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The effects of cardiac arrest recognition by dispatcher on Smart Advanced Life Support

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Abstract

Objectives: The purpose of this study was to analyze the effect of cardiac arrest recognition by emergency medical dispatch on the pre-hospital advanced cardiac life support and to investigate the outcome of out-of-hospital cardiac arrest.

Method: This study was conducted to evaluate the out-of-hospital cardiac arrest patients over 18 years of age, excluding trauma and poisoning patients, from 1 August 2015 to 31 July 2016. We investigated whether it was a cardiac-arrest recognition at dispatch. We compared the pre-hospital return of spontaneous circulation, the rate of survival admission and discharge, good neurological outcome, and also analyzed the time of securing vein, time of first epinephrine administration, and arrival time of paramedics.

Results: A total of 3695 out-of-hospital cardiac arrest patients occurred during the study period, and 1468 patients were included in the study. Resuscitation rate by caller was significantly higher in the recognition group. The arrival interval between the first and second emergency service unit was shorter as 5.1 min on average, and the connection rate of paramedics and physicians before the arrival was 32.3%, which was significantly higher than that of the unrecognized group. The mean time required to first epinephrine administration was 13.1 min, which was significantly faster in the recognition group. However, there was no statistically significant difference between the two groups in patients with good neurological outcome, and rather the rate of return of spontaneous circulation and survival discharge was significantly higher in the non-recognition group.

Conclusion: Although the recognition of cardiac arrest at dispatch does not directly affect survival rate and good neurological outcome, the activation of pre-hospital advanced cardiac life support and the shortening the time of epinephrine administration can increase pre-hospital return of spontaneous circulation. Therefore, effort to increase recognition by dispatcher is needed.

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Out-of-hospital cardiac arrest, advanced cardiac life support, emergency medical dispatch

Introduction

The survival and return of spontaneous circulation (ROSC) rate of out-of-hospital cardiac arrest (OHCA) patients is increasing daily, but the number of survivors is still low and there have been numerous studies to find a solution for this. Among them, it is seen that the faster the ROSC is the higher the chances of good neurological outcome[1] and for this, it was considered to be more advantageous to make a pre-hospital ROSC. But given the procedure in Korea for OHCA, only basic life support (BLS) is given at the site within 5 min and then transported to the hospital so it is difficult to expect circulation recovery before arriving at a hospital. A "Smart Advanced Life Support" (SALS) pilot project was introduced to some areas on a trial basis; where in the event of a cardiac arrest, the nearest two units of emergency medical services (EMS) are dispatched, and through the visual directions of an emergency specialist, the paramedics will use the manual defibrillator, administer drugs, and perform advanced life support.

Our researchers thought it is important that, in this research, the recognition of cardiac arrest by dispatcher be the first step in vitalizing the "SALS" pilot project. In previous studies, resuscitation by the caller under the direction of the dispatcher increased survival, and recognition of cardiac arrest by dispatcher affected and shortened the time to delivery of first chest compression.[2,3] Based on this positive research results, it was the aim of this study to smoothen the carrying out of future SALS project and further more contribute to the ROSC and survival of OHCA.

Method

Study patients and methods

This study is a retrospective cohort study of OHCA occurring in the seven areas where the SALS pilot project took place between 1 August 2015 and 31 July 2016. The seven areas are cities which have an average population of 1,000,000 to 1,300,000 and with the average of one OHCA per day. Non-trauma cardiac arrest patients who were at the age of 18 and above were only considered. Cardiac arrest patients due to trauma, addiction, pregnancy, do not attempt resuscitation (DNAR), and patients whose cardiopulmonary resuscitations (CPRs) were put off due to definite death were excluded from this study. Also, even if they qualified for the pilot project, if the patients' family did not agree on SALS pilot project and wanted the patient transported to a hospital quickly, BLS was given as per standard procedure, and was excluded from the study.

