mean age was 55.9 and 59.1 years in the pre- and post-ACS groups, respectively. ESAS was significantly higher in the post-ACS group than in the pre-ACS group (4.3 ± 3.3 vs. 3.8 ± 3.1, $P = 0.012$, respectively). Although there were statistically significant differences, the small bowel was the most affected organ, and perforation was the most common cause for emergency surgery in both groups. PS matching identified 405 matched pairs. After PS matching, the baseline characteristics of the two groups were balanced ($P > 0.05$ for most variables) in the overall cohort (Table 2).

Table 1. Baseline characteristics of the patients (n = 958)

Characteristics	Pre-ACS group (n = 497)	Post-ACS group (n = 461)	*P*-value
Age, years (SD)	55.9 (16.0)	59.1 (15.9)	**0.002**[a]
Men (n, %)	292 (58.8%)	273 (59.2%)	0.883
Cause of diagnosis (n, %)			0.075
Non-Malignancy	352 (70.8%)	350 (75.9%)	
Malignancy	145 (29.2%)	111 (24.1%)	
Operation type (n, %)			0.120
Open surgery	351 (70.6%)	305 (66.2%)	
Laparoscopic surgery	139 (28.0%)	142 (30.8%)	
Others	7 (1.4%)	14 (3.0%)	
Charlson Comorbidity Index (SD)	2.1 (2.3)	2.3 (2.3)	0.074[a]
ESAS (SD)	3.8 (3.1)	4.3 (3.3)	**0.012**[a]
APACHE II score (SD) (in ICU admitted patients)	4.5 (9.0)	5.0 (8.6)	0.404[a]
Sepsis at admission (n, %)	88 (17.7%)	88 (19.1%)	0.581
Shock at admission (n, %)	43 (8.7%)	50 (10.9%)	0.252
ICU admission (n, %)	120 (24.1%)	143 (31.0%)	**0.017**
Involved major organ (n, %)			**0.001**[b]
Stomach	22 (4.4%)	10 (2.2%)	
Small intestine	224 (45.1%)	237 (51.4%)	
Large intestine	97 (19.5%)	121 (26.3%)	
Gall bladder	7 (1.4%)	4 (0.9%)	
Appendix	124 (25.0%)	71 (15.4%)	
Others	23 (4.6%)	18 (3.9%)	

Causes of emergency surgery (n, %)			**0.046**
Obstruction	106 (21.3%)	119 (25.8%)	
Perforation	161 (32.4%)	172 (37.3%)	
Ischemia/Infarct	46 (9.3%)	47 (10.2%)	
Hernia	26 (5.2%)	19 (4.1%)	
Trauma	13 (2.6%)	6 (1.3%)	
Acute appendicitis	125 (25.2%)	82 (17.8%)	
Others	20 (4.0%)	16 (3.5%)	
Divisions performing surgery (n, %)			**<0.001[b]**
Acute care surgery (ACS)	35 (7.0%)	311 (67.5%)	
(ICU team in TOC model)			
Upper GI (ST)	99 (19.9%)	55 (11.9%)	
Lower GI (CRS)	229 (46.1%)	75 (16.3%)	
Hepatobiliary (HBP)	90 (18.1%)	17 (3.7%)	
Others (Breast, Endocrine, etc.)	44 (8.9%)	3 (0.7%)	

Values are expressed as mean ± standard deviation or number and percentage (n, %).

ACS, acute care surgery; APACHE II, Acute Physiology and Chronic Health Evaluation II; CRS, colorectal surgery; ESAS, emergency surgery acuity score; GI, gastrointestinal; HBP, hepatobiliary surgery; ICU, intensive care unit; SD, standard deviation; ST, stomach surgery; TOC, traditional on-call;

[a] Results from Mann-Whitney *U* test

[b] Results from Fisher exact test

Table 2. Baseline characteristics of the patients after propensity score matching (n = 910)

Characteristics	Pre-ACS group (n = 405)	Post-ACS group (n = 405)	*P*-value
Age, years (SD)	56.7 (15.9)	58.4 (16.1)	0.123[a]
Men (n, %)	241 (59.5%)	238 (58.8%)	0.830
Cause of diagnosis (n, %)			0.937
Non-Malignancy	295 (72.8%)	296 (73.1%)	
Malignancy	110 (27.2%)	109 (26.9%)	
Operation type (n, %)			0.439
Open surgery	283 (70.0%)	294 (72.6%)	
Laparoscopic surgery	115 (28.4%)	101 (24.9%)	
Others	7 (1.7%)	10 (2.5%)	
Charlson Comorbidity Index (SD)	2.1 (2.4)	2.3 (2.3)	0.295[a]
ESAS (SD)	4.0 (3.2)	4.3 (3.3)	0.195[a]
APACHE II score (SD) (in ICU admitted patients)	4.8 (9.1)	5.1 (8.7)	0.573[a]
Sepsis at admission (n, %)	78 (19.3%)	83 (20.5%)	0.660
Shock at admission (n, %)	39 (9.6%)	47 (11.6%)	0.362
ICU admission (n, %)	107 (26.4%)	132 (32.6%)	0.054
Involved major organ (n, %)			0.844[b]
Stomach	8 (2.0%)	10 (2.5%)	
Small intestine	196 (48.4%)	205 (50.6%)	
Large intestine	93 (23.0%)	99 (24.4%)	
Gall bladder	5 (1.2%)	4 (1.0%)	
Appendix	87 (21.5%)	71 (17.5%)	
Others	16 (3.9%)	16 (4.0%)	

