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Strategies for early adrenaline administration using a kitchen timer for time management

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Objective: Limited studies have explored strategies to reduce the interval between initial patient contact and the administration of adrenaline (adrenaline time) in out-of-hospital cardiac arrest (OHCA). This study examines the association between time management interventions using a kitchen timer and adrenaline time in OHCA patients.

Methods: We conducted a before-and-after study utilizing transportation data from OHCA cases handled by the Ibaraki Seinan Fire Department. The study periods were from May 2 to November 30, 2021 (before group), and May 2 to November 30, 2022 (after group). Multiple linear regression analysis was employed to assess the relationship between time management interventions and adrenaline time.

Results: During the study period, 100 OHCA cases were documented (before group, n=51; after group, n=49). The mean (±standard deviation) adrenaline time was 803.2±371.2 seconds in the before group and 766.0±274.6 seconds in the after group. The multiple linear regression analysis indicated no statistically significant association between the kitchen timer intervention and adrenaline time (B coefficient, −27.1; 95% confidence interval, −146.0 to 91.8; P=0.65).

Conclusion: In the context of OHCA, using a kitchen timer for time management did not show a statistically significant association with adrenaline time. Future research should investigate whether adrenaline time can be improved by implementing team dynamics with clearly defined roles, in conjunction with kitchen timer-based time management.

Keywords: Adrenaline; Emergency medical services; Time management; Out-of-hospital cardiac arrest

INTRODUCTION

According to the 2021 committee reports on emergency statistics [1], the 1-month survival rate for out-of-hospital cardiac arrest (OHCA) witnessed by laypersons is only 7.5%, suggesting significant potential for improvement. Consequently, OHCA continues to be a major public health issue in Japan. The chain of survival has been emphasized as a way to improve the survival rate of OHCA [2-4]. In Japan, this chain includes four key components, with the final element being advanced life support (ALS). ALS involves

administering adrenaline [5], and it is crucial that the emergency life-saving technician (ELST) administers adrenaline promptly upon patient contact.

Recent studies have reported that administering adrenaline in cases of OHCA is linked to short- or medium-term outcomes, but it does not necessarily lead to favorable neurological outcomes [6-10]. Conversely, other research suggests that early administration of adrenaline may increase survival rates and enhance neurological outcomes [11-16]. Consequently, the Japan Resuscitation Council Guideline 2020 [17] strongly recommends the prompt administration of adrenaline, especially in OHCA cases with non-shockable rhythms. However, there are few studies focused on reducing the time between patient contact and adrenaline administration (adrenaline time) in OHCA scenarios [18].

The importance of team dynamics in managing time effectively during cardiac arrest treatment has been well-documented. However, in prehospital environments, simultaneous execution of procedures and transportation diminishes time awareness. Furthermore, the task of designating timekeepers and overseeing time management becomes difficult due to limited staff availability. Using a kitchen timer for time management is a common practice across various sectors, as it facilitates efficient time tracking with fewer personnel by utilizing alarms [19-22]. We hypothesized that setting a kitchen timer to go off every 2 minutes and regularly checking the rhythm would enable optimal time management and prevent treatment delays in OHCA cases. Consequently, to minimize the time until adrenaline administration by ELST, we explored the relationship between the use of a kitchen timer for time management and adrenaline timing in OHCA.

METHODS

Study design

This study utilized a before-and-after design and received approval from the Ethics Committee of Kokushikan University (Approval No. 22008). The emergency transport data employed in the research was supplied by the Ibaraki Seinan Fire Department for research purposes and was anonymized prior to provision. Informed consent was provided to the Emergency Medical Team (EMT) of the Ibaraki Seinan Fire Department for conducting this study. The study description and consent process were conducted via an online conference. Informed consent was not obtained from the patient because the data on patient prognosis were officially collected and did not contain any personally identifiable information, thereby protecting individual human rights.

Study setting

The Ibaraki Seinan Fire Department, the focus of this study, is situated in the westernmost part of Ibaraki Prefecture. It spans an area of approximately 31 km from east to west and 31 km from north to south, totaling 500.06 km^2. The department employs 197 emergency medical technicians and 73 ELSTs, and it operates 13 ambulances. Each EMT includes three emergency medical technicians, with at least one ELST on board. The Ibaraki Seinan Fire Department is part of the BANDO Medical Control Council (BANDO-MC), which is comprised of 14 core medical institutions and one emergency medical center in the region. Patients experiencing OHCA are transported to either a regional core medical institution or the emergency medical center, with one regional core medical institution located conveniently within a 20-minute radius.

