Aeromedical Transport After Acute Myocardial Infarction

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Methods

A total of 116 patients were transported according to the algorithm, 64 unescorted and 52 escorted. The decision-making system was based on the recommendations given by the European Society of Cardiology. Whenever possible, patients were evaluated by coronary angiogram or exercise electrocardiogram. Patients at high risk were treated locally if appropriate facilities were available or evacuated to the nearest heart center. Patients at low risk were allowed to fly unescorted home if no other concomitant diseases needed the attention of a physician. The composite end point of death of any cause during transport or departure from the planned repatriation due to worsening of the condition was registered.

Results

No patients reached the end point. Patients who were not risk evaluated more often needed escort ($p < 0.04$). Escort patients were older ($p < 0.001$) and had more post-AMI complications ($p < 0.04$).

Conclusions

Patients can safely travel unescorted after AMI if their risk of ischemia is low as determined by risk stratification examination prior to repatriation.
Euro-Alarm A/S, a medical repatriation and assistance company located in Copenhagen. The algorithm is based on the European Society of Cardiology (ESC) guidelines for the management of AMI\(^\text{10}\) (Figure 1). The main priority is to obtain a comprehensive knowledge—as complete as possible—of the cardiovascular risk and to categorize patients as being at low risk or at high risk of having a new ischemic event. Patients considered at low risk were allowed to fly back to their home country unescorted, and patients at intermediate risk were given medical escort, whereas high-risk patients were only transported by air if local treatment facilities were inadequate. The physicians handling the cases, however, always had the final decision on the exact planning of the repatriation. Patients with positive stress tests were, when possible, referred to further examination locally and were risk evaluated again after treatment. All cases of AMI [ST-elevation myocardial infarction (STEMI) or non-STEMI] during 2005 were identified in a database system containing patient data from all transports managed by Euro-Alarm A/S.

Euro-Alarm A/S handles cases for mainly North European travelers around the world. When the patient comes into contact with the local health care system, Euro-Alarm A/S is informed by the patient, cotravelers, or the hospital. Within the same day, a physician is assigned to the case and will contact the treating doctor to retrieve information about the current disease, assess the severity, estimate the required need of therapy, and, if possible, determine how and when the patient can be repatriated to his home country. In complex cases, repeated contacts may be needed. By the time the disease has stabilized, home transportation of the patient is planned. In a very few cases, the patient is evacuated to his or her home country prior to stabilization of the disease due to inability of treatment by the local health system (treatment failure). In other cases, patients are evacuated to better equipped hospitals within the region to stabilize the patient or complete treatment prior to repatriation. The assistance company organizes every element of the case handling including the repatriation of the patient.

The database contains the medical information of the patient relevant for evaluating the quality of treatment and to organize repatriation. The information is obtained by physicians and is often supplemented by written medical reports from the treating doctors. Each case of AMI was carefully read by two of the investigators (J. B. S. and H. N.) to confirm the diagnosis and thus ensuring that all included cases had AMI. To avoid underdiagnosed cases of AMI, a broad search of the database was performed including cases of “angina pectoris,” “congestive heart failure,” and “arrhythmias.” All these cases were reviewed and no additional cases of AMI were found. Demographic data and parameters characterizing disease and disease severity were recorded. These data included the type of injury (STEMI or non-STEMI), preexisting disease, risk factors, treatment of the AMI [conservative, thrombolysis, PCI, or coronary artery bypass graft (CABG)], complications (postinfarction angina, arrhythmias, and heart failure of any cause), as well as data regarding mode of home transportation (time delay until repatriation, staff allocated to escort the patient, equipment allocated, vehicle allocated, and length of transportation). The outcome of the repatriation was evaluated by registering the composite end point of death of any cause during transport or premature interruption of the air transport caused by deterioration of the condition. These data were obtained from transport files made by escorting staff and by contact to carriers in those cases without escort personnel.

Data were analyzed with the SPSS program using nonparametric statistics. Chi-square tests were performed when frequency distribution data were compared in escorted versus unescorted patients. Median values were compared using the Mann–Whitney test. The investigation was approved by the Danish Agency for Data Protection.

**Results**

**Patient Data**

A total of 124 cases of AMI [STEMI: 84; non-STEMI: 40; female: 34; age median 65 years (range: 35–90 y)] as their primary health problem were evaluated during the

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**Figure 1** Diagram of the risk stratification–based decision-making algorithm for planning home transportation of the post-AMI patient.

ACS = acute coronary syndrome; CABG = coronary artery bypass graft; CAG = coronary angiogram; PCI = percutaneous coronary intervention; STEMI = ST-elevation myocardial infarction; NSTEMI = non-STEMI; UAP = unstable angina pectoris.
period. A total of 107 patients were admitted to hospitals within Europe, primarily from southern European countries, and 17 patients were admitted to hospitals in northern America and Asia. Of the 124 AMI patients evaluated by Euro-Alarm A/S, 116 were repatriated—3 patients died during the first 3 days in hospital and 5 patients were expatriates living in the area. Patient characteristics of the 116 repatriated patients are listed in Table 1. Significant concomitant diseases were registered in 25% of the patients, including chronic heart failure, chronic obstructive pulmonary disease, and diabetes mellitus.

