Original Article

Impact of an Acute Care Surgery Service on Timeliness of Care at Ramathibodi Hospital

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Background: An Acute Care Surgery [ACSx] service is composed of trauma, general surgical emergency cases, and surgical critical care patients, all of which has been introduced at Ramathibodi Hospital since August 1, 2015.

Objective: To evaluate the outcome after one-year of services on the general surgical emergency patients' flow from the emergency room [ER]. We collected data of pre-ACSx and post-ACSx periods to compared time to consultation, waiting time to OR, and resident satisfaction.

Materials and Methods: A retrospective cohort was studied by collecting data to compare outcome of pre-ACSx and post-ACSx periods. Subgroup analysis was done by using Chi-square test and t-test. The resident satisfaction was evaluated by 12 residents using a double-blind questionnaire on http://www.surveycan.com/survey175782.

Results: An ACSx service could improve flow of surgical emergency patients from the ER. From the present study, there were significant decreases in consultation time from 74.23 to 23.40 minutes (p-value <0.05) and in waiting time to operating room [OR] from 299.25 to 213.88 minutes (p-value <0.05). However, there was no statistical difference in the decrease of length of hospital stay (p-value 0.91). On subgroup analysis, there were significant decrease in consultation time in acute appendicitis, gut obstruction, acute cholecystitis, hollow viscus organ perforation, and hernia with complication (p-value <0.05). There was reduction in the acute appendicitis referral cases from 95 to 39 cases, and a reduction of ruptured rate from 45 to 13 cases. Resident satisfaction was more than 80% for ACSx service. Total complication and death were 18 cases (2.45%).

Conclusion: Introduction of an ACSx service in the medical academic center, Ramathibodi Hospital had a good outcome in decrease of consultation time and waiting time to OR, significant in acute appendicitis cases. There were improved time of care and improved surgical emergency patients flow from ER with low complication and death rate (2.45%), with good satisfaction of more than 80% from residents.

Keywords: Acute care surgery, ACS, Surgical emergency, Consultation time

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Acute Care Surgery [ACSx] service is a task force that is set for handling general surgery emergency conditions, i.e., multiple trauma, surgical abdominal emergencies, and surgical critical care. For two decades, management of trauma patients was geared towards non-operative management for solid organ injuries[1]. This reduces trauma surgeons' exposure to operative opportunities. More than that, there are more sub-specialty surgeons for non-general surgery conditions such as neuro-trauma, orthopedic-trauma, and maxillo-facial-trauma. All of these in the past were handled by trauma surgeons, which are declining due to the distribution of the cases to sub-specialties for both administrative and academic reasons. This subspecialty issue also happens to general surgery as well. General surgeons now practice in more organ system oriented and are more reluctant or less confident in taking care of emergency general surgery conditions. While the operative workload of trauma surgeons has significantly decreased, the general surgery emergency patients with severe co-morbidities and active underlying medical problems are markedly increased[2]. The emergency general surgery patients arrive at the emergency room [ER] 24/7, but they frequently undergo life-saving surgery at the end of busy and tight elective operating room [OR]' schedule. The patients get stuck at the ER for a long time and the operations are delayed until night. This off-hour surgery and perioperative care, including those in the surgical intensive care unit [SICU], are mostly attended by general surgery residents. To solve all of these problems, an ACSx

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service was initiated in Ramathibodi Hospital by the Department of Surgery.

The ACSx service model has been introduced in Ramathibodi Hospital since August 1, 2015. Staff from Trauma Surgery and Surgical Critical Care unit with assistance from two staffs from General Surgery unit, two Hepatopancreatobiliary [HPB] unit staff, and two Transplantation unit staff participate in this service on the night shift (16.00 to 8.00) Monday to Friday and 24-hour shift on weekends. The facility and supporting manpower to run this service are trauma ward, ICU trauma, residents in trauma rotation, and nurse staff from trauma ward. Instead of being in standby and authorization by phone calls as in the past, ACSx staff are in-house and go to ER for faster decision making to investigation and operation, and go to OR to supervise residents or be the first surgeon in difficult emergency decision and during critical crisis of emergency patients. During day time (8.00 to 16.00), at least one OR is designated on Monday to Friday to serve the emergency cases from this ACSx service. The outcomes of this service could be demonstrated by decreased time of care at ER and OR, faster patients flow from ER, decreased delay surgery, decreased complication and mortality, reduced length of hospital stays, and increased learning experience and skill of residents. The present study was designed to evaluate the mentioned outcomes at one year after implementation of ACSx.