For this study, paramedics notified the family or guardian that the patient was in cardiac arrest when arriving on site, performed immediate BLS, and SALS pilot project was carried out only when they agreed orally. The patient record written and medical records by the paramedics and attending emergency physicians were retrospectively analyzed and were therefore exempted from the process of attaining patient agreement form. This study was carried after the Institutional Review Board approval from the Research Ethics Committee of the Catholic St. Vincent Hospital.

Data collection

The qualifying patients were sorted according to whether the cardiac arrest was recognized by the control center at the time of dispatch, and records from the paramedics and attending emergency physicians were analyzed to collect basic information, including patient's age, gender, site of cardiac arrest, whether the cardiac arrest was witnessed, whether resuscitation was conducted, and the initial rhythm. Cardiac arrest by dispatcher was defined as when they assumed that it was a cardiac arrest from the immediate time they received the call and ordered mobilization to the paramedic. The factors that were considered to compare the SALS process of each group include the following: the time taken to contact the patient from the time of report, time difference between the site arrival of the first and second units, success rate of inserting advanced respiratory device, success rate and time taken to secure the vein, and time taken until the first dose of epinephrine was administered. In addition, the ROSC rate before arriving at the hospital, total ROSC rate, survival admission rate, and survival discharge rate were analyzed comparatively. The ratio of patients with good neurological outcome at the time of discharge was also researched, as well as a comparison of the SALS process and patient's prognosis according to whether the vein was secured.

Statistical analysis

Statistical analysis was performed using SPSS version 18.0 for Windows (SPSS Inc., Chicago, Illinois, USA). Nominal variables were expressed as counts and percentages of total numbers. Continuous variables were expressed using mean and standard deviation. Chi-square test or Fisher's exact test was used for comparison of the two groups. Independent sample *t*-test was used for continuous data and Mann–Whitney *U* test for non-normal distribution. The statistical significance was judged to be the case when the p value was less than 0.05.

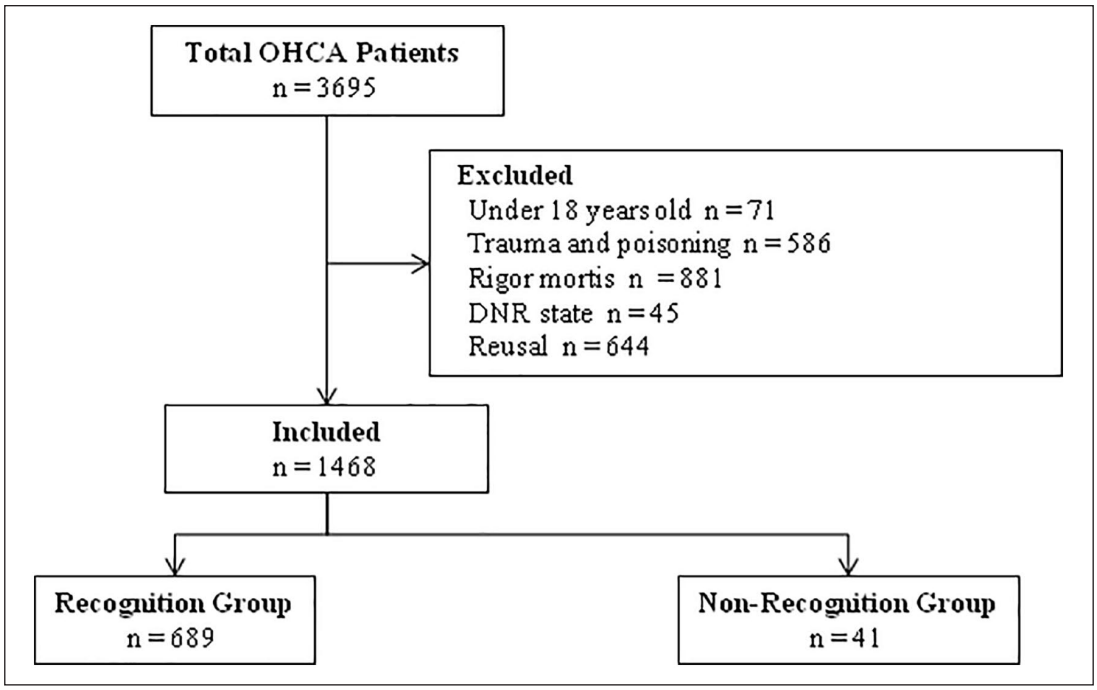

Figure 1. Flow chart of inclusion and exclusion.
OHCA: out-of-hospital cardiac arrest; DNR: do not resuscitation.