Causes of emergency surgery (n, %)			0.668
Obstruction	92 (22.7%)	97 (24.0%)	
Perforation	141 (34.8%)	155 (38.3%)	
Ischemia/Infarct	41 (10.1%)	45 (11.1%)	
Hernia	20 (4.9%)	16 (4.0%)	
Trauma	10 (2.5%)	6 (1.5%)	
Acute appendicitis	88 (21.7%)	72 (17.8%)	
Others	13 (3.2%)	14 (3.5%)	
Divisions performing surgery (n, %)			**< 0.001**[b]
Acute care surgery (ACS)	28 (6.9%)	279 (68.9%)	
(ICU team in TOC model)			
Upper GI (ST)	77 (19.0%)	40 (9.9%)	
Lower GI (CRS)	203 (50.1%)	68 (16.8%)	
Hepatobiliary (HBP)	65 (16.1%)	15 (3.7%)	
Others (Breast, Endocrine, etc.)	32 (7.9%)	3 (0.7%)	

Values are expressed as mean ± standard deviation or number and percentage (n, %).

ACS, acute care surgery; APACHE II, Acute Physiology and Chronic Health Evaluation II; CRS, colorectal surgery; ESAS, emergency surgery acuity score; GI, gastrointestinal; HBP, hepatobiliary surgery; ICU, intensive care unit; SD, standard deviation; ST, stomach surgery; TOC, traditional on-call;

[a] Results from Mann-Whitney *U* test

[b] Results from Fisher exact test

Primarily, there were no statistically significant differences in in-hospital mortality between the groups (2.4% vs 3.4%, $P = 0.408$, Pre-ACS group vs Post-ACS group, respectively) (Table 3). To investigate further on mortality, we divided mortality patients into 4 groups (Table 4), but subsequent subgroup analysis on mortality also failed to show any statistical significance. On the other hand, analysis of PS-matched groups showed notable differences in other areas. Regarding postoperative complication rates, the post-ACS group had fewer mild complications than did the pre-ACS group (2.5% vs. 12.6%, $P < 0.0001$), while there were no differences in other severity groups. Time from presentation to the ED to arrival in the OR was much shorter in the post-ACS group than in the pre-ACS group (476.6 ± 313.2 minutes vs. 547.8 ± 401.0 minutes, $P = 0.005$). Similarly, we observed that the time to decide on surgery was shorter in the post-ACS group than in the pre-ACS group (292.4 ± 232.7 minutes vs. 352.3 ± 302.5 minutes, $P = 0.002$). Compared with the pre-ACS group, the post-ACS group had fewer readmissions within 30 days after hospital discharge (4.9% vs 1.7%, $P = 0.011$), although reasons for readmission were not investigated. As for when the surgery was performed, the post-ACS group underwent more weekend surgeries (47.7% vs. 34.3%, $P < 0.0001$) and fewer weekday night-time surgeries (28.4% vs. 44.7%, $P < 0.0001$) than those of the pre-ACS group.

Table 3. Clinical outcomes between pre-ACS and post-ACS (n = 910)

	Pre-ACS group (n = 405)	Post-ACS group (n = 405)	*P*-value
Primary outcome			
28 days Mortality, (n, %)	10 (2.4)	14 (3.4)	0.408
Clavien-Dindo classification, (n, %)			**<.0001**
No (0)	305 (75.3)	337 (83.2)	
Mild (1-2)	51 (12.6)	10 (2.5)	
Severe (3-5)	49 (12.1)	58 (14.3)	
Secondary outcomes			
Operation time in minutes, median (Q1, Q3)	138 (106, 188)	129 (96, 178)	0.233*
Period that the surgery was performed (n, %)			**< 0.001**
Weekday daytime (7 am–6 pm)			
Weekday night-time (6 pm–7 am)	85 (21.0%)	97 (24.0%)	
Weekend (Sat–Sun)	181 (44.7%)	115 (28.4%)	
	139 (34.3%)	193 (47.7%)	
Length of hospital stay in days, median (Q1, Q3)	12 (8, 20)	10 (6, 16)	0.162*
Length of ICU stay in days, median (Q1, Q3)	3 (2, 10)	3 (2, 6)	0.472*
Time from the ER admission to the OR in minutes, median (Q1, Q3)	441 (286, 688)	396 (269, 597)	**0.005***
Time from the ER admission to decision in minutes, median (Q1, Q3)	278 (166, 438)	243 (146, 365)	**0.002***
Re-operation during hospital stay (n, %)	34 (8.4%)	46 (11.4%)	0.158
Re-admission (within 30 days after hospital discharge) (n, %)	20 (4.9%)	7 (1.7%)	**0.011**