Materials and Methods

A retrospective cohort study was designed to compare one year outcomes from two periods of time. The first one was a pre-ACSx period, the period before introducing an ACSx service, in which all cases were managed by several general surgery subspecialty units, except trauma cases, which were managed by the Trauma Surgery unit. The data were collected between August 1, 2014 and July 31, 2015. The second one was the post-ACSx period that was the period after introducing ACSx service to the hospital, collected data between August 1, 2015 and July 31, 2016.

On sub-group analysis, we collected the top five most common surgical emergency conditions, acute appendicitis, gut obstruction (small and large bowel), acute cholecystitis, hollow viscus organ perforation, and hernia with complication.

The pre-ACSx period data were collected from Ramathibodi Hospital's database by searching from ICD-10 code, acute appendicitis (K35, K352, K353, K358), gut obstruction (small and large bowel) (K565, K566), acute cholecystitis (K800, K810), hollow viscus organ perforation (K255, K265-275, K631), and hernia with complication (K400, K401-404, K413-414, K420-421, K430-431). Three hundred fifty-nine patients were enrolled. The post-ACSx period data were collected by the Acute Care record form, and 734 patients were enrolled. From the data, we determined the basic demographic data of the patients. These data were collected on two separate time intervals to determine the one-year outcome.

1. "Time to consultation" was a time, at which ACSx team was consulted from ER to the time that ACSx teams manage the patients.

2. "Wait time to OR" was the time that ACSx team decided to operate the patient to the time that patient arrived at the OR.

The definition of a weekday-hour surgery was the surgery performed between 8.00 and 16.00, an after-hour surgery was the surgery performed between 16.00 to 8.00 and 8.00 to 8.00 on weekends and public holidays.

Statistical analysis used was Mann-Whitney U test by Stata 14 program. A *p*-value of less than 0.05 was considered statistical significance.

Resident satisfactory was evaluated by using a double-blind questionnaire test on www.surveycan.com. Twelve general surgery residents were enrolled to evaluate their satisfaction on ACSx service work loads and learning experience.

The study protocol was approved by the Ethic Committee of Faculty of Medicine, Ramathibodi Hospital, Mahidol University.

Results

From the comparison of the two periods, the demographic data of the patients are shown in Table 1.

Table 1. The demographic data of patients in pre-ACSx and post-ACSx period groups

	Pre-ACSx	Post-ACSx
Mean ages (years), mean ± SD	57.52±20.73	57.79±20.84
Sex, n (%)		
Males	171 (47.63)	371 (50.54)
Females	188 (52.37)	363 (49.50)
Total	359	734
Diagnosis, n (%)		
Acute appendicitis	204 (58.90)	200 (33.00)
Gut obstruction	77 (22.25)	78 (17.00)
Acute cholecystitis	53 (15.32)	40 (8.00)
Hollow viscus organ perforation	15 (4.33)	25 (4.00)
Hernia	10 (2.89)	13 (4.00)

ACSx = Acute Care Surgery

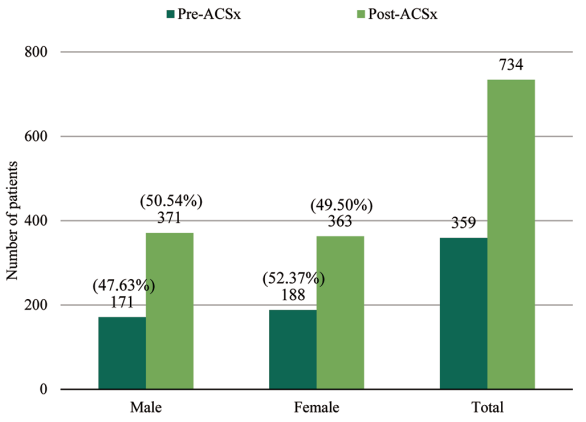

Figure 1. Number of patients that were admitted to trauma ward between pre-ACSx and post-ACSx in one year service.

