Original Article

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Effectiveness of the Alarm System Policy on Reducing Ambulance Response Time in Prehospital Emergency Patient Care

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Abstract:

Objective: Reduction of ambulance response time leads to an increase in positive patient outcomes. Therefore, the aim of this study was to determine whether an accomplished response time within eight minutes could be increased after the introduction of an alarm system policy and to study if the mortality rate would be decreased after the introduction of alarm system policy.

Material and Methods: An interrupted time series was conducted in the collection of code red patients between the following dates: 1st November 2015 and 31st October 2019. The data was collected from the medical records of Maharaj Nakorn, Chiang Mai Hospital. The collected data were separated into: the pre-protocol period (1st November 2015 to 31st October 2017) and the post-protocol period (1st November 2017 to 31st October 2019).

Results: A total of 552 patients were included in the overall analysis. The success rates of response time within eight minutes of patients with code red in the pre-protocol period and post-protocol period were 64.62% and 73.11%, respectively. It was discovered that the success rate was significantly higher (adjusted odd ratio=1.627, 95% confidence interval: [1.017, 2.602]; p-value<0.05) in the post-protocol period versus the pre-protocol period. A decrease in the mortality rate in 24 hours and the mortality rate in the emergency room (ER) was observed in post-protocol period, from the interrupted time series model. However, no significant difference was evident through the process of statistical analysis.

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Conclusion: The implementation of the protocol could significantly reduce response time; thus, achieving the 8-minute goal. Hence, this protocol will be able to promote better emergency services in pre-hospital-based care.

Keywords: alarm system policy, ambulance response time, mortality rate, prehospital emergency patient care

Introduction

Emergency patient treatment and care begin outside the boundaries of a hospital, and emergency medical service (EMS) response time has associated with mortality. Hence, the relationship between successful patient treatment coupled with response time is evident. Ambulance response time was defined as: Emergency call receipt to EMS unit arrival on scene. A shorter ambulance response time, in most cases, leads to a more positive patient outcome[1-3]. To this point, the National Institute for Emergency Medicine has established a standard protocol of outside hospital patient service; wherein, if a patient experiences an emergency condition (e.g.: Life-threatening injury) outside a hospital facility, the patient or bystanders can contact the emergency dispatch center, in order to receive emergency medical directions, which would then distribute information to each respective province and city to send out emergency medical services. The urgency and risk level of each patient case is categorized into-five color codes[4]: red, yellow, green, white, and black. There is also a time limitation placed within each categorization in addition each of the color codes is divided into different protocols. Red: responds with the first responder unit (FR), or if unavailable, responds with the basic life support unit (BLS), which has to reach the patients within four minutes, followed by an advanced life support unit (ALS) within eight minutes. Yellow: responds with FR that has to reach the patients within eight minutes, followed by the BLS within fifteen minutes. Green: responds with only the FR unit; however, no time limit is put in place. White: gives the patient advice through the phone. Black: no medical emergency case; further elaboration on the details of each color is provided[4].

The emergency medical service care of Maharaj Nakorn, Chiang Mai Hospital is composed of the following: emergency physicians, emergency nurses, paramedics, and ambulance drivers. If the emergency dispatch center is required to dispatch the emergency medical service team of the hospital, they will connect to the contact center of the Emergency Department (ED); giving the color code and patient information, then the contact center will telephone each of the EMS team personal and send it out to treat the patient. If the color code is red, emergency physicians, emergency nurses or paramedics in addition to ambulance drivers are sent out. However, if the color code is yellow or green, only nurses and medical workers will be sent out. Through the collection of data from the Center of Medical Care in 2017, observation indicated that response time for patients receiving the color code red (within 8 minutes) only achieved a target 62.5% of the time, with an average of 9.27 minutes. The main, catastrophic reason for this is the contact system and preparedness of the medical personnel. Emergency nurses are in charge of sorting patients according to their urgency at the triage area in front of the ED as well as providing basic medical care to patients in an emergency room (ER). Emergency physicians oversee patients in the ER and observation unit. Lastly, ambulance drivers have the job of moving patients around the medical facility, and standing by in the waiting room. The process of contacting each personnel and forming a medical rescue team takes a substantial amount of time. Therefore, to reduce preparation time, the guidelines of the hospital have been revised: 1) The turnout time, the time of receiving the call up until the time of leaving the hospital, for the color code red patient is determined. 2) The designated

nurses and medical personnel should be allocated near the contact center in the emergency department. 3) The information regarding the patient must be recorded by the contact center in a form (Supplementary Figure 1) that can instantly be passed to the EMS team upon arrival. 4) An alarm system is installed in the staff room as well as in the ER. The alarm rings once, in a situation wherein a patient is categorized by the center into either a green or yellow color code. On the other hand, the alarm rings twice if the categorization is red.

The alarm system has been established (Supplementary Figure 2) and implemented as of 1st November 2017, in the hopes of reducing turnout time to no more than 90 seconds. All in efforts towards increasing the chances of reaching the scene within the presented standard response time; thus, reducing the mortality rate. Therefore, this study has been organized towards the determination of whether the response time accomplished within 8 minutes could be increased, and whether the mortality rate within 24 hours and the mortality rate in the ER could be decreased after the introduction of said alarm system policy.

