Characteristics and Risk Factors of Out-of-Hospital Cardiac Arrest Within 72 Hours After Discharge

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Abstract: *Objective:* To determine the characteristics and risk factors for patients who developed out-of-hospital cardiac arrest (OHCA) within 72 hours after emergency department (ED) discharge. *Methods:* A nested case-control study (1:4 ratio) was conducted in 5 EDs from January 2002 to December 2011. The study group consisted of adults experiencing nontraumatic OHCA who revisited ED within 72 hours after discharge. Patients matched in sex, age group and chief complaints were selected for the control group. Demographic data, discharge diagnosis, discharge vital signs and laboratory result were collected. Etiologies of cardiac arrest and whether the events were expected or related to the 1st ED visit were reviewed. *Results:* In all, 1,657,870 patients were discharged during the study period; 109 developed OHCA within 72 hours of ED discharge (6.6/100,000 per year). The mean age was 64.7 years and 67.9% were men. After comparison with the control group, a higher heart rate (88.5 ± 18.23 versus 81.7 ± 15.93 beat per minutes, P = 0.003) and higher serum creatinine level (2.2 ± 2.30 versus 1.4 ± 1.38 mg/dL, P = 0.002) remain the statistical significant characteristics of study group by conditional logistic regression. Approximately 60% events were expected or unrelated to the 1st ED visit. Among patients whose OHCA were unexpected and related to the 1st ED visit, 71.4% had a cardiac cause. Of these, 20% had chest pain, but 40% had angina-equivalent symptoms during 1st presentation. *Conclusions:* A higher discharge heart rate and higher creatinine level are risk factors in these patients.

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Identifying high-risk patients who may develop unexpected complications and clarifying risk factors for those complications to prevent adverse events is a critical aspect of patient safety. The unscheduled 72-hour emergency department (ED) revisit was thought to be an unsatisfactory outcome and has been widely reviewed since the 1980s.[1,2]

The overall mortality of patients who revisit within 72 hours has been reported to be less than 1%,[3] so a more refined high-risk subgroup may be more appropriate as a quality indicator.[4,5] Patients who revisited the ED within 72 hours and were admitted to hospital[5,6] or intensive care unit[7] were reviewed, but patients developing out-of-hospital cardiac arrest (OHCA) within 72 hours after ED discharge have never been reported to the authors' knowledge. Early death after ED discharge is rare but always of critical concern to emergency physicians (EPs) owing to high mortality and morbidity, although resuscitations have been improving for decades. Among patients who developed an OHCA and sent to ED by ambulance with prehospital treatment, the survival to hospital discharge rate was still as low as 9.6% in the United States[8] and 6.9% in Taiwan.[9] Possible medical-legal consequences and patient safety concerns make it crucial to further investigate these high-risk patients.

Death within 7 days after ED discharge have been reported at rates of 13 to 75 deaths per 100,000 ED discharges[10–13] and up to 208.5 deaths per 100,000 ED discharges within 8 days in an Iceland study.[14] However, most studies were either single-institution studies[10,14] or limited by a relatively short-term study period up to 2 years.[11,12] A 5-year population-based study in Ontario[13] focused on the association between waiting times and left-without-being-seen and 7-day mortality after ED departure rather than analysis of this high-risk group. Furthermore, studies conducted in western countries may not be applicable to Asian populations because of differences in health care systems and ethnicity. Most importantly, the frequently used 30-day mortality or 7-day mortality in previous studies might be too long to reasonably identify risk factors during ED discharge to predict any complications.

Although the 72-hour might not be the best time frame for the quality measures of mortality, 72-hour revisit was still the most commonly used quality indicator for ED regular monitoring. Among 72-hour return visit patients, those who return after an OHCA represent the sickest cohort and are warrant further study. This 10-year multiple-institution study focused on patients who developed OHCA and revisited an ED within 72 hours of previous ED discharge. The objectives of this study were (1) to determine patient characteristics and outcomes and (2) to identify possible risk factors to prevent avoidable revisits and potential medical adverse events.

MATERIALS AND METHODS

Study Design and Setting

This 10-year retrospective case-control study was conducted in 5 EDs in Taiwan from January 1, 2002, to December 31, 2011. The 5 EDs were all branches of the same health care system and were geographically well dispersed nationwide. Two EDs were tertiary referral medical centers with over 3,500 and 2,500 beds. The other 3 were secondary regional hospitals with over 1,200, 1,000 and 250 beds each. Besides the smallest

ED, the other 4 EDs were the largest in their counties. The cumulative mean annual ED visits in the 5 EDs were over 480,000 per year, and the annual health insurance claim cost of the studied hospitals accounts for 8% to 10% of the national health budget according to government statistics.

Participant Selection

Adult patients aged >18 years who revisited an ED within 72 hours of previous ED discharge and developed a nontraumatic OHCA were included. Patients whose initial ED visit was for trauma were included if there was no new traumatic event. Patients discharged against medical advice (AMA) at the 1st ED visit were excluded because these patients would be admitted if they agree. It would be unreasonable if these patients indicated for admission were included in the study group. To further investigate the characteristics and risk factors for patients with 72-hour revisit OHCA, matched control groups were used for comparison. In previous studies, increasing age and male sex were strongly predictive of early death after discharge,[12,14] so age and gender were matched during the selection of control group in the 1st place. Besides, because it is unreasonable to compare characteristics between patients with chest pain and ankle sprain even when adjusting for age and sex, the chief complaint was also matched during control group selection to enhance clinical relevance.