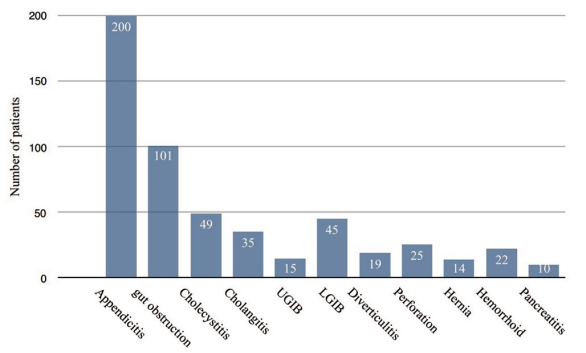

Figure 2. The most common diagnosis in post-ACSx service for 1 year outcome.

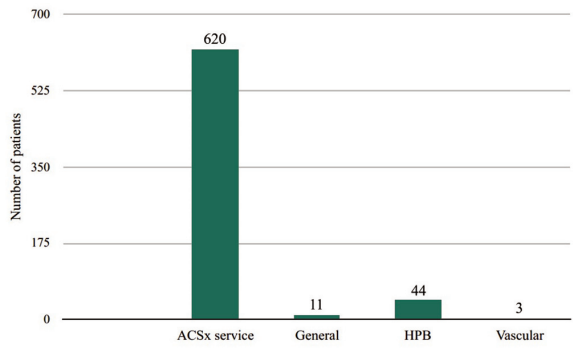

Figure 3. Subspecialty consultations in post-ACSx service for 1 year.

The mean age of two groups was 57.52 years in pre-ACSx period and 57.79 years in post-ACSx period. There was nearly 100% increase in patient volume after ACSx had started service, from 359 cases to 734 cases. The female patients were 2-fold rising, from 188 cases to 363 cases, but the male patients were not different, as shown in Figure 1. In each period, the most common diagnosis was acute appendicitis, 204 and 200 cases, respectively.

From the 734 cases in one year of ACSx service, the most common diagnosis was acute appendicitis, 200 cases (33%), gut obstruction (small and large bowel), 101 cases (17%), acute cholecystitis, 49 cases (8%), acute cholangitis, 35 cases (8%), lower GI bleeding, 45 cases (7%), hollow viscus organ perforation, 25 cases (4%), hemorrhoid, 22 cases (4%), acute diverticulitis, 19 cases (3%), upper GI bleeding, 15 cases (2%), hernia with complication, 14 cases (2%), acute pancreatitis, 10 cases (2%), and other diagnosis, 102 cases (17%), as shown in Figure 2.

The Figure 3 shows ACSx team giving services in 620 cases (90.25%) from 734 cases. The remaining cases were consulted to subspecialty, HPB unit for endoscopic retrograde cholangiopancreatography [ERCP] 44 cases (6%), General Surgery unit for esophageal problem 11 cases (2%), Transplantation unit three cases (1%) for previously kidney or liver transplantation patients, and eight cases of consultation other departments, i.e., Orthopedic, Gynecology.

One-year outcome of ACSx service is shown in Table 2. The average consultation time was 22.68 minutes and the average waiting time to OR was 218.7 minutes.