Material and Methods

Study design and setting

An interrupted time-series design was performed to study the change in response time, the mortality rate in 24 hours, and mortality in ER due to the implementation of the alarm protocol on 1st November 2017. The study site was Maharaj Nakorn, Chiang Mai Hospital. The hospital is a university teaching hospital that is capable of tertiary care, situated in an urban area. Data were collected on the code red report from the 1st November 2015 until 31st October 2019. Following this, the period before the introduction of the protocol (i.e., the "pre-protocol" period) was defined as: the time between 1st November 2015 and 31st October 2017. The period after the introduction of the protocols (i.e., the "post-protocol" period) was defined as: the period between the 1st November 2017 and 31st October 2019. The study was approved by the Institutional Review Board (Approval No. EME-2564-8067).

Study population

This study evaluated "code red" patients that presented at the emergency department of Maharaj Nakorn, Chiang Mai Hospital; between 1st November 2015 to 31st October 2019. Subjects were excluded if they refused medication, arrived at the hospital via air transport, or were out of service area.

Variables and outcomes

Patient information included the following; gender, age, chief complaints, date of the incident, time of the incident, time of ambulance depart from the hospital, time of ambulance arrival at the scene, response time, turnout time, scene time, time used to transport a patient from scene to hospital, distance from hospital to the scene, patient vital signs (blood pressure, pulse rate, respiratory rate), total Glasgow coma score, oxygen saturation, hospital diagnosis, patient outcomes in ER, duration of hospital admission, and patient treatment outcomes.

The primary outcome of this study was an increase in the number of cases with the response time being accomplished within 8 minutes after the introduction of the alarm system policy. The secondary outcome was a decrease in the mortality rate in 24 hours as well as the mortality rate in the ER after the introduction of the alarm system policy.

Statistical analysis

After the implementation of the alarm protocol, it was expected that there would be an increase in the 8-minute goal response time by a success of 80%. The study sample size was calculated according to the expectation by using the formula of comparing two independent proportions with 80% power and an alpha error (two-sided) of 0.05.

Furthermore, missing values are assumed to be 20% of the sample size. The sample size was corrected by using the process of continuity correction. Therefore, at least 288 code red cases would be required to establish a relationship between response time and the alarm protocol. Specifically, at least 144 cases each from the pre-protocol period and post-protocol period. Segmented linear regression models were created to compare the trend of response time and mortality rate between pre-protocol and post-protocol. For statistical analysis, descriptive statistics was used, including mean, median, mode, and standard deviation. All of this was to compare the characteristics via study periods. Chi-squared test statistic was used to compare categorical variables, nonparametric Man-Whitney U test to compare ordinal or continuous variables, and independent-samples t-test was used to compare the means of two independent samples, before and after the intervention. Following this, logistic regression was used to analyze the relationship between multiple independent variables and dependent variables, including response time, mortality in 24 hours, and mortality in ER. All statistical analyses were carried out using IBM Statistical Package for the Social Science (SPSS) Statistics, V23.0. The significance level for all these tests was p-value<0.05 (two-sided 95% confidence interval (CI)).

Ethical approval

The study was approved by the Institutional Review Board (Approval No. EME-2564-8067).

Results

Electronic medical records of Maharaj Nakorn Chiang Mai Hospital between the 1st November 2015 to 31st October 2019, had 620 code red patients; of which 552 patients qualified for the research: according to Figure 1. As demonstrated in Table 1, the participants with code red priorities that do not match any excluded criteria (N=552) were divided into the pre-protocol group (N=195)

