Adaptive process triage system cannot identify patients with gastrointestinal perforation

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ABSTRACT

INTRODUCTION: Adaptive process triage (ADAPT) is a triage tool developed to assess the severity and address the priority of emergency patients. In 2009-2011, ADAPT was the most frequently used triage system in Denmark. Until now, no Danish triage system has been evaluated based on a selective group of patients in need of acute abdominal surgery. Gastrointestinal perforation (GIP) is acknowledged as one of the surgical conditions with the highest mortality rates. The aim of this study was to evaluate whether ADAPT can identify patients with GIP.

METHODS: All abdominal emergency laparoscopies and laparotomies performed over a one-year period at Herlev Hospital, Denmark, were included. Patient data and triage levels were collected from medical records. We defined patients suspected of less severe surgical illness as green-yellow and patients suspected of severe/life threatening illness as orange-red.

RESULTS: A total of 803 patients with a known triage level were identified: 47% green, 38% yellow, 13% orange and 2% red. Of these patients, 136 were identified with a GIP. The negative predictive value was 83.2% (95% confidence interval: 80.1-85.7), meaning that one out of six abdominal surgery patients triaged as green or yellow had a GIP that was not identified by the triage system.

CONCLUSION: ADAPT is incapable of identifying one of the most critically ill patient groups in need of emergency abdominal surgery.

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Since 2009 various triage systems have been implemented in Danish hospitals [1]. The purpose has been to identify critically ill patients and thereby reduce the waiting time for initial assessment and treatment by a doctor.

Adaptive process triage (ADAPT) was developed in Sweden in 2006 [2] and was implemented in several Danish hospitals in 2009. In 2009-2011, ADAPT was the most frequently used triage system in Denmark [1].

All emergency medical or surgical patients enter through the emergency department on admission. In hospitals using ADAPT, patients older than 16 years of age are initially assessed by a nurse and classified according to their main symptom. The nurse grades the severity of the suspected medical or surgical condition into one of five categories depending on the patient's vital signs and a questionnaire regarding the patients' symptoms (**Figure 1**). The category determines the maximum waiting time before the patient needs to be assessed by a doctor (blue: 240 min, green: 180 min, yellow: 60 min, orange: 15 min and red: 0 min) [3]. The blue category is used only for fast-track patients with minor orthopaedic injuries. We aimed to investigate the predictive value of the ADAPT system in detecting patients with gastrointestinal perforation (GIP) and to determine if ADAPT could reduce surgical delay.

METHODS

In this study, we included all abdominal emergency laparoscopy and laparotomies performed over a one-year period from 1 May 2012 to 30 April 2013 at Herlev Hospital, Denmark. The hospital is a 741-bed university teaching hospital, serving a population area of 432,000.

We retrospectively collected data from medical records, and a standardised database was created with the following data: age, sex, ASA score, performance status, comorbidity, alcohol consumption, smoking, ADAPT triage level, surgical delay, surgical diagnosis (International Classification of Diseases, version 10 (ICD-10) code and the 30-day mortality and morbidity registered according to the Clavien-Dindo classification. Comorbidity was registered as present if the condition was medically treated at the time of admission. Performance status was defined according to the Eastern Cooperative Oncology Group [4].

Based on ICD-10 code and the intraoperative findings, patients were categorised into two groups: with or without GIP. The GIP group was described according to the anatomical location of the GIP: stomach/duodenum, small bowel, colon and appendix.

Based on the triage colour, we defined patients suspected of less severe surgical illness as green-yellow (unrecognised critically ill patients: GY) and patients suspected of severe/life threatening illness: orange-red (recognised critically ill patients: OR). The simplification of triage levels was made with a more clinically useful approach in mind: suspected critical illness or not.