On sub-group analysis comparing between pre-ACSx and post-ACSx, there was a significant decrease in consultation time in patients diagnosed with acute appendicitis (p-value <0.001), gut obstruction (p-value <0.001), acute cholecystitis (p-value <0.001), hollow viscus organ perforation (p-value <0.001), and hernia

Table 2. Average time of ACSx service for 1 year

Post-ACSx (August 1, 2015 to July 31, 2016)	Consultation time (minutes)	Waiting time to OR (minutes)
August	34.00	181.00
September	32.00	279.00
October	22.00	138.00
November	14.00	144.00
December	27.00	299.00
January	30.00	227.00
February	23.00	261.00
March	14.00	255.00
April	16.00	235.00
May	14.83	168.00
June	22.46	121.02
July	23.99	165.60
Total average time	22.68	218.70

ACSx = Acute Care Surgery; OR = operating room

with complication (*p*-value 0.006). These results are shown in Table 3. Only patients diagnosed with acute appendicitis (*p*-value <0.001) and hollow viscus organ perforation (*p*-value 0.047) were significantly improved in waiting time to OR as shown in Table 4. There was a significant decrease in length of hospital stay in patients diagnosed with acute appendicitis (*p*-value <0.001) and hallow viscus organ perforation (*p*-value 0.015), but there was no statistically significant differences to demonstrate for other diagnosis as shown in Table 5. Additionally, there was decreased in ruptured rate of acute appendicitis from 45 to 13 cases but no statistical significance (*p*-value 0.500) as shown in Figure 4. There was reduction in the number of referral to other hospitals for acute appendicitis cases from the ER after one year of ACSx service, from 95 to 39 cases. The results are shown in Table 6. For the comparison of all sub-group analysis, there were significant decrease in overall consultation time from 74.23 to 23.40 minutes (*p*-value <0.001) and overall waiting time to OR from 5 to 3.5 hours (*p*-value <0.001), but no statistical significance in length of hospital stay (*p*-value 0.907) as shown in the Table 7.

Table 3. Comparison of consultation time between pre-ACSx and post-ACSx

	Average consultation time (minutes) median (range)		*p*-value
	Pre-ACSx	Post-ACSx	
Acute appendicitis	60 (30 to 72.5)	15 (10 to 20)	<0.001*
Gut obstruction	60 (30 to 60)	15 (10 to 30)	<0.001*
Acute cholecystitis	60 (50 to 120)	17.5 (10 to 30)	<0.001*
Hollow viscus organ perforation	60 (30 to 80)	15 (10 to 20)	<0.001*
Hernia with complication	60 (45 to 120)	20 (10 to 60)	0.006*

ACSx = Acute Care Surgery

* *p*-value <0.05 is significant

Table 4. Comparison of waiting time to OR between pre-ACSx and post-ACSx

	Average waiting time to OR (minutes) median (range)		*p*-value
	Pre-ACSx	Post-ACSx	
Acute appendicitis	240 (105 to 420)	140 (70 to 280)	<0.001*
Gut obstruction	300 (120 to 540)	180 (105 to 390)	0.156
Acute cholecystitis	360 (150 to 600)	300 (120 to 660)	0.620
Hollow viscus organ perforation	60 (45 to 120)	120 (70 to 260)	0.047*
Hernia with complication	225 (120 to 600)	90 (60 to 270)	0.092

ACSx = Acute Care Surgery; OR = operating room

* *p*-value <0.05 is significant

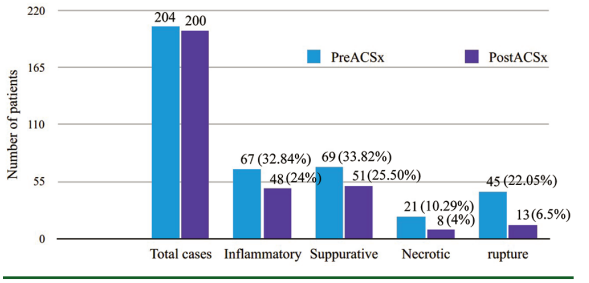

Figure 4. Comparison of types of acute appendicitis between pre-ACSx and post-ACSx.

The trauma cases admitted to trauma ward were reduced from 346 cases to 208 cases after one year of ACSx service as shown in Figure 5 and 6. ACSx had 150 trauma patients (72%), mostly presented with uncomplicated chest injuries and abdominal injuries, as shown in Figure 7.