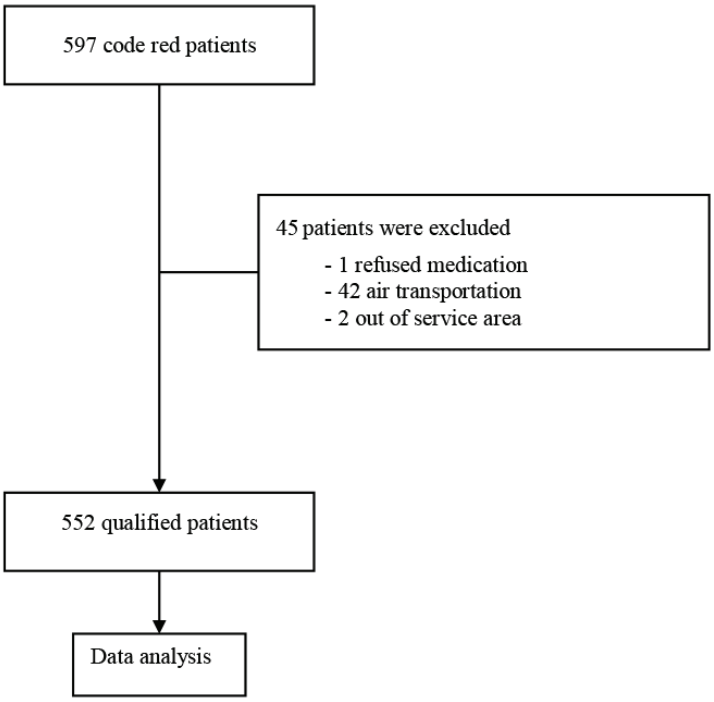

Figure 1 Enrollment

Table 1 Characteristics of the collected patients

Characteristic	Missing data N (%)	Pre-protocol N=195 (%)	Post-protocol N=357 (%)	p-value
Gender				
Male		130 (66.67)	209 (58.54)	0.067
Female		65 (33.33)	148 (41.46)	
Age, mean (years)±S.D. [pre N=185, post N=348]	19 (3.44)	53.01±21.25	48.65±23.62	0.031
Patient's chief complaint				
Pregnancy/childbirth/gyn.		6 (3.08)	10 (2.80)	<0.001
Chest pain/discomfort/heart problems		8 (4.10)	10 (2.80)	
Other medical problem*		10 (5.12)	13 (3.64)	
Other trauma problem**		14 (7.18)	29 (8.12)	
Breathing difficulty/choking		25 (12.82)	23 (6.44)	
Seizures		13 (6.67)	42 (11.77)	
Stroke		13 (6.67)	5 (1.40)	
Cardiac arrest		16 (8.21)	67 (18.77)	
Motor vehicle accident		29 (14.87)	57 (15.97)	
Unconscious/unresponsive/syncope		61 (31.28)	101 (28.29)	
Response time, mean (min)±S.D.		8.45±4.92	7.23±3.98	0.003
Response time				0.041
Within 8 min		126 (64.62)	261 (73.11)	
More than 8 min		69 (35.38)	96 (26.89)	
Scene time, mean (min)±S.D.		12.95±8.80	12.77±7.99	0.806
Distance from hospital to the scene, mean (km)±S.D.		2.70±2.28	2.83±2.49	0.549
Type of patient				
Non Trauma		148 (75.90)	256 (71.71)	0.288
Trauma		47 (24.10)	101 (28.29)	
Cardiac arrest (trauma & non trauma) (N=163)		66 (33.85)	97 (27.17)	0.145
Non trauma without cardiac arrest (N=285)		99 (50.77)	186 (52.10)	
Trauma without cardiac arrest (N=104)		30 (15.38)	74 (20.73)	
First record vital signs				
Non trauma without cardiac arrest (N=285)				
Pulse rate (median) (IQR)	6 (2.11)	93 (78, 114)	98 (82, 120)	0.369
Systolic BP (mean)±S.D.	16 (5.61)	137±36	137±34	0.962
Respiratory rate (median) (IQR)	19 (6.67)	20 (20, 27)	20 (18, 24)	0.127
GCS (median) (IQR)		15 (11, 15)	15 (10, 15)	0.850
Percent of oxygen saturation (mean)±S.D.	16 (5.61)	93±13	94±11	0.447
Trauma without cardiac arrest (N=104)				
Pulse rate, median (IQR)	5 (4.81)	90 (77, 110)	97 (84, 113)	0.398
Systolic BP, mean±S.D.	14 (13.46)	128±30	131±30	0.642
Respiratory rate, median (IQR)	11 (10.58)	20 (18, 24)	20 (18, 22)	0.876
GCS, median (IQR)		14 (9, 15)	14 (8, 15)	0.604
Percent of oxygen saturation, mean±S.D.	14 (13.46)	93±9	94±8	0.548
Mortality in ER		134 (68.72)	278 (77.87)	0.024
Alive		61 (31.28)	79 (22.13)	
Death				
Mortality in 24 hours		126 (64.62)	265 (74.23)	0.018
Alive		69 (35.38)	92 (25.77)	
Death				

*Other medical problem (abdominal pain, mental/emotional/psychological, anaphylaxis, bleeding non trauma (GI hemorrhage), sick/infectious disease), **Other trauma problem (drowning, burns, assault, falls)
S.D.=standard deviation, IQR=interquatile range, BP=blood pressure, GCS=Glasgow coma scale, ER=emergency room

and the post-protocol group (N=357). The average age of the pre-protocol group was higher than the post-protocol group: at 53.01 (S.D.=21.25) to 48.65 (S.D.=23.62) years old (p-value<0.05). From this, 130 (66.67%) of the pre-protocol group were male and 209 (58.54%) of the post-protocol group were male. Analyzed data, obtained from EMS, is described as following: average response time of EMS service before intervention being 8.45 (S.D.=4.92) minutes, which was reduced after the intervention was introduced to 7.23 (S.D.=3.98) minutes (p-value<0.05). The number of cases that had a response time within 8 minutes is 126 (64.62%) during pre-protocol and increased to 261 (73.11%) during post-protocol (p-value<0.05). The average scene time before the intervention was 12.95 (S.D.=8.80) minutes and after the intervention this was 12.77 (S.D.=7.99) minutes. The average distance between the hospital and the scene before intervention was 2.70 (S.D.=2.28) km and after the intervention this was 2.83 (S.D.=2.49) km.

Patients were categorized into trauma or non-trauma. From these, 148 (75.9%) cases were traumatic and 47 (24.1%) were non-traumatic during the pre-protocol period, with 256 (71.71%) being traumatic and 101 (28.29%) being non-traumatic during the post-protocol period. Patients' cases were classified further into cases with cardiac arrest, traumatic cases without cardiac arrest, and non-traumatic cases without cardiac arrest. Sixty-six (33.85%) and 97 (27.17%) cases with cardiac arrest were in the pre-protocol and post-protocol, respectively. Traumatic cases without cardiac arrest consisted of 99 (50.77%) cases in pre-protocol and 186 (52.10%) cases in post-protocol. Thirty (15.38%) of the pre-protocol cases and 74 (20.73%) of post-protocol cases were non-traumatic cases without cardiac arrest.