Table 1. General characteristics of patients in the recognition and non-recognition group.

	Recognition group N = 844 (57.5%)	Non-recognition group N = 624 (42.5%)	p
Demographic features			
Age, mean ± SD	68.6 ± 15.3	66.2 ± 15.4	0.003
Man (%)	570 (67.5%)	440 (70.5%)	0.246
Incidence location			<0.001
Public place	122 (14.5%)	146 (23.4%)	
Home	635 (75.2%)	414 (66.3%)	
Nursing facility	82 (9.7%)	51 (8.2%)	
Ambulance	0 (0.0%)	7 (1.1%)	
Other	5 (0.6%)	6 (1.0%)	
Resuscitation by caller	694 (82.2%)	331 (53.0%)	<0.001
Witness	387 (45.9%)	328 (52.6%)	0.013
Shockable rhythm	161 (19.1%)	143 (22.9%)	0.084

SD: standard deviation.

Result

There were a total of 3695 OHCAs during the study period. Among them, 1468 were included in the study with the criteria (Figure 1). Those whose cardiac arrest was recognized numbered 844, and those whose cardiac arrest was not recognized numbered 624; the average age were 68 ± 15.3 years and 66.2 ± 15.4 years accordingly. Patients in the recognition group were older, and the percentage of men were 67.5% (570) in the recognition group and 70.5% (440) in the non-recognition group (Table 1). The incidence of OHCAs was higher in the order of home, public place, and nursing facility in both groups. The incidence of home as 73.5% was significantly higher in the recognition group than the other group ($p < 0.001$). Performance of CPR by caller and witnessing of cardiac arrest was higher in the recognition group by 694 (82.2%) as compared to 387 (45.9%) in the other group, but the ratio of initial shockable rhythm did not show a significant difference in both groups (Table 1).

In the process of SALS pilot project according to recognition of cardiac arrest at dispatch, the contact time for

Table 2. Comparison of smart Advanced Life Support process.

	Recognition group N = 844	Non-recognition group N = 624	p
Patient contact time after calling (minute, mean ± SD)	7.5 ± 3.1	8.5 ± 3.8	<0.001
Arrival rate of second unit (%)	99.6% (828)	98.4% (605)	0.025
Interval of first–second unit (minute, mean ± SD)	5.1 ± 6.9	8.9 ± 7.2	<0.001
Connection to physician before arrival	274 (32.5%)	94 (15.1%)	<0.001
Advanced airway (I-gel or LMA)	818 (96.9%)	584 (93.6%)	0.004
Success of securing vein	618 (75.8%)	469 (79.6%)	0.016
Time to securing vein (minute, mean ± SD)	9.7 ± 4.8	13.1 ± 6.2	<0.001
Time to first epinephrine administration (minute, mean ± SD)	13.1 ± 6.0	16.3 ± 7.2	<0.001

SD: standard deviation; LMA: laryngeal mask airway.

Table 3. Comparison of outcome due to securing vein.

	Success of securing vein N = 1087	Fail of securing vein N = 381	p
Pre-hospital ROSC	263 (24.2%)	24 (7.6%)	<0.001
Total ROSC	340 (31.3%)	64 (20.2%)	<0.001
Survival admission	207 (19.0%)	40 (12.6%)	0.01
Survival discharge	95 (8.7%)	20 (6.3%)	0.203
Good neurological outcome (CPC 1, 2)	65 (6.0%)	12 (3.8%)	0.171

ROSC: return of spontaneous circulation; CPC: cerebral performance category.

Table 4. Comparison of outcome of Smart Advanced Life Support.

