CAUSE ANALYSIS OF NON-TRAUMATIC OUT-OF-HOSPITAL CARDIAC ARREST IN THE ELDERLY

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SUMMARY

Background: There have been many studies of the resuscitation of non-traumatic out-of-hospital cardiac arrest (NTOHCA) in elderly patients; however, these have tended to focus on the outcomes and predictors of survival rather than on the causes. The purpose of this study was to investigate the leading causes of NTOHCA in the elderly.

Methods: This was a retrospective study of 330 patients admitted to the emergency department (ED) of Mackay Memorial Hospital in Taipei between January 1 and December 31, 2005 because of NTOHCA. Of the 330 NTOHCA patients, 31 were excluded because resuscitation in the ED was discontinued. Of the remaining 299, 198 were elderly patients aged over 65 years and 101 patients ranged in age from 18–64 years. The causes of NTOHCA were divided into eleven categories, including malignant neoplasm, neurologic disease, cardiovascular disease, diabetes mellitus, pulmonary disease, gastrointestinal system disease, renal and urinary system disease, sepsis, electrolyte imbalance, unknown causes, and other causes. Patients were defined as survivors if they survived to hospital discharge.

Results: The overall survival rate of study participants was 7.4%. The survival rate was 6.1% for the elderly group and 9.9% for the younger group. There was no significant difference between the elderly and adult groups ($p = 0.229$). The first three leading causes of NTOHCA in the study were cardiovascular disease, unknown origin, and pulmonary disease. Comparing the elderly group and the adult group, elderly patients had significant more pulmonary causes of NTOHCA (17.7% vs. 7.9%; $p = 0.008$) and a larger proportion of NTOHCA with more than one cause (34.3% vs. 18.8%; $p = 0.007$). None of the elderly patients whose NTOHCA were attributed to unknown causes, diabetes mellitus, gastrointestinal system disease or malignant neoplasm survived to discharge.

Conclusion: In this study, cardiovascular disease was found to be the leading cause of NTOHCA in both elderly and adult patients. The NTOHCA of elderly patients was due to pulmonary causes significantly more frequently than those of the adult group. [International Journal of Gerontology 2009; 3(1): 47–52]

Key Words: cause, elderly patients, non-traumatic out-of-hospital cardiac arrest, resuscitation
Death Register, the leading cause of death in 2005 was malignant neoplasm, but it is unclear whether this is also the leading cause of NTOHCA.

There have been no previous studies comparing the causes of NTOHCA in the elderly with the causes of NTOHCA in adult patients younger than 65 years. We believe that recognizing the causes of NTOHCA may affect the proposed course of treatment and may thus help physicians to treat each patient more effectively. Furthermore, we hope that understanding the causes of NTOHCA in the elderly patients may help develop good strategies aimed at reducing NTOHCA in the future.

Materials and Methods

This was a retrospective study approved by the institutional review board of Mackay Memorial Hospital (MMH-I-S-341). From January 1, 2005 to December 31, 2005, 330 patients older than 18 years old who had experienced NTOHCA and were admitted to the emergency department (ED) of Mackay Memorial Hospital were retrospectively enrolled in the study. The 31 NTOHCA patients whose resuscitation at the ED was discontinued were excluded. The elderly group, defined as patients older than 65 years, consisted of 198 patients, while the adult group, aged between 18 and 64 years, consisted of the remaining 101 patients. All patients were treated at the Mackay Memorial Hospital, a 2,060-bed medical center in northern Taiwan. All of the emergency physicians, nurses and medical staff had completed the Advanced Cardiac Life Support 2000 guideline training course.

Signs of NTOHCA were defined by unresponsiveness, absence of spontaneous respiration, and absence of palpable pulse upon arrival at the ED. The diagnosis of NTOHCA was confirmed by the emergency physician.

