Innovations in prehospital emergency cardiac care: alleviating the strain on overcrowded hospitals
Koning, E.R. de
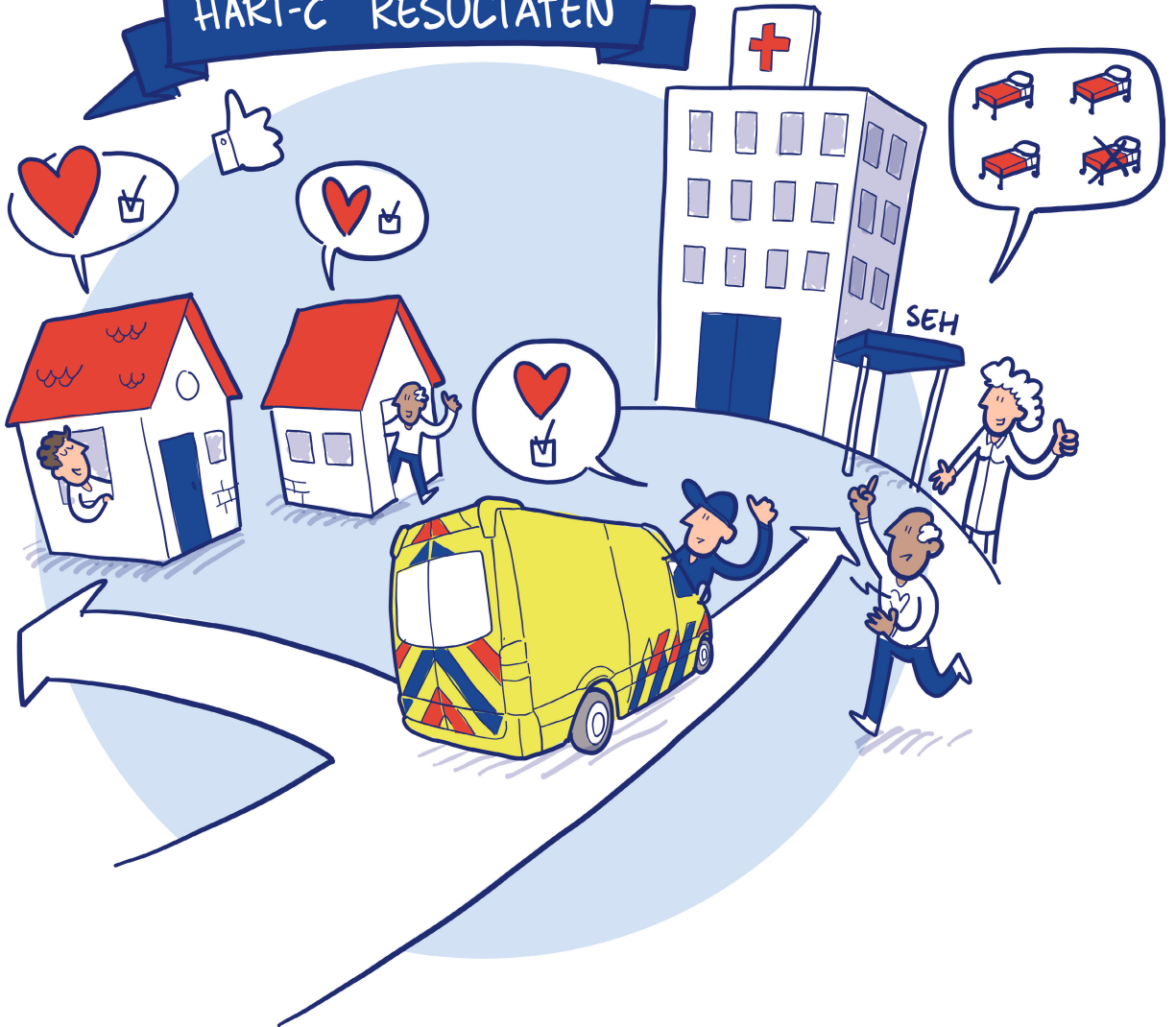
Chapter 6

Improved Prehospital Triage for Acute Cardiac Care: Results from a Multicentre Prospective Study – Hollands–midden Acute Regional Triage – cardiology (HART–c)