ADAPT was used as a test for identification of pa-

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FIGURE 1

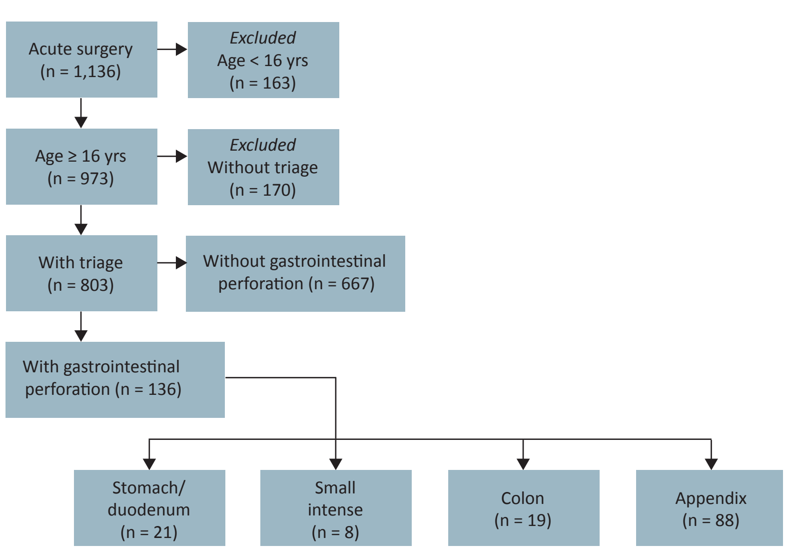
Categories of severity of the suspected medical or surgical condition.

	Red	Orange	Yellow	Green	Blue
Questionnaire					
Haematemesis	Continuously	Frequently	Few	None	None
Rectal bleeding/melaena	–	Continuously	Blood mixed in the stool/melaena	None	None
Hernia	–	Irreducible/strangulated	–	Reducible	None
Pain	–	Very severe: VAS 10	Severe: VAS 6-9	Few or none: VAS 1-5	Few or none: VAS 1-5
Alimentary vomiting	–	–	Continuously	Few	None
Diarrhoea	–	–	Yes	No	No
Fragile patient	–	–	Yes	No	No
ECG abnormalities	Life-threatening	Dangerous	Not dangerous	Not acute	Not acute
Vital signs					
Airway	Obstructed airway Stridor	Threatened airway	–	Free airway	
Breathing	SpO_2 < 80 without O_2-supply RF > 35 or < 8	SpO_2 < 90 without O_2-supply RF > 30	SpO_2 < 95 without O_2-supply RF > 25	SpO_2 ≥ 95 without O_2-supply RF 8-25	
Circulation	SR > 130 Pulse > 180 SysBP < 80	Pulse > 120 or < 40 SysBP < 90	Pulse > 110 or < 50	Pulse 50-110	
Disability	Unresponsive Ongoing seizures	Respond to pain Very agitated	Respond to speech Moderately agitated	Alert Slightly agitated	
Exposure	–	Temp. > 40 °C or < 32 °C	Temp. > 39 °C or < 35 °C	Temp. 35-39 °C	
For patients with severe chronic obstructive lung disease					
Breathing	SpO_2 < 75 without O_2-supply RF > 35 or < 8	SpO_2 < 85 without O_2-supply RF > 30	SpO_2 < 90 without O_2-supply RF > 25	SpO_2 ≥ 90 without O_2-supply RF 8-25	

ECG = electrocardiography; RF = respiratory frequency, /min; SpO_2 = peripheral capillary oxygen saturation, %; SR = sedimentation rate, mm/h; SysBP = systolic blood pressure, mmHg; VAS = visual analogue scale, 0-10.

FIGURE 2

Selection of the study cohort.



tients with GIP as critically ill patients and the sensibility, specificity, positive predictive value (PPV) and negative predictive value (NPV) were calculated.

Surgical delay was defined as the time (hours) between admission to the emergency department and initiation of the surgical procedure. The statistical analysis was made in SPSS Statistics Version 23 where a significant difference was defined as a p-value ≤ 0.05.