Patients' vital signs without cardiac arrest, inspected at the ER entrance, were recorded for both traumatic and non-traumatic patients.

The percentage of all-cause mortality of patients in this study at the ER was 31.28% in the pre-protocol group, which decreased to 22.13% in the post-protocol group (p-value<0.05). The percentage of all-cause mortality of patients in this study within 24 hours also decreased, from 35.38% during the pre-protocol group to 25.77% during the post-protocol group (p-value<0.05).

From univariate and multivariate analysis, cases of code red patients with a response time within 8 minutes were significantly higher (adjusted odd ratio=1.627, 95% CI: [1.017, 2.602]; p-value<0.05) in the post-protocol period compared to the pre-protocol period. Moreover, distance from the hospital to the scene was significantly associated with the success of response time to achieve an eight-minute goal; wherein, an increase in the distance reduced the response time success rate. (adjusted odd ratio=0.521, 95% CI: [0.449–0.604]; p-value<0.05). Furthermore, cases involving motor vehicle accidents were found to significantly increase the occurrence of the response time achieving the 8-minute goal. (adjusted odd ratio=6.198, 95% CI: [2.147-17.895]; p-value<0.05) (Table 2).

The multivariate logistic regression analysis; examining factors associated with mortality in the first 24 hours and mortality in the ER, found that the pre- and post-protocol periods did not show an association with mortality in either timeframe. However, trauma cases are shown to have a higher mortality rate in the 24-hour setting (adjusted odds ratio=3.429, 95% CI: [1.121-10.483], p-value<0.05), while the distance from the hospital to the scene was associated with mortality in the ER (adjusted odds ratio=1.335, 95% CI: [1.067-1.671], p-value<0.05). Additionally, patients without cardiac arrest had a lower rate of mortality in the first 24 hours (adjusted odds ratio=0.003, 95% CI: [0.001-0.006], p-value<0.05) and in the ER (adjusted odds ratio=0.001, 95% CI: [0.000-0.004], p-value<0.05) (Table 3 and 4).

Table 2 Factors associated with success of response time within an 8-minute goal

Factor	Response time within 8 minutes					
	Crude OR	95% CI	p-value	Adjusted OR	95% CI	p-value
Pre and post alarm protocol						
Pre	1.000		Reference	1.000		Reference
Post	1.489	1.023–2.167	0.038	1.627	1.017–2.602	0.042
Age	0.996	0.988–1.004	0.359	1.003	0.992–1.015	0.560
Sex						
Male	1.000		Reference	1.000		Reference
Female	0.767	0.529–1.112	0.162	0.891	0.558–1.424	0.629
Symptom/condition						
Cardiac arrest	1.000		Reference	1.000		Reference
Other medical problem	1.933	0.651–5.743	0.235	1.395	0.378–5.154	0.617
Chest pain/discomfort/heart problems	1.880	0.567–6.236	0.302	1.423	0.311–6.506	0.649
Pregnancy/childbirth/gyn.	0.895	0.296–2.711	0.845	0.904	0.240–3.402	0.881
Other trauma problems	1.112	0.509–2.430	0.789	1.350	0.533–3.419	0.527
Breathing difficulty/choking	0.895	0.428–1.873	0.769	0.497	0.209–1.183	0.114
Seizures	1.200	0.579–2.487	0.623	0.735	0.312–1.728	0.480
Stroke	0.537	0.192–1.502	0.236	0.388	0.115–1.304	0.126
Unconscious/unresponsive/syncope	1.169	0.668–2.046	0.585	0.983	0.509–1.895	0.958
Motor vehicle accident3	3.312	1.551–7.072	0.002	6.198	2.147–17.895	0.001
Distance from hospital to scene (km)	0.564	0.494–0.643	0.000	0.521	0.449–0.604	<0.001

*Other medical problem (abdominal pain, mental/emotional/psychological, anaphylaxis, bleeding non trauma (GI hemorrhage), sick/infectious disease), **Other trauma problem (drowning, burns, assault, falls)
OR=odds ratio, CI=confidence interval

Table 3 Factors associated with mortality in 24 hours

Factor	Mortality in 24 hours					
	Crude OR	95% CI	p-value	Adjusted OR	95% CI	p-value
Pre and post alarm protocol						
Pre	1.000		Reference	1.000		
Post	0.634	0.435–0.925	0.018	0.426	0.175–1.035	0.060
Age	1.008	0.999–1.016	0.070	1.005	0.983–1.027	0.680
Sex						
Male	1.000		Reference	1.000		Reference
Female	0.454	0.303–0.680	0.000	0.423	0.174–1.030	0.058
Distance from hospital to scene (min)	1.128	1.048–1.214	0.001	1.114	0.942–1.316	0.207
Response time						
Within 8 min	1.000		Reference	1.000		Reference
More than 8 min	1.325	0.894–1.964	0.160	1.050	0.391–2.817	0.923
Scene time (min)	1.035	1.013–1.058	0.002	1.014	0.962–1.070	0.605
Non trauma	1.000			1.000		Reference
Trauma	1.347	0.899–2.018	0.149	3.429	1.121–10.483	0.031
Type of patient in ER						
Cardiac arrest	1.000		Reference	1.000		Reference
Not cardiac arrest	0.004	0.002–0.008	0.000	0.003	0.001–0.006	<0.001