	Recognition group N = 844	Non-recognition group N = 624	p
Pre-hospital ROSC	153 (18.1%)	161 (25.8%)	0.001
Total ROSC	214 (25.4%)	220 (35.3%)	<0.001
Survival admission	136 (16.1%)	138 (22.1%)	0.004
Survival discharge	65 (7.7%)	72 (11.5%)	0.016
Good neurological outcome (CPC 1, 2)	49 (5.8%)	48 (7.7%)	0.183

ROSC: return of spontaneous circulation; CPC: cerebral performance category.

those whose cardiac arrest was recognized was 7.5 ± 3.1 min, and interval between the arrival of first and second emergency service unit was 5.1 ± 6.9 min which is significantly shorter ($p < 0.001$). The rate of connection for paramedic and attending emergency physician did not show a significant difference in both groups, but the connection rate before arriving on site showed a significant difference of 32.5%; the group where cardiac arrest is recognized as compared to the other showing a higher rate. The success rate of securing vein did not show a significant difference in both groups but the time of securing vein was meaningfully short, 9.7 ± 4.8 min, and the first dose of epinephrine administered was 13.1 ± 6.0 min, which is also significantly short (Table 2) ($p < 0.001$). In addition, the result of OHCAs based on securing vein was, for the successful group the rate of pre-hospital ROSC and survival admission rate was 24.2% ($p < 0.001$) and 19.0% ($p = 0.01$) respectively, being significantly high, but in terms of survival discharge rate and good neurological outcome, it did not show a significant difference (Table 3).

In terms of comparing the results of OHCA depending on the recognition of cardiac arrest, the number of pre-hospital ROSC was more in the non-recognition by 161 (25.8%). Also, survival admission rate and survival discharge rate were higher as compared to those in the recognition group ($p < 0.05$) (Table 4). However, good neurological outcome was not significantly different between the two groups.

Discussion

There have been various studies to increase the survival rate of OHCAs and the recovery of brain function. In 2015, the American Heart Association emphasized the rapid recognition of cardiac arrest and the activation of emergency medical systems as the first ring of the chain of survival.[4] Also, other researchers reported that the performance of

CPR by caller helps in the survival of patients, and such performance of CPR's effect is increased when done under the direction of dispatcher, and ultimately results in the increase of survival rate of OHCAs.[2,3,5] Then, it is reported that the failure to recognize cardiac arrest in its early stages is one of the factors that lowers the survival rate, so efforts to recognize cardiac arrest is needed.[6]

But, as shown in our study, cardiac arrest was recognized in a little more than half of the patients, and there were a lot of cases where a cardiac arrest was witnessed but dispatcher was not able to recognize it. There are several different factors that hinder the correct recognition of cardiac arrest by dispatcher, but the most prominent factor is thought to be the imprecise evaluation of the patient made by the caller. There have been existing studies that report professional physicians who were not able to correctly recognize cardiac arrests in agonal breathing patients, emphasizing the necessity of education and training.[7] In the general population, it is even more difficult to distinguish between agonal and normal breathing, so that despite the resuscitation instructions for the dispatcher, the rate of CPR performance by caller was found to be lower.[8] Although CPR is at the discretion of the caller, or instructed by the dispatched paramedic who recognized a cardiac arrest, the results of this study found that the rate of CPR performance by caller was very high in the recognition group, and due to the fact that there is a significant difference with the unrecognized group, the recognition of cardiac arrest by the dispatch was thought to be of great importance.

Another factor that interferes with the recognition of cardiac arrest is the unique emergency call system in Korea. In our country, the initial respondents and medical consulting respondents are separated. When a call is placed, the initial respondent identifies the condition and location of patient, then dispatches an ambulance, then ends the call. Although they are notified of the patients' major conditions, it is dependent on the information given by the caller; so unless cardiac arrest is clearly mentioned by the caller, it is difficult to connect such calls to medical consulting respondents. Therefore, in this emergency call system, seizure, loss of consciousness, abnormal breathing, and so on are considered as cardiac arrest, and then paramedics are activated by dispatcher and must be connected to medical consulting respondents.