Difference in age was calculated using the Mann Whitney U test; and differences in comorbidity, smoking, alcohol consumption and 30-day mortality rate were calculated using Fisher's exact test; difference in ASA score was calculated using likelihood ratio; difference in surgical delay was calculated using Brown-F ANOVA; differences in performance status and Clavien-Dindo Classification were calculated using Pearson's chi-squared test for the overall population and using likelihood ratios for the GIP cohort.

This research was approved by the Danish Data Protection Agency; HEH-2013-034 I-Suite: 02336.

TABLE 1

Demographics, 30-day morbidity: Clavien-Dindo classification, and mortality rate. Apart from age, the values are n (%).

	All patients			Gastrointestinal perforations		
	triage level			triage level		
	green-yellow	orange-red	p-value	green-yellow	orange-red	p-value
Age, yrs, mean (range)	51 (16-101)	59 (17-98)	0.001	58 (17-97)	59 (18-88)	0.84
Gender						
Male	317 (46.3)	62 (52.1)	0.274	56 (48.7)	13 (61.9)	0.344
Female	367 (53.7)	57 (47.9)	0.274	59 (51.3)	8 (38.1)	0.344
Total	684	119		115	21	
Chronic obstructive lung disease	31 (4.5)	10 (8.4)	0.109	3 (2.6)	4 (19.0)	0.011
Diabetes	28 (4.1)	12 (10.1)	0.010	6 (5.2)	2 (9.5)	0.358
Ischaemic heart disease	32 (4.7)	13 (10.9)	0.015	7 (6.1)	3 (14.3)	0.185
Cirrhosis	2 (0.3)	2 (1.7)	0.107	1 (0.9)	0	1.000
Hypertension	167 (24.4)	43 (36.1)	0.009	34 (29.6)	7 (33.3)	0.797
Chronic nephropathy	8 (1.2)	4 (3.4)	0.087	3 (2.6)	0	1.000
Smoker	167 (24.4)	29 (24.4)	1.000	23 (20.0)	11 (52.4)	0.004
Alcohol consumption: female/male > 7/14 U weekly	41 (6.0)	10 (8.4)	0.311	10 (8.7)	4 (19.0)	0.231
ASA score			0.000			0.336
I	302 (44.2)	36 (30.3)		43 (37.4)	6 (28.6)	
II	243 (35.5)	39 (32.8)		44 (38.3)	6 (28.6)	
III	94 (17.7)	26 (21.8)		17 (14.8)	6 (28.6)	
IV	22 (3.2)	11 (9.2)		5 (4.3)	2 (9.5)	
V	0	1 (0.8)		0	0	
Missing	23 (3.4)	6 (5.0)		6 (5.2)	1 (4.8)	
Performance status			0.005			0.108
0	517 (75.6)	72 (60.5)		81 (70.4)	10 (47.6)	
1	89 (13.0)	21 (17.6)		21 (18.3)	7 (33.3)	
2	37 (5.4)	12 (10.1)		8 (7.0)	1 (4.8)	
3	28 (4.1)	10 (8.4)		3 (2.6)	3 (14.3)	
4	9 (1.3)	4 (3.4)		1 (0.9)	0	
Missing	4 (0.6)	0		1 (0.9)	0	
Clavien-Dindo classification			0.000			0.175
0	530 (77.5)	72 (60.5)		79 (68.7)	10 (47.6)	
1-2	67 (9.8)	11 (9.2)		12 (10.4)	3 (14.3)	
3-5	87 (12.7)	36 (30.3)		24 (20.9)	8 (38.1)	
Missing	0	0		0	0	
30-day mortality	37 (5.4)	18 (15.1)	0.001	7 (6.1)	4 (19.0)	0.068

ASA = American Society of Anesthesiologists.

Trial registration: HEH-2013-034 I-Suite: 02336.

RESULTS

A total of 1,136 abdominal emergency procedures were identified of which 803 patients had a known triage level (**Figure 2**). The distribution of triage levels was: 47% green, 38% yellow, 13% orange and 2% red.