Values are expressed as mean ± standard deviation, median and interquartile range or number and percentage (n, %).

ED, Emergency department; ICU, intensive care unit; OR, operating room; Q1, the 25th quartile; Q3 = the 75th quartile; SD, Standard deviation.

*Results from Mann-Whitney *U* test

Table 4. Mortality subgroup

Mortality subgroup	Pre-ACS group (n = 405)	Post-ACS group (n = 405)	*P*-value
Death < 24 hours (n, %)	2 (0.5)	6 (1.5)	0.163*
Death < 48 hours (n, %)	4 (1)	8 (2)	0.249*
Death < 7 days (n, %)	5 (1.2)	12 (3)	0.084
Death < 28 days (n, %)	10 (2.4)	14 (3.4)	0.408

Values are expressed as number and percentage (n, %).

*Results from Fisher exact test

DISCUSSION

Since the introduction of the ACS model in the United States in the early 2000s, although different in structure and components between countries, it has been widely accepted as a replacement for the TOC model for providing prompt care in non-trauma emergency surgery [11]. The ACS model has reduced mortality and complication rates, time until operation, and medical expenses [15-17]. In a meta-analysis of 27 studies, implementing the ACS model improved the clinical and financial outcomes of emergency surgical cases in surgeries, such as acute appendicitis, acute cholecystitis, and inguinal hernia [15]. Regarding acute appendicitis, one study reported that the ACS model significantly decreased the time to operation, rupture rate, complication rate, and length of hospital stay [18]. Although various studies have examined the effect of the ACS model in single disease entities such as acute appendicitis, this is the first study to describe the impact of the ACS model in the context of all emergency abdominal surgeries.

Contrary to our speculation, our study showed no reduction in mortality after implementation of the ACS model (2.4% vs 3.4%, P = 0.408, pre-ACS group vs post-ACS group, respectively). In order to investigate further, we divided mortality patients into 4 groups, based on the time of death after surgery (i.e. 24 hrs, 48 hrs, 7 days and 28 days). Not only was there no statistical significance, but also no tendency of lower mortality rate in post-ACS group. Critical care system in AMC can explain such results.

Long before implementation of the ACS model, there was Surgical Intensive Care Unit (SICU) with dedicated intensivist residing full time and treating post-surgical patients. So even in TOC model, post-surgical critical care was already taken care of. The implementation of the ACS model might have brought new concept in confronting and operating acute surgical patients, but it did not have much effect in post-surgical critical care, from where all mortality cases originated. As both promptness to surgery and post-surgical critical care are two pillars in preventing mortality, already firm standing pillar of post-surgical critical care played major role in low mortality rates in both groups.

Our study showed that the ACS model successfully reduced minor complication rates, which is in line with the results of previous studies [17, 18, 21]. Some examples of minor complications include post-operative ileus, pneumonia, and surgical site infection to name a few. Although the rate of serious complications requiring surgery or intervention were similar, mild complication rates were significantly lower in the post-ACS group, and there could be several explanations for this. As mentioned earlier, transitioning from the pre-ACS to the post-ACS model meant a change from on-call surgeons to surgeons on a rotation schedule, who were much less predisposed to fatigue. Although the quality of life and fatigue of surgeons have not been investigated in this study, and complication rates could be attributed to technical failure to some extent, a surgeon's fatigue can be a critical risk factor concerning complication rates. Further, as on-call surgeons in the pre-ACS group were fellows or junior attendants with less experience in emergency surgical cases, this could be another reason for higher complication rates compared with surgeons in the post-ACS group who had at least 3 to 5 years of experience in the field.