Three hundred cases were admitted to our 6-bed Trauma ICU in pre-ACSx and 301 cases admitted in post-ACSx. The trauma and surgical critical care cases were increased from 81 cases in pre-ACSx to 173

Table 5. Comparison of length of hospital stay between pre-ACSx and post-ACSx

	Length of hospital stay (days) median (range)		*p*-value
	Pre-ACSx	Post-ACSx	
Acute appendicitis	2 (2 to 3)	2 (1 to 2)	<0.001*
Gut obstruction	7 (4 to 11)	5 (3 to 11)	0.133
Acute cholecystitis	2 (3 to 5)	3 (3 to 6)	0.641
Hollow viscus organ perforation	8 (5 to 32)	4 (3 to 8.5)	0.015
Hernia with complication	6 (3 to 8)	4 (3 to 6)	0.378

ACSx = Acute Care Surgery

* *p*-value <0.05 is significant

Table 6. Comparison of referral cases of acute appendicitis due to insufficiency resources

Acute appendicitis	Pre-ACSx	Post-ACSx
Referral cases	95	39

ACSx = Acute Care Surgery

Table 7. Comparison of all subgroup analysis between pre-ACSx and post-ACSx

	Pre-ACSx	Post-ACSx	*p*-value
Consultation time (minutes)	74.23	23.40	<0.001*
Waiting time to OR (minutes)	299.25	213.88	<0.001*
Length of hospital stay (days)	7.75	6.58	0.907

ACSx = Acute Care Surgery; OR = operating room

* *p*-value <0.05 is significant

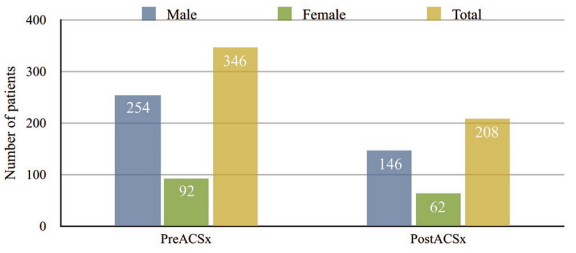

Figure 5. Number of IPD trauma cases compared between pre-ACSx and post-ACSx.

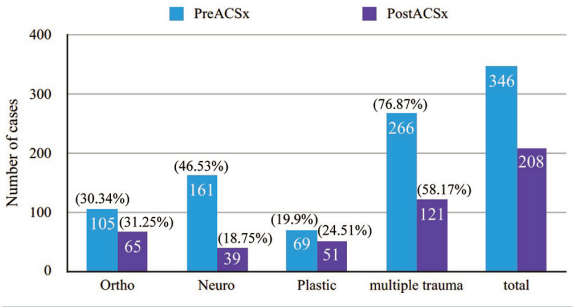

Figure 6. Subspecialty trauma cases admitted at trauma ward compared between pre-ACSx and post-ACSx.

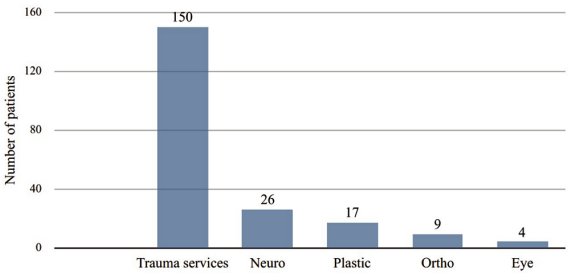

Figure 7. Cases consultation of trauma subspecialty in post-ACSx services.

patients in post-ACSx as shown in Figure 8. There were decreased ICU trauma admissions by other unit from 219 to 128 cases in post-ACSx.

Figure 9 shows the comparison of weekday-hour

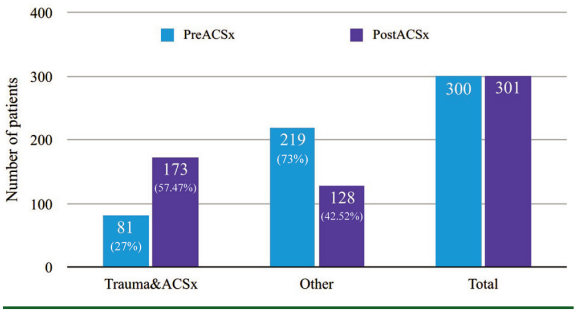

Figure 8. ICU occupying cases compared between pre-ACSx and post-ACSx.