Authors: Enrico R de Koning[1], Saskia LMA Beeres[1], Jan Bosch[2], Barbra E Backus[,3], Wouter J Tietge[4], Reza Alizadeh Dehnavi[5], Rolf HH Groenwold[6,7], Allena M Silvius[8], Pepijn TS van Lierop[1], J Wouter Jukema[1], Martin J Schalij, Mark J Boogers*[1]

1. Cardiology, Leiden University Medical Center, Leiden, the Netherlands.
2. Research and Development, Regional Ambulance Service Hollands-Midden (RAVHM), Leiden, the Netherlands.
3. Emergency Medicine, Leiden University Medical Center, Leiden, the Netherlands.
4. Department of Cardiology, Alrijne Hospital, Leiderdorp, the Netherlands.
5. Department of Cardiology, Groene Hart Hospital, Gouda, the Netherlands.
6. Clinical Epidemiology, Leiden University Medical Center, Leiden, the Netherlands.
7. Biomedical Data Sciences, Leiden University Medical Center, Leiden, the Netherlands.
8. Public Health and General Practice, Leiden University Medical Center, Leiden, the Netherlands.

Abstract

Background: Cardiac symptoms are the most prevalent reason for emergency department visits. However, over 80% of these patients are sent home after ruling out acute cardiovascular disease.

Objective: The HART-c study aims to investigate whether a novel prehospital triage method, combining prehospital and hospital data with expert consultation, can increase the number of patients who could safely stay at home after emergency medical service (EMS) consultation.

Methods: The triage method combined prehospital EMS data, such as ECG and vital parameters in real-time, and data from regional hospitals (including previous medical records and admission capacity) with expert consultation. During the 6 months intervention and control periods 1536 and 1376 patients were consulted by the EMS respectively. The primary endpoint was the percentage change of patients who could stay at home after EMS consultation.

Results: The novel triage method led to a significant increase in patients who could safely stay at home, 11.8% in intervention group versus 5.9% in the control group: odds ratio 2.31 (95% CI 1.74-3.05). Out of 181 patients staying home, only 1 (<1%) was later diagnosed with ACS, no patients died. Furthermore the amount of interhospital transfers decreased: relative risk 0.81 (95% CI 0.67-0.97).

Conclusion: The HART-c triage method led to a significant decrease in interhospital transfers and an increase in patients with cardiac symptoms who could safely stay at home. The presented method thereby reduced overcrowding and, if implemented throughout the country and for other medical specialties, could potentially reduce even more cardiac and non-cardiac hospital visits.

Introduction

Cardiac symptoms are one of the most prevalent reasons for emergency department (ED) visits (1). Interestingly, the vast majority of patients with cardiac symptoms are sent home after ruling out acute cardiovascular disease. Previous studies showed that up to 80% of all patients with chest pain do not have an acute coronary syndrome (ACS) (2-4). This calls for improvement, especially in an era in which the Dutch healthcare system is increasingly under pressure.

Overcrowding of EDs leads to worse patient outcomes, increased healthcare costs and dissatisfied patients and - healthcare workers (5-8). From a cardiologist's perspective, previous attempts to reduce overcrowding mostly focused on rapid risk stratification to rule-out ACS with the development of risk scores, including the frequently used HEART (History, Electrocardiogram, Age, Risk factors, Troponin) score (9, 10). These risk scores, however, do not address the root cause of overcrowding, as it still requires patients to visit the ED. Accordingly, attention shifted from in-hospital triage towards prehospital triage. The recent FamouS Triage(11) and ARTICA(12) studies focussed on prehospital risk stratification. These studies bring progress, but only focus on chest pain patients, whereas patients with other cardiac symptoms also contribute considerably to ED overcrowding. Improved prehospital triage of all cardiac patients, could potentially reduce unnecessary ED visits and contribute to effectively combatting overcrowding throughout the Netherlands.

To improve prehospital triage for all patients with cardiac symptoms a comprehensive novel triage method was developed, entitled Hollands-midden Acute Regional Triage – cardiology (HART-c). This triage method combined *prehospital* real-time emergency medical services (EMS) data with *hospital* data and direct consultation of a cardiologist with insight in the triage platform. The primary aim of the HART-c study was to investigate whether this novel triage method could increase the number of patients who could safely stay at home.