Various studies have been done to solve the above mentioned issues and increase the recognition of cardiac arrest. In one study, it was reported that by asking the caller three questions including chief complain, presence of consciousness, and normal breathing increased the recognition rate of cardiac arrest.[9] Dispatch may be able to recognize cardiac arrest on the phone, but it is not possible in every situation. Therefore, there is a need to prepare for different situations, and mentioned the need for much training to identify agonal respiration, and for not asking unnecessary questions to shorten the time until cardiac arrest recognition and first chest compression.[3] Jensen et al.[10] analyzed the factors that hinder the recognition of agonal respiration and cardiac arrest over the phone, and recommended the use of guidelines to overcome these issues. Vaillancourt et al.[11] analyzed calls which reported deteriorated consciousness, and advised the use of existing guidelines by dispatch to assess cardiac arrest and order CPR since the assessment of cardiac arrest and application of appropriate CPR by dispatch over the phone showed high sensitivity and low specificity. At present, Korea is implementing medical guidance through a common guideline, and we think it is necessary to simplify this process except for unnecessary questions and to train the respondent to prepare the previously mentioned symptoms similar to cardiac arrest.

Although epinephrine in CPR is a major drug, it has been controversial to administer epinephrine in pre-hospital stages. Some researchers reported that administering epinephrine to OHCA increases circulation recovery rate in short term, but does not aid in the survival discharge and good neurological outcome, and may even harm the patient.[12,13] On the contrary, Ewy et al.[14] reported that early administration of epinephrine by paramedics increased survival discharge rate; delayed administering dramatically dropped survival discharge rate, especially in shockable rhythm. In another studies, epinephrine administered by the paramedics in pre-hospital stage had a positive effect on better neurological outcome for a long time in pulseless electrical activity (PEA) rhythm, and the use of epinephrine for OHCA with non-ventricular fibrillation (non-VF) affected good prognosis.[15,16] In our study, the rate of shockable rhythm as initial cardiac arrest rhythm was almost the same in the both groups, a comparison based on the rhythm was not done, but the vein was secured much faster and the time of first epinephrine administration was significantly faster in the recognition group. In further comparison, the group which was successfully in securing vein did not show a significant increase of survival discharge rate and good neurological outcome, but did positively affect ROSC and survival admission rate. In addition, we thought that it is necessary to compare the initial cardiac arrest rhythm (shockable or non-shockable) in future.

Unfortunately, the group of recognized cardiac arrest did not display better neurological outcome. Instead, the unrecognized group was found to have more patients with pre-hospital ROSC and higher survival discharge rate. Additional analysis is necessary as the final result of the patient depends not only on whether the dispatcher recognized the cardiac arrest, but also on several factors like the quality of advanced life support, hospital treatment after cardiac arrest, and so on. Therefore, all patients with pre-hospital ROSC should be transferred to a hospital they can be treated in after resuscitation, if possible. Nevertheless, in cases like Korea where the emergency units arrive on site within a relatively short period of time, if pre-hospital ROSC can be improved through prompt administration of

medication and resuscitation in the pre-hospital stage through SALS activation, the increase in recognition of cardiac arrest by dispatcher will ultimately increase good neurological outcome.

Limitations

Our study has several limitations:

1. We were not able to analyze recordings in dispatch in the initial responding stages, so we divided the group into two groups—those whose cardiac arrest was recognized and those whose were not recognized only based on paramedics' records. So, the exact time of the patient's cardiac arrest could not be known, and the time to recovery could be inaccurate. Some patients who were actually undergoing cardiac arrest have a slight chance that their cardiac arrest were not recognized during the report or while being dispatched, and these patients could have shown better results because the duration of arrest was relatively short, and not being able to recognize such cardiac arrest patients is believed to have affected the result.
2. In the case of survival discharge and good neurological outcome, it is known that treatment method for patients with ROSC is important, but the study took place in various areas and not all patients were transported to the same hospital so there is a chance that resuscitation treatment after cardiac arrest could differ and this is also considered a limitation of the study.
3. We were unable to view the medical record of every patients, and it was difficult to keep track of their medical history if they were transferred without a guardian or to a new hospital. Not being able to correctly standardize the two group may have also affected our results.