The BANDO-MC ALS protocol for OHCA encompasses intravenous (IV) injection, adrenaline administration, and advanced airway management (AAM) featuring either supraglottic airway or endotracheal intubation (ETI). These procedures are directed by online medical instructions from the emergency department. Only ELSTs certified by Ibaraki MC are authorized to administer adrenaline and perform ETI. Certification for adrenaline administration is achieved through training and hospital practice. In contrast, ETI certification requires a minimum of 62 hours of training and 30 successful ETI cases in a medical setting, all under the supervision of an anesthesiologist.

The target patients for adrenaline administration included those experiencing OHCA who were estimated to be 8 years of age or older, regardless of whether an initial electrocardiogram (ECG) rhythm was present or if the event was witnessed. The indications for ETI encompass individuals suffering from OHCA who are estimated to be 15 years or older, cases of choking due to a foreign body, and situations where airway management is considered difficult, with the exception of ETI. The decision to proceed with ETI is made based on criteria determined by the EMT and subsequently evaluated and approved by the medical director as appropriate.

Study participants

The study encompassed cases of OHCA that occurred from May 2 to November 30 in both 2021 and 2022. The "before group" refers to the cohort prior to the initiation of the kitchen timer intervention, spanning from May 2 to November 30, 2021. Conversely, the "after group" consists of the cohort following the commencement of the kitchen timer intervention (May 2 to November 30, 2022).

Exclusion criteria were as follows: (1) age under 8 years old; (2) cases where resuscitation was not attempted; (3) return of spontaneous circulation (ROSC) before EMT arrival at the scene; (4) difficult airway management (cases with ETI performed or discontinued, choking or drowning); (5) incidents witnessed by an EMT; (6) cases for which only basic life support was ordered by a physician; (7) occurrences in a nursing home; (8) cases not suitable for IV administration; (9) instances where adrenaline was not administered before hospital arrival; and (10) cases where time management was not possible from the time of contact (in the after group).

Interventions

The Ibaraki Seinan Fire Department was informed of the study on May 2, 2022, and the intervention commenced shortly thereafter. The kitchen timer, set for 2 minutes, was intended to facilitate online medical direction for ALS by ensuring that a physician was contacted within 2 minutes of patient interaction. Our goal was to administer adrenaline within 10 minutes of patient contact. Since 2018, the Ibaraki Seinan Fire Department has been aiming to achieve this timeframe for adrenaline administration. The kitchen timer was the only tool used to manage the timing of adrenaline administration in cases of OHCA. Although the semi-automatic defibrillator employed by the emergency medical technicians features an alarm that sounds every 2 minutes, it does not have a repeat function. Consequently, a kitchen timer (model TD-415WH by Tanita) was utilized to prevent any alarms from being missed. Whenever the 2-minute alarm went off, the EMT immediately notified the ELST and managed the timing accordingly. No further detailed arrangements were implemented, nor were additional personnel recruited specifically for time management. The use of the kitchen timer for time management was communicated to the emergency medical technicians in advance, but no specific training was provided. Moreover, there were no changes made to the existing adrenaline administration protocol for OHCA.

Data collection and quality control

The database was populated using the NEFOAP Fire OA system from NEC, an emergency case management system that adheres to the Utstein Style. The data collected included: date, place, age, sex, whether the cardiac arrest was witnessed (yes/no), time of the witnessed cardiac arrest, type of bystander (family/healthcare provider), bystander cardiopulmonary resuscitation details (chest compression [yes/no], artificial ventilation [yes/no]), use of bystander automated external defibrillator (yes/no), dispatcher instructions (yes/no), initial ECG waveform, ALS details (defibrillation [yes/no], time of first defibrillation, adrenaline administration [yes/no], time of first adrenaline administration, AAM [yes/no], time of first AAM), and various time data (time the dispatcher received the emergency call, arrival time on scene, patient contact, start of cardiopulmonary resuscitation, hospital admission, and estimated time of cardiac arrest). Outcomes and prognoses were also collected, including ROSC, 1-month survival, cerebral performance category (CPC), and overall performance category. The CPC scale ranges as follows: CPC1 and CPC2 indicate moderate cerebral impairment; CPC3 indicates severe impairment; CPC4 indicates a coma or vegetative state; CPC5 indicates death. The CPC was assessed by the treating physician using data managed by the Ibaraki Seinan Fire Department.