Methods

Study design
The HART-c study was a multicentre prospective cohort study with a historical control group. The intervention group comprised adult patients visited by the EMS in the Dutch region Hollands-Midden, for symptoms of suspected cardiac origin during a six-month period, between 09-09-2019 and 06-03-2020. The historical control period was six months in the year prior, between 09-09-2018 and 06-03-2019. Full details on the study protocol were published previously.(13)

Intervention group – novel triage method
During the intervention period, patients presenting to the regional EMS with symptoms of suspected cardiac origin received standard clinical assessment including medical history,

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physical examination and a 12-lead ECG in line with the National Protocol for Emergency Medical Care (LPA version 8.1, June 2016). For the HART-c study, all regional ambulances were equipped with a Tempus Pro Monitor (Philips, the Netherlands) which streams encrypted patient specific pre-hospital data (vital parameters, ECG) to IntelliSpace Corsium (Philips, the Netherlands). All acquired data from the clinical assessment and Tempus Pro Monitor were transferred to the newly developed digital triage platform.

Following informed consent, the nurse paramedic was directly connected to a cardiologist who was on-call. On the triage platform, the patient specific pre-hospital data is combined with in-hospital data (such as real-time admission capacity for the regional hospitals and previous medical history). The paramedic and cardiologist decided whether transfer to a hospital would be of added value and, if so, which hospital suited best. The on-call cardiologist noted the decision in the triage platform and a message was automatically sent to the nursing staff of the chosen hospital, thereby immediately informing them of a new referral and updating the hospital's admission capacity (Figure 1). Notably, in the control group the nurse paramedic's decision was based only on prehospital data without expert cardiologist consultation.

Figure 1. Triage method with (A) standard care and possible interhospital transfers in the case of overcrowded ED or nursing ward and (B) novel triage method combining prehospital data with live streaming of ECG and vital parameters, hospital data such as previous ECG's, medical history and admission capacity and expert consultation.
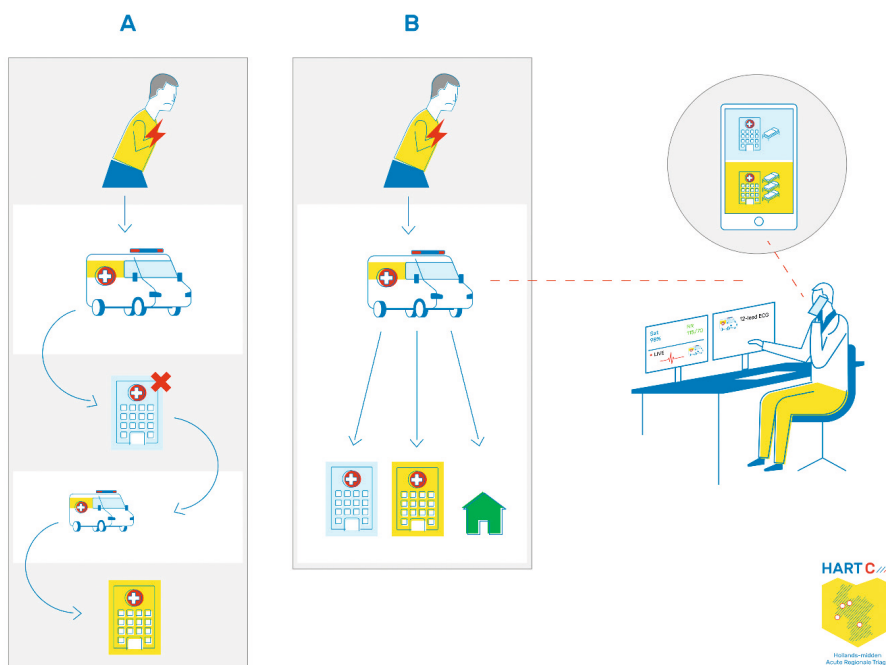
Outcome measures

The main objective of the HART-c study was to investigate whether the triage method could safely increase the number of patients with suspected cardiac symptoms who could stay at home after EMS consultation. For the purposes of this study, safety was defined as the absence of MACE (death or ACS) 30 days after EMS consultation.