The overall population was significantly (p = 0.001) older in the OR group than in the GY group (**Table 1**) with an eight-year difference in mean age.

Furthermore, the overall population had a significantly higher AS A score and performance status and higher frequencies of diabetes, hypertension, ischaemic heart disease and complications registered in the OR group than in the GY group. In the overall population, we found no differences in sex, smoking, alcohol consumption or in any other comorbidity registered between the GY and the OR group. In the GIP cohort, the only differences between the GY and the OR group was a significantly higher rate of smoking and chronic obstructive lung disease. In the GIP cohort, there were no differences in sex, age, all other comorbidities registered, alcohol consumption, ASA score, performance status and complications registered between the GY and the OR group.

Only one patient (5%) with a perforated colon was allocated to the OR group by the triage system (**Table 2**). The 18 other patients with this condition were found in the GY group. Likewise, only 48% of perforated ulcers,

TABLE 2

Distribution of gastrointestinal perforation in the triage categories.
The values are n (%).

	Green	Yellow	Orange	Red
Stomach/duodenum	6 (28.6)	5 (23.8)	6 (28.6)	4 (19.0)
Small intestine	1 (12.5)	4 (50.0)	2 (25.0)	1 (12.5)
Colon	8 (42.1)	10 (52.6)	1 (5.3)	0
Appendix	40 (45.5)	41 (46.6)	7 (8.0)	0

38% of perforated small bowel and 8% of perforated appendicitis were triaged orange or red.

In the overall population, the 30-day mortality was 5.4% for the GY group and 15.1% for the OR group, and the difference was significantly higher for the OR group (p = 0.001; odds ratio = 3.1 (95% confidence interval (CI): 1.7-5.7)) than for the GY group.

In the GIP cohort, the 30-day mortality was 6.1% in the GY group and 19.0% in the OR group, but the difference was not statistically significant (p = 0.068; odds ratio = 3.6 (95% CI: 0.96-13.7)).

The GIP cohort had no difference in mean surgical delay: 12.0 (95% CI: 10.1-13.9) and 12.7 (95% CI: –0.7-26.2) hours for the GY group and the OR group (p = 0.912), respectively.

Testing ADAPT for detection of GIP, we found 21 true positive GIP, 569 true negative non-GIP, 115 false negative GIP and 98 false positive non-GIP. The sensitivity of the test for detecting a GIP was 15.4%, the specificity was 85.3%, the PPV was 17.6% (95% CI: 11.5-25.9%) and the NPV was 83.2% (95% CI: 80.1-85.7%).

DISCUSSION

Until now, no Danish triage system has been evaluated based on a selective group of patients in need of acute abdominal surgery. We found that as a binary test for identifying GIP, ADAPT had a NPV of 83.2%, meaning that one out of six abdominal surgery patients triaged green or yellow had a GIP that was not identified. Of the unidentified non-appendix-related GIPs, an unacceptably high frequency of 71% (34/48) was triaged green or yellow. ADAPT is therefore unsuitable as a clinical test for recognition of patients with GIP. Studies have shown a 30-day mortality rate of 22% for perforated ulcer [5] and 16.9% for perforated colon [6]. GIP is hereby acknowledged as one of the surgical conditions with the highest morbidity and mortality rates [7], and thus it is clinically important to identify patients with GIP.

A previous study shows a higher mortality rate in a similar triage system called Hillerød Akut Process Triage in patients with red triage compared with green triage (odds ratio = 24.0 (95% CI: 14.8-38.8); p < 0.0001) [8]. The study cohort had patients suffering from various medical and surgical conditions [8].

In our study, the OR group in the overall population of all surgical procedures had more elderly patients with a higher frequency of chronic diseases and higher ASA scores, performance status, Clavien-Dindo classification and 30-day mortality rates than the GY group. We believe that the significantly higher morbidity and mortality rates may be explained by the increased frequency of comorbidities and higher ASA scores in this subpopulation. Studies have shown that these parameters are associated with increased mortality rates when patients undergo acute abdominal surgery [7, 9, 10].