The causes of NTOHCA were divided into eleven categories: malignant neoplasm, neurologic disease, cardiovascular disease, diabetes mellitus, pulmonary disease, gastrointestinal system disease, renal and urinary system disease, sepsis, electrolyte imbalance, unknown origin, and other causes, which included severe anemia, AIDS and drug-related anaphylaxis. Diagnoses of the cause of NTOHCA were made by first-aid records and medical records that included pre-arrest symptoms, medical history, resuscitation responses, laboratory findings, and death certificates. The final diagnoses were confirmed by two experienced emergency physicians.

If a patient had several chronic diseases, this could impede the physicians’ ability to determine which disease was the main cause of the NTOHCA and thus affect their treatment decisions. If no probable cause for the NTOHCA could be identified, a classification of “unknown cause” was used.

Statistical analyses

Statistical analyses of the data were conducted using SPSS version 12.0 software (SPSS Inc., Chicago, IL, USA) for Windows. Chi-squared tests and Fisher’s exact tests were performed for categorical variables. Independent samples t tests were used for continuous variables. A p value of <0.05 was the criterion for statistical significance.

Results

The overall survival rate of the subjects used for this study was 7.4%. The survival rate of the elderly was 6.1% and that of the adult patients was 9.9%. The difference between the two groups was not statistically significant (p=0.229) (Table 1).

The rank of causes of NTOHCA for all patients is shown in Table 2. The most common NTOHCA was cardiovascular disease (38.8%). This differed from the leading cause of death given by the Taiwan National Register, which was malignant neoplasm (26.8%). The primary cause of NTOHCA was cardiovascular disease for both the adult (42.6%) and the elderly samples (36.9%) (Table 3). The other causes of NTOHCA in the elderly were, in order of decreasing frequency, pulmonary disease, unknown origin, diabetes mellitus, sepsis, electrolyte imbalance, renal and urinary system disease, gastrointestinal system disease, malignant neoplasm, neurologic disease, and other causes.

Compared with the adult group, the elderly group had significantly more pulmonary causes of NTOHCA (19.7% vs. 7.9%; p=0.008). The adult group had significantly more unknown causes of NTOHCA (22.8% vs. 13.1%; p=0.033) (Table 3 and Figure).

A comparison of the survival rates for different cause of NTOHCA indicated that when the cause of NTOHCA was cardiovascular, the elderly group had a significantly lower survival rate than the adult group (5.5% vs. 18.6%, p=0.025). There were no significant statistical differences in the survival rates of the two groups for any of the other causes of NTOHCA. None of
the patients whose NTOHCA were caused by malignant neoplasm, gastrointestinal system disease or unknown origin survived (Table 1).

The elderly patients were significantly more likely than the adult patients to have multiple causes for their NTOHCA (34.3% vs. 18.8%; \( p = 0.007 \)) (Table 4). However, patients who had more than one cause for their NTOHCA did not have a significantly lower survival rate than those with a single cause (5.7% vs. 8.0%; \( p = 0.494 \)) (Table 5).

### Discussion

According to Taiwan’s National Cause of Death Register, the leading cause of death in 2005 was malignant neoplasm. However, the present study found that the leading cause of NTOHCA was cardiovascular disease.

It would, therefore, seem that the causes of death preceded by NTOHCA are quite different from the general causes of death published in the register. This may

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**Table 1.** Comparison of survival rate of different cause of non-traumatic out-of-hospital cardiac arrest (NTOHCA) between the elderly and adults*