Our study has shown a reduction in time from presentation to the ED to the OR, like previous studies that reported similar results [17]. As discussed earlier, the problem with the TOC model was that the on-call surgeons were often unavailable during the daytime due to elective surgeries and outpatient clinical sessions. As a result, when patients came to the ED during the daytime, they often had to wait until the on-call surgeons became available after their daytime duties ended. Such delay in examination by surgeons, who could solely decide whether to operate, delayed the actual decision and the time to the surgery. In contrast, the ACS model mandates that board-certified general surgeons be in-house round-the-clock, readily available to examine the patients presenting to the ED when consulted. With the round-the-clock availability of dedicated surgeons, compared with the pre-ACS group, time from the ED to the OR was successfully reduced in the post-ACS group, which was consistent with the result that the time from the ED admission to the decision for surgery was also reduced in the post-ACS group. With the availability of ACS surgeons on-site to examine the patient when consulted after the primary survey in the ED, the decision time to admission and the time to the OR was quicker.

However, compared with previous studies, our study showed a significantly longer ED stay and time to the OR even after the implementation of the ACS model compared to other similar studies [5, 17, 19, 20]. Such results may be because our institution does not reserve an exclusive OR dedicated solely to emergency surgeries, and as a high-volume center, finding a vacant OR during the daytime for emergency surgical cases is challenging. Therefore, even with dedicated ACS surgeons and ED working round-the-clock, surgeries tend to get delayed due to the unavailability of the OR. This phenomenon is consistent with our study's result, which showed the daytime surgeries to be relatively similar in both groups. The types of surgeries performed during the daytime did not differ significantly between the groups, and we can safely assume that the lack of a dedicated OR may account for this phenomenon.

The limitation of this study lies in its retrospective nature and that it was a single-center study. First, owing to this study's retrospective nature, a propensity score matching was performed to compensate the selection bias. Second, since the study criteria only included patients who went directly from the ED to the OR, this data might not represent all patients with acute abdomen who required surgery. Since this study focused on the time from ED admission to the OR, patients who were already hospitalized were not included. Third, since this was a single-center study, the characteristics of the hospital were reflected in the overall study results. The length of stay in the ED or the time taken for surgery may differ from those of other hospitals in South Korea or overseas. Hence, a multicenter study is needed in the future.

Conclusion

In conclusion, this study was one of the few that explored the impact of the ACS model regarding all surgeries involved in a high-volume center. Based on this study, it is safe to state that the ACS model is non-inferior as to the mortality rate, effectively lowers complication rates, reduces the time from the ED to the OR and reduces the time from the ED to a decision. Thus, the ACS model is a safe and effective replacement of the TOC model.

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국문요약

서론: 지난 3 년 동안 대략 23,000 건의 응급 수술이 전국적으로 매년 수행되었는데, 이는 한국에서 총 수술의 1% 이상을 차지한다. 이러한 많은 응급 수술들을 전문성을 갖추고 치료해야 할 필요성이 커지면서, 외국에서부터 시작해 국내에서도 많은 병원에서 Acute Care Surgery (ACS) 팀이 도입되었다. ACS 팀의 도입의 효과를 증명하기 위해 많은 연구들이 시행되었는데 응급실 입실부터 수술실 입실까지의 시간이 단축되고 입원 기간이 짧아지며 합병증이 적어지는 여러 좋은 결과들을 보여 주었다. 본 연구는 대한민국의 한 기관에서 ACS 도입으로 인해 하나의 수술만이 아닌 전체 수술을 대상으로 비교함으로서 그 효과를 검증하고자 한다.

방법: 이 연구는 단일 센터의 회고적 관찰 연구이며, 2014 년 7 월부터 2016 년 12 월까지(ACS 도입 전)와 2017 년 7 월부터 2019 년 12 월까지(ACS 도입 후) 응급실 내원하여 바로 응급 수술을 받은 18 세 이상의 환자들을 포함하였다.

결과: 958 명의 환자 중 497 명은 ACS 도입 전 그룹에 속했고 461 명은 ACS 도입 후 그룹에 속했다. 나이, 성별, 기저 질환 및 ESAS 점수에 따라 propensity score matching 을 거친 후 각 그룹에 405 명이 남았다. 분석 결과 ACS 도입 전 그룹과 ACS 도입 후 그룹 간에 사망률에 유의한 차이가 없었으나(각각 2.4% vs 3.4%, $P = 0.408$), 응급실 입실부터 수술실 입실까지 걸리는 시간 (547.8 ± 401.0 vs. 476.6 ± 313.2 분, $P = 0.005$) 및 합병증은 (24.7% vs. 16.8%, $P < 0.001$) 감소한 것으로 나타났다. 수술 총 소요 시간 및 입원 기간에는 유의한 차이가 없었다.

결론: ACS 도입 후 그룹에서 예상했던 대로 사망률이 감소하지 않았지만, 응급실 입실부터 수술실 입실까지의 시간과 합병증은 통계적으로 유의미하게 감소했다. 응급 수술을 전문으로 하는 ACS 팀을 도입함으로써 보다 안전하고 더 나은 임상 결과를 얻을 수 있다는 결론이다.