Outcomes

The primary outcome measured was adrenaline administration time, while the secondary outcomes included the variance in adrenaline time and the rate of ROSC.

Statistical analysis

Continuous variables are presented as means (standard deviations), while nominal variables are shown as numbers (%). We employed multiple linear regression analysis to estimate the partial regression coefficient (B) and the 95% confidence interval (CI) for the relationship between the kitchen timer intervention and adrenaline administration time. The model included the following covariates: before/after group, age, sex, number of emergency medical technicians present, time taken to select a medical facility, presence of a mechanical chest compression device, and number of IV injections. The number of IV injections refers to the instances where the ELST attempted IV injections.

The variance inflation factor for each explanatory variable was less than 10, confirming the absence of multicollinearity. The coefficient of determination (R^2) was employed to assess the accuracy of the model. The variance in adrenaline time was compared using the F-test. For all analyses, a P-value of less than 0.05 (two-tailed) was considered statistically significant. Statistical analysis was conducted using JMP Pro version 15.0.0 (SAS Institute Inc.).

RESULTS

Extraction of patient data and characteristics

A total of 360 OHCAs occurred during the study periods, which spanned from May 2 to November 30 in both 2021 and 2022. Of these, 100 OHCAs were included in the analysis after excluding

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irrelevant items (Fig. 1).

Patient characteristics for the two groups are detailed in Table 1. Notably, the proportion of cardiac arrests witnessed was higher in the after group compared to the before group (30.6% vs. 19.6%, respectively). Additionally, the incidence of cardiogenic OHCA was greater in the after-intervention group than in the before-intervention group (81.6% vs. 49.0%). The percentage of initial ventricular fibrillation ECG findings was also higher in the after group compared to the before group (18.3% vs. 5.8%).

Association between the intervention and adrenaline time

The adrenaline time results are presented in Fig. 2. The mean (±standard deviation) adrenaline time was 803.2±371.2 seconds in the before group and 766.0±274.6 seconds in the after group. The results of the multiple linear regression analysis are shown in Table 2. The intervention did not lead to a significant difference (B, –27.1; 95% CI, –146.0 to 91.8; P=0.65).

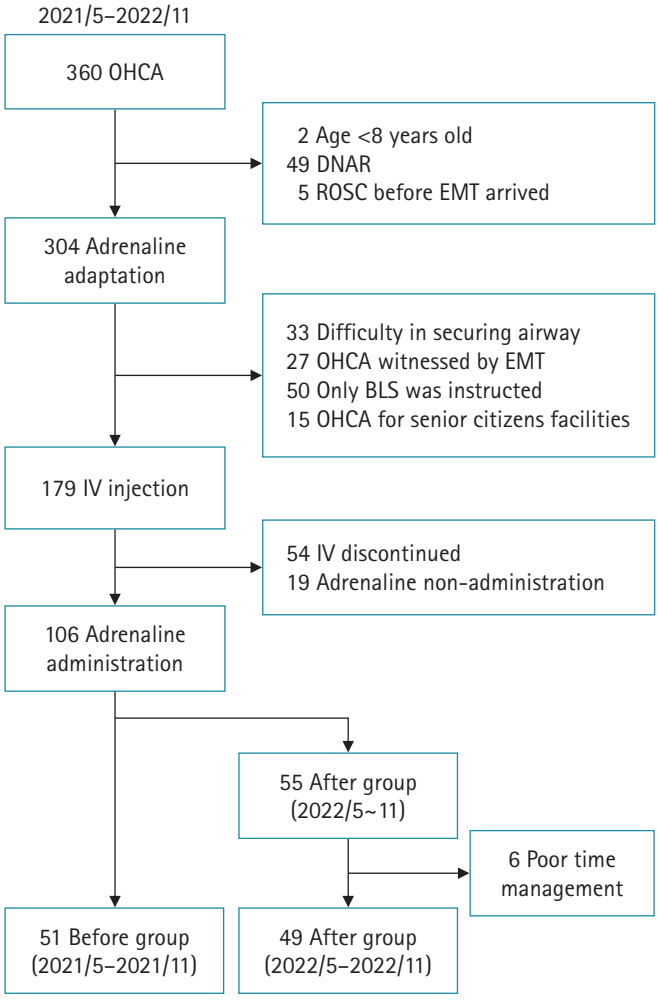


Fig. 1. Flowchart of patient inclusion. OHCA, out-of-hospital cardiac arrest; DNAR, do not attempt resuscitation; ROSC, return of spontaneous circulation; EMT, Emergency Medical Team; BLS, basic life support; IV, intravenous.