Conclusion

Recognition of cardiac arrest in dispatch does not affect good neurological outcome directly. However, the activation of Smart Advanced Life Support pilot project, securing vein in a short time, and shortening the time of epinephrine administration can increase pre-hospital ROSC, and therefore effort to increase recognition by dispatch is needed.

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References

1. Shinada T, Hata N, Kobayashi N, et al. Efficacy of therapeutic hypothermia for neurological salvage in patients with cardiogenic sudden cardiac arrest: the importance of prehospital return of spontaneous circulation. *J Nippon Med Sch* 2013; 80(4): 287–295.
2. Rea TD, Eisenberg MS, Culley L, et al. Dispatcher-assisted cardiopulmonary resuscitation and survival in cardiac arrest. *Circulation* 2001; 104: 2513–2516.
3. Lewis M, Stubbs BA and Eisenberg MS. Dispatcher-assisted cardiopulmonary resuscitation: time to identify cardiac arrest and deliver chest compression instructions. *Circulation* 2013; 128(14): 1522–1530.
4. Kronick SL, Kurz MC, Lin S, et al. Part 4: system of care continuous quality improvement: 2015 American Heart Association Guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation* 2015; 132: S397–S413.
5. Hauff SR, Rea TD, Culley LL, et al. Factors impeding dispatcher-assisted telephone cardiopulmonary resuscitation. *Ann Emerg Med* 2003; 42(6): 731–737.
6. Sasson C, Rogers MAM, Dahl J, et al. Predictors of survival from out-of-hospital cardiac arrest: a systematic review and meta-analysis. *Circ Cardiovasc Qual Outcomes* 2010; 3: 63–81.
7. Smereka J, Szarpak Ł, Czyzewski Ł, et al. Are physicians able to recognition ineffective (agonal) breathing as element of cardiac arrest? *Am J Emerg Med* 2016; 34(6): 1165.
8. Fukushima H, Imanishi M, Iwami T, et al. Abnormal breathing of sudden cardiac arrest victims described by laypersons and its association with emergency medical service dispatcher-assisted cardiopulmonary resuscitation instruction. *Emerg Med J* 2015; 32(4): 314–317.
9. Nurmi J, Pettilä V, Biber B, et al. Effect of protocol compliance to cardiac arrest identification by emergency medical dispatchers. *Resuscitation* 2006; 70(3): 463–469.
10. Jensen JL, Vaillancourt C, Tweedle J, et al. Factors associated with the successful recognition of abnormal breathing and cardiac arrest by ambulance communications officers: a qualitative iterative survey. *Prehosp Emerg Care* 2012; 16(4): 443–450.
11. Vaillancourt C, Charette M, Kasaboski A, et al. Cardiac arrest diagnostic accuracy of 9-1-1 dispatchers: a prospective multi-center study. *Resuscitation* 2015; 90: 116–120.
12. Shao H and Li CS. Epinephrine in out-of-hospital cardiac arrest: helpful or harmful? *Chin Med J* 2017; 130: 2112–2116.

13. Hagihara A, Hasegawa M, Abe T, et al. Prehospital epinephrine use and survival among patients with out-of-hospital cardiac arrest. *JAMA* 2012; 307: 1161–1168.
14. Ewy GA, Bobrow BJ, Chikani V, et al. The time dependent association of adrenaline administration and survival from out-of-hospital cardiac arrest. *Resuscitation* 2015; 96: 180–185.
15. Tomio J, Nakahara S, Takahashi H, et al. Effectiveness of prehospital epinephrine administration in improving long-term outcomes of witnessed out-of-hospital cardiac arrest patients with initial non-shockable rhythms. *Prehosp Emerg Care* 2017; 21(4): 432–441.
16. Fujii T, Kitamura T, Kajino K, et al. Prehospital intravenous access for survival from out-of-hospital cardiac arrest: propensity score matched analyses from a population-based cohort study in Osaka, Japan. *BMJ Open* 2017; 7: e015055.