OR=odds ratio, CI=confidence interval, ER=emergency room

Table 4 Factors associated with mortality in ER

Factor	Mortality in ER					
	Crude OR	95% CI	p-value	Adjusted OR	95% CI	p-value
Pre and post alarm protocol						
Pre	1.000		Reference	1.000		Reference
Post	0.624	0.422–0.924	0.019	0.422	0.160–1.116	0.082
Age	1.013	1.004–1.022	0.003	1.020	0.997–1.043	0.090
Sex						
Male	1.000		Reference	1.000		Reference
Female	0.553	0.365–0.837	0.005	0.870	0.340–2.221	0.770
Distance from hospital to scene (min)	1.141	1.058–1.229	0.001	1.335	1.067–1.671	0.012
Response time						
Within 8 min	1.000		Reference	1.000		Reference
More than 8 min	1.435	0.955–2.156	0.082	0.768	0.270–2.184	0.621
Scene time (min)	1.040	1.018–1.064	0.000	1.002	0.948–1.059	0.950
Non trauma	1.000		Reference	1.000		Reference
Trauma	0.927	0.599–1.435	0.734	0.886	0.312–2.517	0.821
Type of patient in ER						
Cardiac arrest (OHCA)	1.000		Reference	1.000		Reference
Not cardiac arrest	0.001	0.000–0.004	0.000	0.001	0.000–0.004	<0.001

ER=emergency room, OR=odds ratio, CI=confidence interval, OHCA=out of hospital cardiac arrest

To illustrate the results of segmented regression analysis of response time before and after the implementation of the alarm protocol, the plots of three months data aggregated were used (Supplementary Figure 3). According to Supplementary Table 1, before implementation of the alarm protocol there was a gradual rise in the success rate (Baseline trend) (0.31, 95% CI: [-3.55, 4.18] per 3 months; p-value 0.86) with a baseline level (62.25, 95% CI: [42.72, 81.77]; p-value<0.05); after using the alarm protocol, there was an additional rise in the success rate (change in trend) (0.86, 95% CI: [-4.61, 6.32] per three months; p-value= 0.74); with sudden rise of level (change in level) (2.95, 95% CI: [-22.41, 28.31]; p-value=0.80) however, this rise in the success rate and level still lacked statistical significance. To describe the effect of the alarm protocol to the mortality rate within 24 hour and the mortality rate in the ER, the plotted accumulated mortality rate per three months was used (Supplementary Figure 4). According to the result of the 24 hour mortality rate (Supplementary Table 2), before implementation of the alarm system, a slight decrease could be observed in the mortality rate (baseline trend) (-1.02, 95% CI: [-4.96, 2.92] per 3 months; p-value=0.58) with baseline level (40.87, 95% CI:[20.96, 60.78]; p-value<0.05); after implementation of the alarm protocol there was a sudden decrease in level (-5.28, 95% CI: [-31.13, 20.58]; p-value=0.66). This indicated the immediate effect of the alarm protocol to the mortality rate within 24 hours. However, this sudden decrease in level still lacked statistical significance. In addition, the results of the mortality rate in the ER, (Supplementary Figure 5) (Supplementary Table 3) before implementation of the alarm protocol, showed a gradual decrease in the mortality rate (baseline trend) (-1.09, 95% CI: [-4.65, 2.47] per 3 months; p-value=0.52), with baseline level (36.93, 95% CI: [18.94, 54.92]; p-value<0.05). After implementation of the alarm protocol there was little decrease in both trend and level (0.40, 95% CI: [-4.64, 5.44] per 3 months; p-value=0.87) and (-2.12, 95% CI: [-25.48, 21.23]; p-value=0.85), respectively. However, it still lacked statistical significance.

Discussion

Binary logistic regression analysis showed that the implementation of the alarm protocol significantly increased the amount of cases that achieved a response time within the 8-minute goal. Similarly, the segmented linear regression model showed a positive trend for success rate of response time accomplished within the 8-minute goal during the post-protocol period. However, no significant difference in response time was evident through the process of segmented linear regression. This could be impart due to variables other than intervention of interest, which was associated with response time; for which these variables have been adjusted in the multivariate regression analysis. A previous study mentioned that delays in communicating with the emergency control center is an important factor affecting response time[5]. Paging-based protocol showed the reduction of approximately 30 seconds on response time[6]. In comparison, this alarm protocol reduced the average response time by 1 minute: 22 seconds.

Despite the statisfying effect on response time reduction, the alarm protocol could not significantly reduce mortality rates within 24 hours nor in the ER. Neverthelesss, this protocol still provides significant response time improvement, and is essential in pre-hospital care as the intervention is not sophisticated and does not require much expenditure for implementation. According to a previous study, the odds of death increased by 9% for every 10-minute increase in prehospital time[7], which could indicate that the alarm protocol has the potential to decrease prehospital time as well as prevent increased patient mortality.