Table 1. Patient characteristics

Characteristic	Before group (n=51)	After group (n=49)
Age (yr)	72.3±17.1	71.4±14.0
Male sex	26 (50.9)	32 (65.3)
Witnessed cardiac arrest	10 (19.6)	15 (30.6)
Bystander chest compression	22 (43.1)	15 (30.6)
Bystander AED	0	1 (2.0)
No. of emergency medical technicians on board		
1	29 (56.8)	22 (44.9)
2	22 (43.2)	27 (55.1)
Cardiogenic	25 (49.0)	40 (81.6)
Initial ECG		
VF	3 (5.8)	9 (18.3)
PEA	13 (25.4)	12 (24.4)
Asystole	35 (68.6)	28 (57.1)
Defibrillation		
0	44 (86.2)	36 (73.4)
1	3 (5.8)	4 (8.1)
2–3	2 (3.9)	4 (8.1)
≥4	2 (3.9)	5 (10.2)
Airway device		
SGA	18 (35.2)	16 (32.6)
No. of IV injections		
1	36 (70.5)	38 (77.5)
Mechanical chest compression device	43 (84.3)	32 (65.3)
119 to arrival on scene (min)	9.2±3.1	9.5±3.0
Time spent on scene (min)	8.4±4.3	10.8±6.0
Hospital transport time (min)	14.9±8.1	15.8±8.2
Hospital contact time (min)	3.9±3.5	5.1±5.0
Time to first Defibrillation (min)	0.4±0.1	0.5±0.3
Time to SGA (min)	9.4±4.2	10.4±4.2

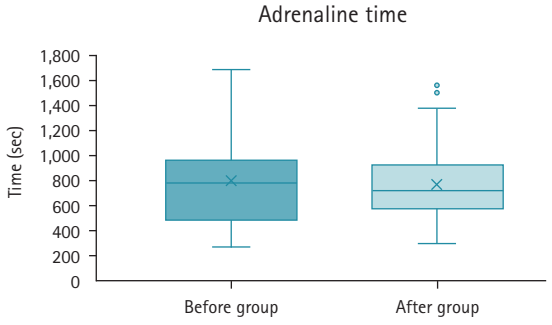
Values are presented as mean±standard deviation or number (%). The "Before group" refers to the study period from May 2 to November 30, 2021, and the "After group" refers to the research period from May 2 to November 30, 2022.
AED, automated external defibrillator; ECG, electrocardiogram; VF, ventricular fibrillation; PEA, pulseless electrical activity; SGA, supraglottic airway device; IV, intravenous; No. of IV injections, number of attempted IV injections; 119, emergency phone number of the fire department in Japan; Time spent on scene, on-scene arrival to on-scene departure; Hospital transport time, departure from the scene to arrival at the hospital; Hospital contact time, arrival on scene to hospital contact; Time to first defibrillation, time from patient contact to first defibrillation; Time to SGA, time from patient contact to SGA implementation.

Variance in adrenaline time

As shown in Fig. 2, the variance in adrenaline time was significantly smaller in the after group than in the before group (P=0.03).

ROSC rate

The results for the ROSC ratio and CPC1, 2 are presented in Table 3. The risk ratio for ROSC was 3.12 for the after group compared to the before group (P=0.15). Due to the small sample size, multivariate analysis was not conducted for ROSC. CPC1 and CPC2 were recorded as 0 in both groups.



	Mean±SD (sec)	P-value (F-test)
Before group	803.2±371.2	0.03
After group	766.0±274.6	

Fig. 2. Variance in adrenaline time. The "Before group" refers to the study period from May 2 to November 30, 2021, and the "After group" refers to the research period from May 2 to November 30, 2022. SD, standard deviation.

Table 2. Multiple linear regression analysis of adrenaline administration

	B	95% CI	β	P-value
Univariable analysis	−37.2	−167.2 to 92.7	−0.1	0.57
Multivariable analysis	−27.1	−146.0 to 91.8	−0.08	0.65

In this study, multiple liner regression analysis was performed on a total of 7 variables: a dummy variable for whether the patient belonged to before group or after group and 6 explanatory variables that may affect adrenaline time (age, sex, number of ELST on board, time required to select a medical facility, with or without mechanical chest compression device, number of intravenous injections). Multiple liner regression analysis was performed on the variables. The coefficient of determination (R^2) was R^2=0.35 to evaluate the accuracy of the model.
B, unstandardized partial regression coefficient; CI, confidence interval; β, standardized partial regression coefficient.