<table>
<thead>
<tr>
<th></th>
<th>Elderly patients</th>
<th>Adult patients</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average age, mean ( \pm ) SD (yr)</strong></td>
<td>77.9 ( \pm ) 7.5</td>
<td>48.8 ( \pm ) 11.3</td>
<td>0.000</td>
</tr>
<tr>
<td>Overall</td>
<td>12 (6.1)</td>
<td>10 (9.9)</td>
<td>0.229</td>
</tr>
<tr>
<td>Cardiovascular disease</td>
<td>4/73 (5.5)</td>
<td>8/43 (18.6)</td>
<td>0.025†</td>
</tr>
<tr>
<td>Pulmonary disease</td>
<td>4/39 (10.3)</td>
<td>1/8 (12.5)</td>
<td>1.000</td>
</tr>
<tr>
<td>Unknown cause</td>
<td>0/26 (0)</td>
<td>0/23 (0)</td>
<td>NA‡</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>0/26 (0)</td>
<td>1/10 (10)</td>
<td>0.278</td>
</tr>
<tr>
<td>Sepsis</td>
<td>1/23 (4.3)</td>
<td>0/5 (0)</td>
<td>1.000</td>
</tr>
<tr>
<td>Electrolyte imbalance</td>
<td>2/20 (10)</td>
<td>1/10 (10)</td>
<td>0.584</td>
</tr>
<tr>
<td>Renal and urinary system disease</td>
<td>1/19 (5.3)</td>
<td>2/7 (28.6)</td>
<td>0.167</td>
</tr>
<tr>
<td>Gastrointestinal system disease</td>
<td>0/18 (0)</td>
<td>0/8 (0)</td>
<td>NA‡</td>
</tr>
<tr>
<td>Malignant neoplasm</td>
<td>0/16 (0)</td>
<td>0/6 (0)</td>
<td>NA‡</td>
</tr>
<tr>
<td>Neurologic disease</td>
<td>1/7 (14.3)</td>
<td>0/3 (0)</td>
<td>1.000</td>
</tr>
<tr>
<td>Others</td>
<td>1/5 (20)</td>
<td>0/1 (0)</td>
<td>1.000</td>
</tr>
</tbody>
</table>

*Data are presented as \( n \) (%); †statistically significant, \( p < 0.05 \); ‡the \( p \) value could not be computed for the variables of malignant neoplasm, gastrointestinal system disease and unknown origin, because there were no survivors. SD = standard deviation.

**Table 2.** Comparison of causes of non-traumatic out-of-hospital cardiac arrest (NTOHCA) and national cause of death

<table>
<thead>
<tr>
<th>Rank</th>
<th>Cause of NTOHCA* ((n = 299))</th>
<th>National cause of death† ((n = 101))</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cardiovascular disease 38.8%</td>
<td>Malignant neoplasms 26.8%</td>
</tr>
<tr>
<td>2</td>
<td>Unknown cause 16.4%</td>
<td>Cerebrovascular disease 9.5%</td>
</tr>
<tr>
<td>3</td>
<td>Pulmonary disease 12.0%</td>
<td>Heart disease 9.3%</td>
</tr>
<tr>
<td>4</td>
<td>Diabetes mellitus 10.0%</td>
<td>Diabetes mellitus 7.6%</td>
</tr>
<tr>
<td>5</td>
<td>Electrolyte imbalance 15.7%</td>
<td>Accidents and adverse effects 6.0%</td>
</tr>
<tr>
<td>6</td>
<td>Sepsis 8.7%</td>
<td>Pneumonia 4.1%</td>
</tr>
<tr>
<td>7</td>
<td>Gastrointestinal system disease 8.7%</td>
<td>Chronic liver disease and cirrhosis 4.0%</td>
</tr>
<tr>
<td>8</td>
<td>Renal and urinary system disease 7.4%</td>
<td>Nephritis, nephritic syndrome and nephrosis 3.5%</td>
</tr>
<tr>
<td>9</td>
<td>Malignant neoplasm 9.4%</td>
<td>Suicide 3.1%</td>
</tr>
<tr>
<td>10</td>
<td>Neurologic disease 3.3%</td>
<td>Hypertensive disease 1.4%</td>
</tr>
</tbody>
</table>

*The sum of percentage is over 100%, because some of the patients have more than one possible cause of NTOHCA; †2005 Taiwan national cause of death.
be because terminal cancer patients with a “do-not-resuscitate” agreement pass away at home or in hospices and are not subject to cardiopulmonary resuscitation in the ED. This study found cardiovascular disease to be the leading cause of NTOHCA. This finding is in line with results of other studies.