Limitations

The results of this study may be of limited value in hospital settings where medical staff have dual hospital and ambulance roles while on-duty. Some EMS Systems that are dedicated as single-role EMS personnel (paramedics and EMTs) are usually dispatched directly by the emergency dispatch center, from a designated ambulance station via individual paging and overhead alarms. One of the limitations of this study was that there are missing values in the collected data due to the retrospective study design. As a result, variables with considerable amount of missing values, such as turnout time in the pre-protocol period, prehospital notification from ambulances and body temperatures could not be used for the statistical analysis. Pre-hospital notification is implemented in our setting for severe cases or time-specific diseases, such as severe trauma, MI, stroke, or cardiac arrest, which may affect mortality rates in the ER and within 24 hours. However, the electronic medical records used in this study did not contain data regarding prehospital notification. Another limitation was the considerably higher number of cases in the post-protocol period than in the pre-protocol period. Moreover, study samples could not be randomized, which led to variabilities in patient characteristics between pre- and post-protocols. To reduce possible confounding, multivariate adjustment was performed for the variables that affected the outcomes of interest.

Recommendation

Further modifications could be made on this study model to increase the effectiveness of this study. Both the intervention and the study methods could be performed in different trauma centers within different areas. Additional data and outcomes will be of benefit, if the protocol works under varied environments such as between urban and rural areas. In addition, with different emergency transporting procedures, the comparison of results would be helpful to identify unseen problems for individual centers, while also likely to provide a promising benefit during the intervention period.

Conclusion

This research has explored the relationship between a new intervention and its consequences on emergency medical services response time and mortality rates. The intervention could significantly reduce mean response time by more than one minute, which increases the percentage of the response time under the predetermined goal of eight minutes. Its effect on decreasing the mortality rate could not be established as the results, although suggesting a declining trend, were insignificant.

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Conflict of interest

The authors confirm that there are no potential conflicts of interest to declare.

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Supplementary Table 1 Coefficients of segmented regression models of success rate (response time within 8 minutes) in each of 3 months

Coefficient of segmented regression models that describe response time in each 3 months				
Parameter	Coefficients	95% CI		p-value
		Lower	Upper	
Baseline level	62.25	42.72	81.77	0.05
Baseline trend	0.31	−3.55	4.18	0.86
Change in level	2.95	−22.41	28.31	0.80
Change in trend	0.86	−4.61	6.32	0.74

CI=confidence interval

Supplementary Table 2 Coefficients of segmented regression models of mortality within 24 hours in each of 3 months

Coefficient of segmented regression models that describe mortality within 24 hours in each of 3 months				
Parameter	Coefficients	95% CI		p-value
		Lower	Upper	
Baseline level	40.87	20.96	60.78	0.05
Baseline trend	−1.02	−4.96	2.92	0.58
Change in level	−5.28	−31.13	20.58	0.66
Change in trend	0.70	−4.88	6.28	0.79

CI=confidence interval

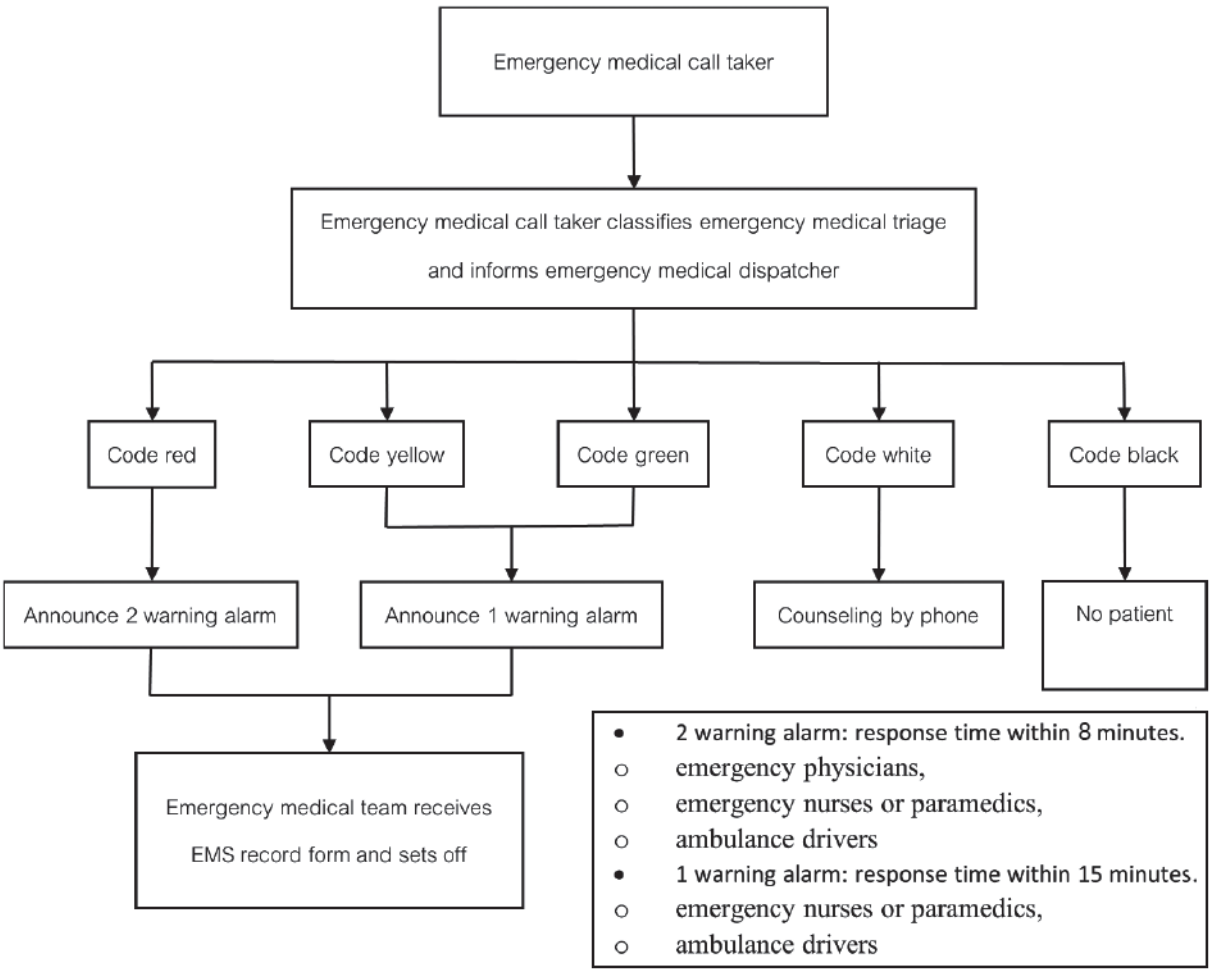
Supplementary Table 3 Coefficients of segmented regression models of mortality rate in emergency room in each months