Secondary endpoints were the total amount of hospital referrals, the total number of interhospital transfers, the time from EMS consultation to hospital arrival, final diagnoses, and patient -, GP -, and cardiologist satisfaction.

Interhospital transfers were defined as an EMS transfer from one of the three participating hospitals to any other hospital. The final cardiac diagnoses at the ED were assessed using hospital billing data. EMS consultation, ED admission, hospital admission, or GP consultation for any reason within 30 days after EMS consultation were noted. Cardiologists, patients and their GPs rated their satisfaction with the triage method on a 1-10 scale, where 1 was the least satisfactory and 10 the most satisfactory.

Statistics

Baseline characteristics were reported as mean and standard deviation (SD) or median and interquartile range (IQR) and compared between control and intervention. The proportions of patients staying at home during the intervention and control periods were compared using binary logistic regression analysis, adjusted for age, sex and month (14). The total number of EMS consultations during the intervention and the control period were compared based on incidence rates based on data on the regional population at the time from Statistics Netherlands (www.cbs.nl), 808.860 and 801.600 in intervention and control period respectively, and compared using a chi-squared test. The number of interhospital transfers were compared based on incidence rates from the total number of EMS consultations. The difference in the percentage of final diagnoses per presenting symptom, per ACS diagnosis and in total were evaluated using a chi-squared test. Data were analysed using IBM SPSS Statistics V.25.

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Results

Baseline

The intervention group comprised 1536 patients (69±15 years, 51.3% male) and the historical cohort group 1376 patients (68±15 years, 49.9% male). The baseline characteristics of both groups were well comparable (Table 1).

Table 1. Baseline characteristics in control - (n=1376) and intervention group (n=1536).

	Control (n=1376)	Intervention (n=1536)	p-value
Age (years)	68 ± 15	69 ± 15	0.181
Sex (male,%)	49.9	51.3	0.637
Main presenting symptom (n,%):			0.186
Chest pain	733 (53.3%)	880 (57.3%)	
Palpitations	198 (14.4%)	206 (13.4%)	
Dyspnoea	282 (20.5%)	284 (18.5%)	
(Near) syncope	163 (11.8%)	166 (10.8%)	
Sinus rhythm (%)	75.1	77.3	0.182
Breathing frequency (breaths per minute)	19 ± 9	19 ± 8	0.153
Oxygen saturation (%)	97 (96-98)	97 (96-98)	0.611
Pulse (beats per minute)	90 ± 31	88 ± 29	0.102
Systolic blood pressure (mmHg)	148 ± 29	150 ± 28	0.220
Diastolic blood pressure (mmHg)	86 ± 18	86 ± 17	0.987
Distance to hospital (km)	11 ± 8	11 ± 8	0.940

Explanatory footnote: Missing data were excluded. Figures represent mean ± standard deviation, or absolute numbers (%).

Primary objective

In the intervention group, 181 (11.8%) patients could stay at home after EMS consultation, compared to 77 (5.9%) patients in the control group (Figure 2). The percentage of patients who could stay at home per month is shown in Figure 3.

Figure 2. Percentage of patients with cardiac symptoms left at home in control group (5.9%) and intervention group (11.8%).
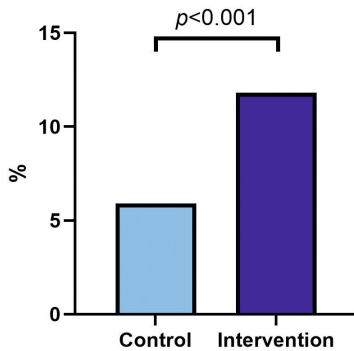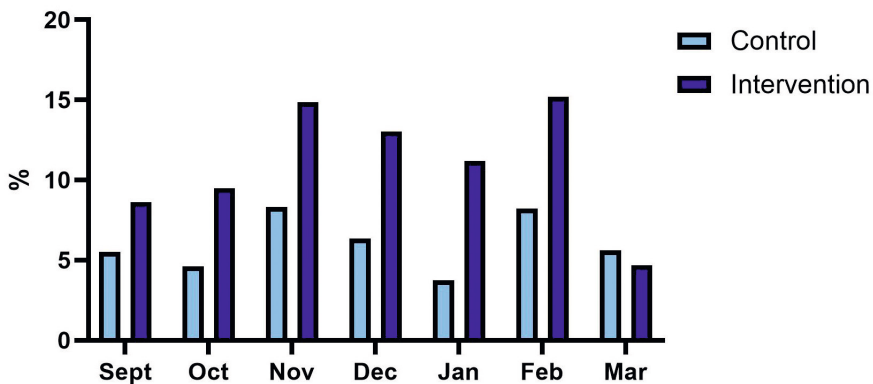