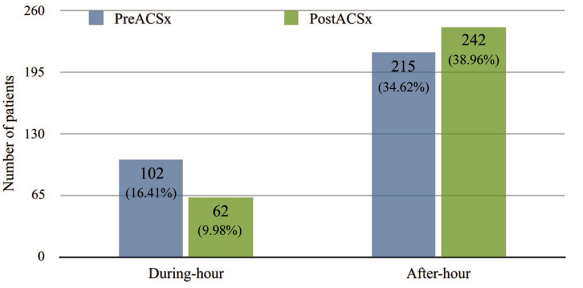

Figure 9. Comparison of during-hour and after-hour surgery cases.

and after-hour surgery cases between pre-ACSx and post-ACSx. There were decrease in during-hour operation and were increase after-hour operation due to most of patients arrived at ER after-hour.

The overall resident' satisfaction was more than 80% for ACSx service evaluated by second and fourth year general surgery residents who had the experience for both pre-ACSx and post-ACSx periods. Twelve residents were enrolled and filled-in the questionnaire at www.surveycan.com. The results as shown in Table 8 revealed that residents were satisfied with the ACSx workloads, both weekday-hour and after-hour, and with in-house ACSx staff supervision, both intra-operative and in critical decision making for the patients in ER and ICU.

Table 8. Satisfaction of general surgery residents to ACSx service

	Most satisfy (9-10 points)	Satisfy (6-8 points)	Moderate (5 points)	Quite satisfy (3-4 points)	Least satisfy (0-2 points)
Knowledge, n (%)	2 (16.67)	8 (66.67)	2 (16.67)	0 (0.00)	0 (0.00)
During-hour activities, n (%)	10 (83.33)	2 (16.67)	0 (0.00)	0 (0.00)	0 (0.00)
After-hour activities, n (%)	10 (83.33)	1 (8.33)	1 (8.33)	0 (0.00)	0 (0.00)
Improve operative skill, n (%)	8 (66.67)	0 (0.00)	0 (0.00)	4 (33.33)	0 (0.00)
ACSx staffs, n (%)	8 (66.67)	4 (33.33)	0 (0.00)	0 (0.00)	0 (0.00)
ACSx unit, n (%)	8 (66.67)	4 (33.33)	0 (0.00)	0 (0.00)	0 (0.00)

ACSx = Acute Care Surgery

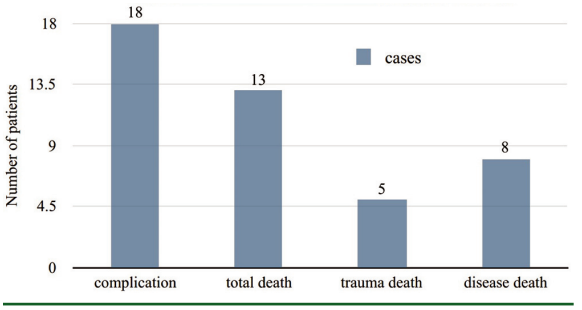

Figure 10. One year ACSx service complication and death.

One-year complication and death are shown in Figure 10, in which there were total of 18 cases complication, death 13 cases (trauma death five cases, disease death eight cases), life threatening required ICU one case, no general anesthesia to correct complication two cases, and one case of re-operative under general anesthesia. There were five cases of non-death complication, wound dehiscent with bowel evisceration, postoperative collection requiring percutaneous drainage, two cases of anastomosis leakage. There was no surgical site infection from all complications.

Discussion

After one year of introduction, the ACSx service has improved the time of care, increased patients flow from the ER, decreased the time to consult surgery team, decreased waiting time to the OR, and improved the learning experience and skills of residents. There were only 2.45% complication, 18 cases from 734 cases. Although the cases in ACSx services were emergency and had active medical conditions, ACSx service had its own ICU supply and in-house supervised staff.