In this study, the second most frequent cause of NTOHCA in elderly patients was found to be pulmonary disease, which was a significantly more frequent cause than for the adult group. However, this finding has not been previously reported in other studies. In this situation, we should continue to focus on resuscitation in those with pulmonary disease, such as chronic obstructive pulmonary disease, asthma, tension pneumothorax and pneumonia. During resuscitation, pulmonary barotrauma and tension pneumothorax should always be kept in mind. Castle et al. have reported that patients with chronic respiratory disease could present with NTOHCA caused by bilateral tension pneumothorax, and should be resuscitated by empiric tube thoracotomy.

Compared with the elderly group, the adult group has significantly more unknown causes of NTOHCA (22.8% vs. 13.1%; \( p = 0.033 \)). In our previous study, we found that approximately 35% of the NTOHCA experienced by patients were not witnessed when they occurred. In otherwise healthy adult patients who suffered an un-witnessed NTOHCA, it will always be difficult to determine the cause of out-of-hospital cardiac arrest, especially if the history is incomplete, as is the case in retrospective studies.

Although there was no significantly difference in the frequency of cardiovascular causes of NTOHCA,
between the elderly and adult groups (36.9 vs. 42.6; 
\(p=0.338\)), the elderly group showed a significantly lower survival rate than the adult group when the cause of the NTOHCA was cardiovascular (5.5% vs. 18.6%; 
\(p=0.025\)). Aging is associated with significant changes in the cardiovascular system\(^{18}\), and this may be the cause of the poor outcome in our elderly cardiovascular patients. The cause of NTOHCA seems to influence the survival rates of NTOHCA patients. The cardiovascular disease category, which includes congestive heart failure, coronary artery disease and arrhythmia, affected the survival rates of NTOHCA patients in both the elderly and adult samples. Bonnin et al.\(^{6}\) found no significant difference between the survival rate for younger and older patients when the causes of NTOHCA were ventricular fibrillation/tachycardia.

Significantly more elderly than adult patients had multiple causes for their NTOHCA (34.3% vs. 18.8%; 
\(p=0.007\)). Significantly, pathophysiologic changes are associated with aging\(^{18}\) and this can lead to multiple chronic diseases. An elderly person has an average of three to four chronic diseases\(^{19}\), and each of these chronic diseases could cause NTOHCA. This is why it is sometimes difficult to determine the primary cause of NTOHCA, especially in un-witnessed cases without information on pre-arrest symptoms.

Patients who have more than one cause for their NTOHCA did not show a lower survival rate than others (5.7% vs. 8.0%, 
\(p=0.494\)). However, Khalafi et al.\(^{7}\) have found that age is not a determinant of survival but three or more comorbid conditions could decrease survival rate. While it seems likely that patients with multiple causes of NTOHCA would tend to show a decreased survival rate, this was not proven to be the case in the study.

This retrospective study had several limitations. First, no autopsy data were available, so the causes of NTOHCA could only be speculated upon based on the history and laboratory data recorded by two experienced emergency physicians. In addition, limited or unreliable information on pre-arrest symptoms may also have influenced our decision about the cause of NTOHCA. Second, counting two or three causes in one patient separately might have contributed to statistical error. Finally, the scale of the study was a limitation, as results from only one medical center study may not accurately reflect the entire population.

The main finding of this study was that cardiovascular disease is the leading cause of NTOHCA in both elderly and adult patients. To the best of our knowledge, there has been no previous comparison of the causes of NTOHCA between elderly and adult patients. The results of this comparison indicated that the elderly are significantly more prone to pulmonary causes of NTOHCA and to multiple causes of NTOHCA. In the future, it is hoped that this study can contribute to the development of an appropriate strategy for faster and more accurate diagnosis of etiology and, thus, more effective decisions regarding resuscitation following NTOHCA in the elderly.

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**References**