Figure 3. Percentages of patients with cardiac symptoms left at home by the EMS in the control group and in the intervention group per month.

Logistic regression showed an increased odds for staying at home in the intervention group as compared to the control group: 2.31 (CI 1.74-3.05, p<0.0001). The logistic regression model was adjusted for age, sex and month of presentation (to account for seasonal patterns) (Table 2). The most prevalent presenting symptom in patients who could stay at home was chest pain (37.6% in control and 48.6% in intervention group), followed by palpitations (36.4% and 27.1%), and dyspnoea (10.4% and 12.2%) (p=0.31).

Table 2. Logistical regression model showing the relative risk of staying at home. The final model (in bold) was adjusted for age, sex and month of presentation.

	RR	95% CI lower limit	95% CI upper limit	p value
Prehospital triage	**2.31**	**1.74**	**3.05**	**<0.001**
Age	0.91	0.87	0.96	**<0.001**
Age^2	1.07	1.03	1.11	**<0.001**
Sex (male)	0.70	0.54	0.92	**0.007**
Month				0.078

Explanatory footnote: 'Age^2' is a composite value of (Age*Age)/100. The p-value of 'Month' is the likelihood ratio of contribution of the variable to the logistic regression model.

Safety

Of the 181 patients who stayed at home after EMS consultation in the intervention group, 1 patient developed ACS within 30 days after evaluation by the EMS (MACE rate <1%). No patients died. Five (2.8%) patients were lost to follow-up.

Secondary endpoints

There were 1536 EMS consultations in the intervention group and 1376 in the control group. The incidence of EMS consultation did not differ between both groups (190/100.000 vs. 172/100.000 inhabitants) with a relative risk of 1.10 (CI 0.90-1.36, p=0.344). In the intervention group, the number of interhospital transfers was lower compared to in the control group (206 vs. 173). The incidence of interhospital transfer was significantly lower in the intervention group (173/1355) as compared to the control group (206/1299) with a relative risk of 0.81 (CI 0.67-0.97, p=0.023). Time from EMS consultation to hospital arrival increased by 6 minutes from 37±11 minutes in the control group to 43±14 minutes in the intervention group (p<0.001). A triage cardiologist handled an average of 12 calls per day, taking 5-10 minutes each. The total amount of time a cardiologist spends on prehospital triage is therefore around 1-2 hours per day.

In total 126 (9.2%) patients presenting to the EMS ultimately had an ACS in the control group, compared to 127 (8.2%) in the intervention group. All ACS diagnoses are noted in Table 3. There were no differences in ACS diagnoses between control and intervention (p=0.928). There were no differences in final diagnoses as shown in Table 4 (Electronic Supplementary Material).

Table 3. Overview of final diagnoses of acute coronary syndrome patients in control - (n=1299) and intervention group (n=1355) presented to the hospitals.

	Control (n)	%	Intervention (n)	%	p-value
ACS	**126**		**127**		0,928
STEMI	8	6,3%	8	6,3%	
NSTEMI	85	67,4%	83	65,4%	
Unstable angina	33	26,2%	36	28,3%	

Explanatory footnote: STEMI: ST-elevation myocardial infarction, NSTEMI: non-ST-elevation myocardial infarction.

Satisfaction

Patients who could stay at home averaged a satisfaction score of 8.8. GPs from these patients scored the care given with an average of 7.7. Cardiologists scored each shift, averaging a score of 7.7.