Faryniuk and Hochman study showed that, from 2-fold rising of the patients, the consultation time was 61.6 and 48.9 minutes of the newly formed ACSx service and established ACSx services, respectively[4]. Our data showed that despite nearly 100% increase in number of cases (from 359 to 734 cases, pre-ACSx and post-ACSx) the consultation time was 22.68 minutes after one year of ACSx service, which is faster than in the previous study[4]. These was a significant decrease in consultation time because the in-house ACSx staffs arrived at ER and made decision with residents. Thus, there was a decrease in steps of authorization to send for investigation or to operate from staff. The overall waiting time to OR was 218.70 minutes and was significantly decreased when compared to pre-ACSx period (p-value <0.001), because ACSx service had an emergency OR available during daytime, from Monday to Friday, that did not disturb the normal elective schedule, and were supervised intra-operative 24 hours by staffs.

On sub-group analysis, Earley et al reported that the key time interval of consultation in acute appendicitis had no significant improvement but improved in time to operation, length of hospital stays, and ruptured rate[5]. In our study, there were significant decrease in waiting time to OR in acute appendicitis from 310.40 minutes to 198.73 minutes (p-value <0.001) and hollow viscus organ perforation from 101.79 minutes to 41.16 minutes (p-value 0.0296), while the others, there were no statistical significant decrease. The comparison of length of hospital stay have not significantly decrease because most of surgical emergency patients had short postoperative recovery[3]. Because of statistically significant decrease in consultation time and waiting time to OR in acute appendicitis patients, there was also a decrease in ruptured rate of acute appendicitis, yet not reaching statistical significance (p-value >0.05).

The present study showed a decrease of the weekday-hour operations and an increase of the after-hour operations, because most of surgical emergency patients arrived at ER after-hour.

The trauma cases were decreased after ACSx service from 346 to 208 cases. The orthopedics and the neuro-trauma cases were also decreased because they were directly relocated to the orthopedics and neuro-surgery wards instead of being admitted to Trauma service and making consultation later as in pre-ACSx period. The Trauma ICU facilities fully supported the ACSx service cases, and there were 173 cases of ACSx service admitted in ICU increased from 81 cases in pre-ACSx period.

From the previous study, Wanis et al showed the high average of the personal measurement of satisfaction to ACSx service[3]. In our study, we obtained the personal measurement of satisfaction from residents who had experience both in pre-ACSx and post-ACSx periods. More than 80% were satisfied about this ACSx service because they always had an intra-operative supervision from in-house ACSx staff, it decreased process of decision making, and it increased the supervision in critical crisis of the patients. The resident learning skill was improved from the personal measurement due to the staffs' supervision.

For the one-year outcome after an introduction of ACSx service in Ramathibodi Hospital, there were

improvement in the surgical emergency patients' flow from ER by decreasing consultation time and waiting time to OR while maintaining the normal elective schedule, and improved residents learning experience and skills under supervision of the in-house ACSx staff. The improvement of this ACSx service reduced the complication and death rate from delay operation, delay consultation, and improved emergency surgical patients flow from the ER in Ramathibodi Hospital.

Conclusion

Introduction of the ACSx Service in the medical academic center of Ramathibodi Hospital had a good outcome in decreasing consultation time and waiting time to OR, which is significant in acute appendicitis cases. There were improved time of care and improved surgical emergency patients flow from ER with good satisfaction by more than 80% of the residents. There were only 2.45% of complication and death rate after one year of ACSx service, even though our patients were emergent and had active medical conditions.

What is already known on this topic?

Previous study in USA shows a good outcome provided by ACSx service. It decreases consultation time, decreases wait time to OR, and has a good satisfaction of staffs and residents in general surgery training program.

What this study adds?

An introduction of ACSx service provided a good outcome to Ramathibodi Hospital. It decreased consultation time despite a 100% increase in patients in the service, decreased wait time to OR, and had an 80% satisfaction of general surgery residents with in-house staff supervised in emergency operations and care.

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Potential conflicts of interest

The authors declare no conflict of interest.

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