Coefficient of segmented regression models that describe mortality in emergency room in each 3 months				
Parameter	Coefficients	95% CI		p-value
		Lower	Upper	
Baseline level	36.93	18.94	54.92	0.05
Baseline trend	−1.09	−4.65	2.47	0.52
Change in level	−2.12	−25.48	21.23	0.85
Change in trend	0.40	−4.64	5.44	0.87

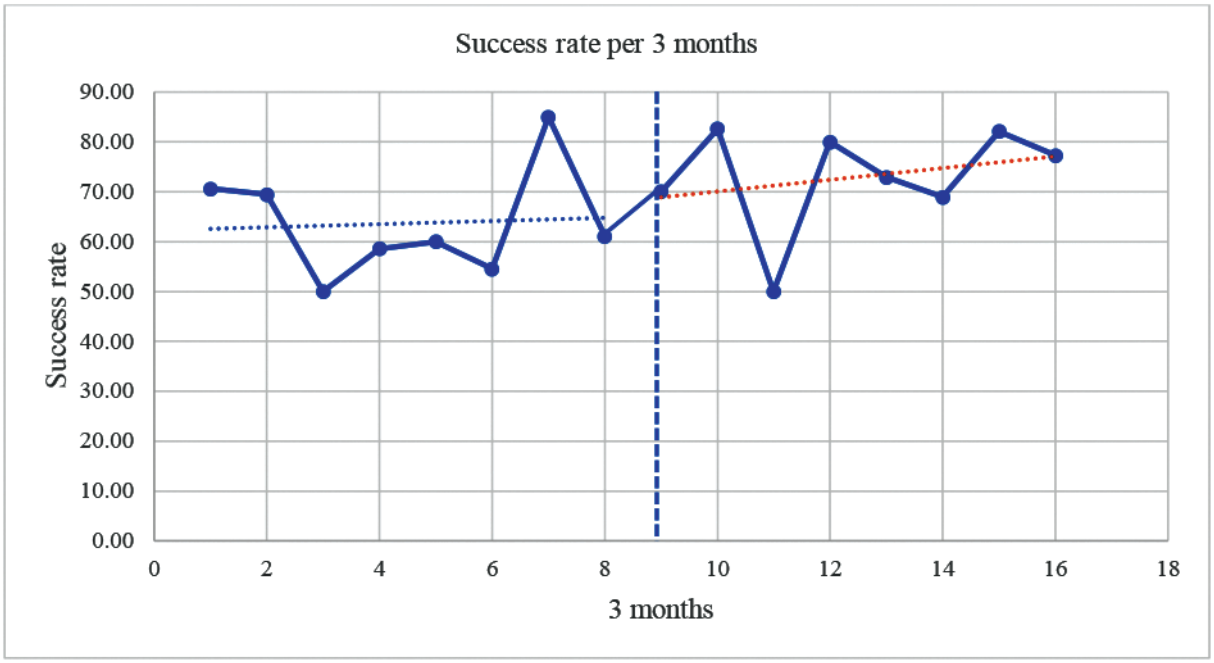
CI=confidence interval

D/M/Y		Time	
I	EMS Team (Radio channel # 4) Call received time…… / Exit time……		
	1. Identification	☐ Male ☐ Female Age…….years	☐ Trauma ☐ Non-trauma
S B	**2.Patient Symptoms**	…… …… …… **Underlying :** ……	☐ Fever ☐ URI ☐ Hx: Contact COVID pt.
A	**3.Conscious?**	☐Conscious ☐Unconscious ☐**Pulse** ☐**No Pulse**	☐Advice CPR
	4.Breathing?	☐Normal Breathing ☐Abnormal Breathing ☐ No Breathing	
R	**5.Address?**	……	
	6.Telephone number	_ _ _ - _ _ _ - _ _ _ _	
	7.Color Code	**Code** ☐Red ☐Yellow ☐Green	
Turn Out Time ……(Sec.)		**Exceed 90 seconds because** …… ……	