The APAPT system probably identifies patients with several comorbidities since these patients had a weakened physiological capacity of resistance and may be likely to present with measurable symptoms on admission.

In the GIP cohort, we found a significantly higher frequency of smoking and chronic obstructive lung disease only in the OR group, whereas there was a trend towards a significantly higher 30-day mortality also in the OR group. There were 21 patients with GIP in the OR group. This could indicate a lack of statistical power. This is also considered a main point of interest since ADAPT identified only 15.4% of the patients with GIP.

The 30-day mortality in the GY group with GIP was 6.1%. Previous studies have found that perforated appendicitis with emergency appendectomy is associated with a mortality rate of 0.4-0.5% [11, 12]. The 30-day mortality rate in the GY group is thus higher than expected, as perforated appendicitis accounts for 70% of the GIP in this group in our study. This once again indicates that ADAPT does not identify the most critically ill patients in need of abdominal surgery.

According to a Danish study, time to surgery is essential for survival among patients with a perforated peptic ulcer with survival rate declining by 2.4% for every hour of surgical delay [13]. Another study identifies surgical delay as a critical determinant of survival in patients with GIP associated with septic shock with a 0% chance of surviving if the surgical delay exceeded six hours [14]. In the present study, there were no significant differences in surgical delay between GIP in the GY and the OR group, which indicates that even when the ADAPT identified a small proportion of patients with GIP, the system had no effect on the length of surgical delay. A Dutch study reported similar results with no decrease in waiting time for treatment after implementation of a triage system [15]. An explanation for this may be that the high frequency of unidentified GIP made it difficult to prioritise the resources in a clinical setting and thereby impossible to reduce surgical delay. An alternative explanation may be a lack of acute surgical capacity at the hospital or an inefficient preoperative setting.

There are several limitations to this study. It was a

Surgical triage.

single-centre study and the results might therefore not be generalizable. The cohort in this study was a selective population of patients undergoing acute abdominal surgery. It would have been of clinical value if we could have collected data from all patients admitted to the surgical emergency department, thereby also including patients with acute pancreatitis, abscesses, gastrointestinal bleeding and incorrectly referred patients with urinary tract infections, kidney stones, etc. We would then have expected a higher NPV for ADAPT in recognising GIP and the percentage of GIP in the GY group would decrease.

It is debatable whether patients with acute appendicitis have a poorer outcome associated with surgical delay than the non-appendix-related GIPs [16]. Yet, another study has shown that surgical delay was associated with a significant risk of progression from acute appendicitis to perforated appendicitis ($p < 0.001$) and an increased incidence of both infectious and non-infectious post-operative complications ($p < 0.001$) [17].

Since this study was conducted, ADAPT was replaced by the Danish Emergency Triage (DEPT) which in many ways is similar to ADAPT. However, there are some differences between the two triage systems, especially regarding the questionnaire for abdominal pain.

A Danish study shows that compared with DEPT, eyeball triage by inexperienced hospital staff was a significantly better prognostic marker with regards to 30-day mortality risk ($p < 0.01$) and this study has thereby questioned the clinical value of DEPT [18].

It would be clinically relevant to investigate whether DEPT is more efficient in identifying the critically ill patients in need of abdominal surgery, preferably in a prospective cohort study with inclusion of all patients admitted to the surgical emergency department.

CONCLUSION

ADAPT is incapable of identifying one of the most critically ill patient groups in need of emergency abdominal surgery and should not replace highly experienced clinicians in the initial assessment of patients. ADAPT should only be considered as a complementary tool for the nurse in the initial assessment of acute medical disease.

ADAPT did not reduce surgical delay for patients with GIP.

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CONFLICTS OF INTEREST: Disclosure forms provided by the authors are available with the full text of this article at www.danmedj.dk

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