DISCUSSION

This study investigated the relationship between the use of kitchen timers for time management and the timing of adrenaline administration in OHCA patients. The results indicated no statistically significant correlation between the implementation of kitchen timers and adrenaline time.

The results of this study indicated that using a kitchen timer for time management did not significantly reduce adrenaline time, although there was a trend toward an average reduction of 27 seconds. Additionally, the variance in adrenaline time was smaller.

Hansen et al. [14] reported a 4% decrease in the odds ratio of ROSC for every minute delay between the 119 calls and the administration of adrenaline. Therefore, the trend of shorter adrenaline administration times observed across our entire EMT at the fire department could potentially enhance the ROSC rate. Since 2018, the Ibaraki Seinan department has aimed to administer adrenaline within 10 minutes. However, challenges in staff time management and a general lack of time awareness often prevented the emergency medical services (EMS) team from meeting this goal. To address this, the implementation of kitchen timers set to alarm every 2 minutes has enabled the EMS team to maintain awareness of time at the OHCA site without needing additional personnel to manage timing. Additionally, the timer's repeat function has helped reduce the incidence of missed alarms, contributing to the trend toward shorter adrenaline times. The OHCA scene is often cluttered with sounds from various devices, such as metronomes and alarms from semi-automatic defibrillators, which can distract the EMT from managing time effectively. The persistent ringing of the kitchen timer's repeat function, unless manually stopped, ensures that the entire EMT remains conscious of time. This heightened awareness has likely played a role in reducing adrenaline times by keeping the team consistently focused on time management. Although this may increase the burden on emergency medical technicians, who

Table 3. Return of spontaneous circulation rate

	No. (%)	Risk ratio	P-value
Before group	2 (3.9)	1.00	0.15
After group	6 (12.2)	3.12	

The "Before group" refers to the study period from May 2 to November 30, 2021, and the "After group" refers to the research period from May 2 to November 30, 2022.
Multivariate analysis was not performed for return of spontaneous circulation due to the small sample size.

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must actively stop the timer, the benefits of faster adrenaline administration outweigh this inconvenience. Moreover, fostering an awareness of time management across all emergency medical technicians may help bridge skill gaps between different teams or ELST members. Efforts to reduce adrenaline time and minimize variability require significant, coordinated training among emergency medical technicians. This study demonstrates a low-cost approach to time management using an inexpensive kitchen timer. Thus, the kitchen timer has proven to be an effective solution for addressing issues of manpower, missed alarms, and awareness of the passage of time.

In this study, despite using a kitchen timer to manage time, the average time to administer adrenaline was 766 seconds (12.7 minutes), which did not meet the target of administration within 10 minutes. The tasks performed by the EMT at the scene of OHCA events include providing basic life support, obtaining informed consent from the family, requesting online medical direction, transporting the patient, and following dispatcher instructions. To significantly reduce the adrenaline administration time, it is essential to review all these activities and clearly define the timing of adrenaline administration in the protocol. Additionally, using a kitchen timer helps participants remain aware of time constraints in the field and adhere to the protocol for early adrenaline administration. Moreover, although the location of the IV was not standardized in this study, reducing adrenaline time might be feasible if the IV tract is secured and adrenaline is administered on the scene, rather than during patient transport to the ambulance.

In summary, this study analyzed transport data from OHCAs at the Ibaraki Seinan Fire Department to assess adrenaline administration times before and after implementing time management with a kitchen timer. The findings showed an average reduction of 27 seconds in adrenaline time attributed to the use of a kitchen timer and time management techniques, although this reduction was not statistically significant. Future research should investigate whether adrenaline time can be further improved by incorporating team dynamics with clearly defined roles and effective time management strategies.

This study had several limitations. First, the observed shortening of adrenaline administration time could be attributed to the Hawthorne effect [23,24]. Second, there may be residual, unmeasured confounders, such as the location of the IV. Third, the reduction in adrenaline time might have occurred independently of the intervention, as time-series trends were not accounted for. Fourth, the sample size may have been inadequate, given that the trial was conducted in a single fire department.

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CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

AUTHORS' CONTRIBUTIONS

Conceptualization, Data curation, Formal analysis, Investigation, Methodology: NN. Project administration: NN, HU. Software: NN. Supervision: KN, HU, KH, HT. Visualization: NN. Writing-original draft: NN, KN. Writing-review & editing: KN, HU, KH, HT. All authors have read and agreed to the published version of the manuscript.

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