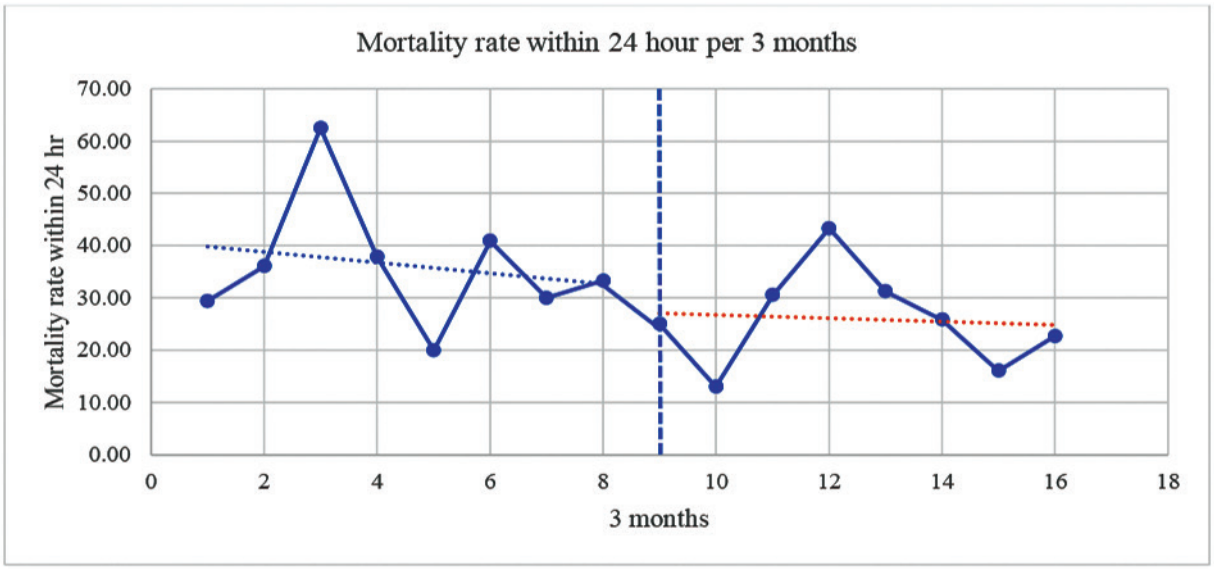
Supplementary Figure 1 Dispatch record form



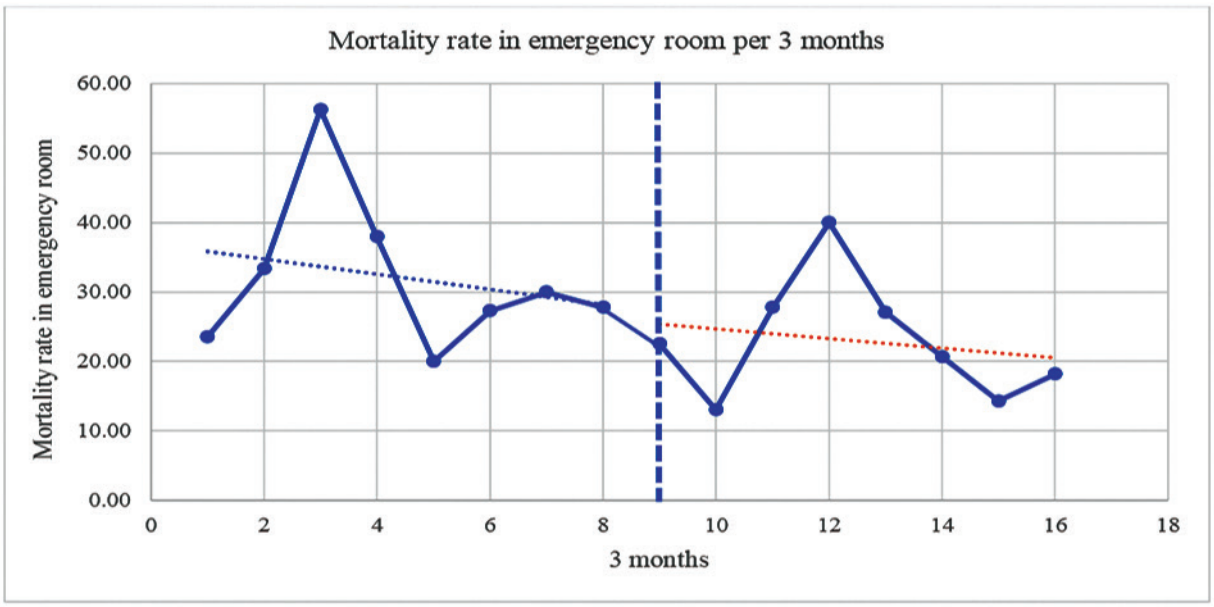
Supplementary Figure 2 Alarm system policy process diagram



Supplementary Figure 3 Plot of success rate (response time within 8 minutes) in each of 3 months



Supplementary Figure 4 Plot of mortality rate within 24 hours in each of 3 months



Supplementary Figure 5 Plot of mortality rate in emergency room over 3 months