Discussion

Implementing a novel prehospital triage method for patients visited by the EMS for cardiac symptoms combining live-streamed prehospital data, insight in previous medical history, and expert consultation led to a significant increase in the number of patients who could stay at home. The triage method had a MACE rate <1%, none of these patients died. Furthermore, a decrease in interhospital transfers was achieved. Patients and healthcare workers were very satisfied with the presented triage method. These results may help to relief the pressure from the currently overcrowded Dutch EDs.

Overcrowding of EDs is a major healthcare challenge (5-8). Cardiac patients form a large part of all ED consultations, with more than 10% of all ED consultations involving patients experiencing chest pain (1). However, over 80% of these patients do not suffer from acute cardiovascular disease. To reduce overcrowding, in-hospital triage for rapid risk stratification of chest pain patients has been in use for several years with the use of risk scores (9, 15, 16). Although these result in accurate and fast risk stratification, patients are still presented and evaluated at the ED, and thus still contribute to overcrowding. Therefore, scientific focus has shifted on improving prehospital triage.

The ARTICA (12) study assesses whether the addition of POC cTnT measurement is cost-effective in ruling out ACS and leaving patients at home after EMS consultation. The FamouS Triage (17) investigators concluded that it seems feasible and non-inferior to rule out myocardial infarction in prehospital chest pain patients using a modified HEART score at the patient's home, incorporating only a single troponin T (cTnT) measurement on intravenously acquired blood samples (18). The PRESTO (19) study seeks to evaluate the diagnostic accuracy of the validated T-MACS decision rule to rule out ACS in the prehospital

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environment. This could allow paramedics to rule out ACS for chest pain patients in the very low risk group and avoid the need for transport to the ED.

The present HART-c study differs from the aforementioned studies in its included patients, triage method and main objective. Firstly and uniquely, the HART-c study does not limit its inclusion to chest pain patients, but also includes patients with other cardiac symptoms. Thus, the HART-c study could be of benefit to a larger cohort of patients. , and for this reason, could be of greater value in preventing overcrowding of EDs and hospitals. Since the method is not solely focused on chest pain patients, it is easier to recreate, adjust and implement for other medical specialties. Second, the HART-c study is unique in its triage method. The ARTICA, FamouS and PRESTO studies rely solely on prehospital data, whereas the HART-c study is the first study to combine prehospital - and hospital data. Furthermore, the HART-c study includes expert consultation on the scene by having a cardiologist available for the nurse paramedic. Lastly, this is the first study to publish its results regarding *safely* leaving cardiac patients at home after EMS assessment. Appropriate selection of patients at (very) low risk for MACE, who could therefore safely stay at home following EMS consultation, could contribute substantially to providing overcrowded EDs and hospitals with much-needed relief. Of utmost importance, patients who can safely stay at home after EMS consultation are spared the (unnecessary) strain and stress of a ED visit.

The HART-c study has some limitations. First of all, this is not a randomised controlled trial, so selection bias could influence its results and therefore these results should be seen as promising and not definitive. A randomised controlled trial or a study with a stepped wedge design should be conducted in the future to confirm the results presented in the current study. Another limitation is the patients lost to follow-up when not transferred to an ED. Unfortunately, not all these patients (or their GP's) could be contacted after 30 days as some patients did not have a GP (tourists or homeless) or in some cases phone numbers were not noted correctly. Therefore, the true MACE rate could be slightly higher than 1%. Furthermore, the MACE rate might have been this low due to the wide inclusion criteria: 'symptoms of possible cardiac origin'. Chest pain patients with possible ACS have a higher MACE rate than, for example, patients with palpitations or dyspnoea. The intervention was planned for one year, however in March 2020 COVID-19 struck the Netherlands which had a huge impact on acute and non-acute (cardiac) care. As patients might have hesitated to contact the GP, EMS or hospitals this would have introduced too much bias in the study affecting the comparability between the intervention and the (historical) control group. Therefore, the study was closed in March 2020.

In conclusion, the HART-c study evaluated a novel triage method combining prehospital live-streamed EMS data, insight in previous medical records, real-time hospital admission capacity with expert cardiologist consultation. The achieved increase in patients who could safely stay at home after EMS consultation and the reduction in interhospital transfers could help take substantial pressure of the currently overloaded healthcare system. Furthermore, the presented triage method is adjustable and easily implementable for other medical specialties to further reduce overcrowding.

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