For the selection of the control group, the cohort of age- and sex-matched patients who were treated by the same EP and discharged from ED in the same month was extracted from the electronic ED administrative database. Coauthors reviewed the electronic chart of the age- and sex-matched cohort and collected the patients with similar chief complaints. The number of control group was set as 4 times of study group so the 1st 4 patients collected were selected as control group. Eventually, the matched group consisted of patients of the same sex, similar age (±5 year old) and similar chief complaint discharged during the same month.

Measurements and Outcomes

After extracting patient lists, medical records were reviewed including ED visit logs, nursing record and laboratory and radiology reports. Documented variables included patient demographics, triage level, vital signs at discharge, chief complaints, do-not-resuscitation (DNR) status and patient outcome. Whether patients underwent laboratory tests (any complete blood count, biochemistry study or urinary analysis), electrocardiogram (ECG), radiography or computed tomography scan were also documented. Basic laboratory test results, including hemoglobin (Hb), creatinine (Cr) and glucose, were recorded. Major underlying diseases documented included hypertension (HTN), diabetes mellitus (DM), coronary artery disease (CAD), cerebral vascular disease, chronic lung diseases (chronic obstructive pulmonary disease [COPD] and asthma), cirrhosis and any hematologic or solid organ malignancy.

The OHCA were categorized by whether the event of cardiac arrest was expected and whether the event of cardiac arrest was related to the 1st ED visit as in previous studies.[10,11] Expected OHCA were those in which a clear pathological process had been identified and was terminal and untreatable with death likely to result in a short time. Diseases included were terminal-stage malignancy (eg, metastatic lung cancer) and bedridden status due to chronic neurological problems (eg, parkinsonism or amyotrophic lateral sclerosis). Related OHCA were those in which a clear connection existed between the 1st ED visit and the cause of death (eg, a patient who visited ED for

abdominal and radiating back pain and revisited with OHCA due to dissection).

To determine the etiology of the cardiac arrest, 2 experienced EPs independently selected one of the following possible causes: cardiac, respiratory, cerebral, metabolic, sepsis, exsanguinations, hypothermia, drug overdose or other[15]; trauma and near drowning were not included in the study. Respiratory causes included respiratory failure, pulmonary embolism, upper airway obstruction, chronic lung disease and pneumonia. Cerebral causes included ischemia or hemorrhagic cerebrovascular accident. Nontraumatic exsanguinations included tumor bleeding, gastrointestinal bleeding and ruptured aortic aneurysm or dissection. Terminal cancer, electrolyte imbalance, chronic renal disease, acidosis and DM-related complications were categorized as metabolic causes. Reviewers also consulted the initial treating EPs, if available, to clarify details and possible aetiologies. If opinions were inconsistent, the 3rd experienced EP would be consulted, and a final decision made after group discussion.

Analyses

Descriptive analyses of independent variables are reported as percentages and means ± SD values. Factors that may be associated with cardiac arrest were analyzed using the χ^2 test, Fisher's exact test and Student's t test. All statistical analyses were performed using SPSS statistical software (SPSS for Windows, version 14; SPSS, Inc, Chicago, IL). All P values were 2-tailed, and a value of <0.05 was considered to be statistically significant. Variables with a P value of <0.05 on univariate analysis were included in the multivariable model using conditional logistic regression and odd ratio, as well as 95% confidence interval were calculated. The study protocol was approved by the Institutional Review Boards at the studied hospitals.

RESULTS

There were 4,887,538 ED visits and 2,760,811 (56.5%) adult nontraumatic patients during the study period, with 110,975 patients discharged AMA or transferred to other hospitals and 1,657,870 patients discharged by duty EPs. In total, 162 patients developed nontraumatic OHCA within 72 hours after ED discharge, and 109 patients were finally enrolled after excluding 53 patients who were discharged AMA in the 1st ED visit. Of the 53 AMA patients, 31 cases (58.5%) had signed DNR. Some patients who had chronic illness and signed DNR tend to refuse admission for further treatment even the admission was indicated. Thus, the patients who signed DNR consent were all coincidentally discharged AMA in the 1st ED visit. The overall rate of 72-hour revisit OHCA was 6.6 deaths per 100,000 ED discharges.

Patient characteristics and chief complaint in the 1st ED visit are presented in Table 1. The initial chief complaints were widely dispersed, and most patients (35.8%) visited ED due to nonspecific general medical symptoms including dizziness, myalgia, anorexia, malaise and general weakness. In total, patients with chest pain (5.5%) or dyspnea (6.4%) accounted for approximately 12% of study group. More than half the patients underwent ≥1 laboratory test or radiological exam in ED. Patients developed OHCA and returned to ED in a relatively short time with mean return interval 28.8 hours. After resuscitation, 23 (21.1%) patients developed return of spontaneous circulation, but only 5 (4.6%) survived to discharge.

Comparisons of characteristics between study and matched control groups by univariate analysis were shown in