**Injury and Treatment**

Thirty-one STEMI patients were treated with thrombolysis and 46 with PCI. Three patients received CABG, and in 11 patients, only a coronary angiography (CAG) was performed. In patients with non-STEMI, 12 had a PCI performed, and 4 were operated with CABG. Six patients had a CAG performed with no further intervention. Forty-eight patients had complications. The most frequent complications were arrhythmias (13%), followed by congestive heart failure (8%) and postinfarction angina (7%). Eighteen percent of all cases had two or more of these complications. Median time between onset of symptoms and repatriation was 15 days (interquartile range: 9–16 d) in all acute coronary syndrome (ACS) patients.

**Risk Stratification**

Seventy-one (68%) of all AMI cases had an invasive procedure performed, whereas 22 (19%) had an exercise test performed. Ten (12%) of the STEMI patients and 13 (33%) patients with non-STEMI had no risk stratification test performed prior to repatriation (p < 0.006). In all cases where exercise tests were found positive, additional invasive procedures were performed prior to repatriation.

**Repatriation**

Forty-five (59%) patients with STEMI and 19 (48%) patients with non-STEMI were repatriated unescorted (statistically nonsignificant). Subsequent analysis of the data was done by dividing the AMI group into those who were escorted and those who were allowed to travel back on their own (Table 2). Not surprisingly, patients who were escorted had more complicating diseases and had more postinfarction complications than unescorted patients. Patients with postinfarction complications (primarily arrhythmias) were most likely to be escorted (p < 0.007). The more well investigated the patients were, the less was the need of medical escort during repatriation. Thus, patients who had any kind of risk evaluation prior to repatriation, including negative exercise stress test and/or invasive procedures (CAG, PCI, and CABG), were less often escorted than patients without invasive procedures performed (p < 0.04). We subsequently analyzed what factors determined the level of assistance given to the patients during repatriation. Of the 52 patients escorted home, 2 were escorted by a nurse only, 38 by a physician, and 12 by a team of a nurse and a doctor. Twelve of the escorted patients were transported on a stretcher and the rest on either economy or business class seats. Eleven patients were transported home by air ambulance. Patients transported by air ambulance were unstable or were evacuated from places where appropriate therapy was not available. Postinfarction complications were important for the planning of the quality of escort needed (Figure 2). The more complications patients had, the more extensive was the escort team and equipment (p < 0.04). Apart from complications and risk stratification, age was found to be an important factor determining the need of escort. Patients who were escorted were older than unescorted patients (p < 0.001). In general, patients with non-STEMI were repatriated later than patients with STEMI (16 vs 12 d after their injury, respectively) (p < 0.04).

Doctors escorting patients on commercial flights were equipped with a box of medicine for cardiopulmonary emergency treatment and a basic medical bag in 5 cases. This equipment was supplemented with an additional Propaq monitoring system in 5 cases. In 23 cases, the equipment included a box of medicine for cardiopulmonary emergency treatment, a basic medical bag, a Propaq monitoring system, and a defibrillator. In 12 cases, doctors escorting patients had the equipment of a fully equipped air ambulance. Oxygen was given in 43 cases.

**Complications During Transport**

The composite end point of death during repatriation or premature ending of the repatriation was not achieved in any case (0 of 116; 95% confidence intervals: 0%–3%).

**Discussion**

Safety of air transport of patients after myocardial infarction is of special concern to the patients, the carriers, and the medical assistance companies. We now report a safety study based on the use of a risk evaluation algorithm for repatriation of patients after AMI. The algorithm is based on contemporary guidelines for treatment of patients.
with ACS. The main aim of our study was to investigate if we were able to allocate medical escort to patients considered at risk and to allow low-risk patients to be safely repatriated unescorted. No patients reached the composite end point of death during repatriation or premature interruption of the repatriation due to deterioration of their condition regardless of repatriation mode. The results support that patients allocated to the low-risk group can be repatriated unescorted on commercial flights. The risk of events during repatriation is similar to the risk found in other studies, although only few reports exist. In a study from 2002, 38 patients were randomized to either oxygen therapy or no oxygen therapy during flight, and the risk of flying was evaluated by Holter monitoring and clinical evaluation of an escorting physician. Asymptomatic myocardial ischemia was registered in one patient and chest pain in two patients. In a larger retrospective study from 1996, 196 patients were repatriated after AMI. The risk of cardiac symptoms was low (5%); the symptoms registered were not considered serious and not related to the number of days after the AMI, and it was concluded that repatriation could be performed safely with escort by a physician 2 to 3 weeks after AMI. None of these studies provided insight to the role of AMI disease course and need of escort or the role of prior risk evaluation. In a recent study, with a patient population comparable to the one in this study, 213 transports were evaluated to determine the role of time after the AMI on the outcome of the repatriation. All patients were escorted by a physician. No serious events occurred, but 31 patients had hypoxia during flight and 3 patients experienced angina, and it was concluded that AMI patients can safely be repatriated less than 2 weeks after AMI when escorted by a physician. The present study is the first to investigate the safety of unescorted repatriation after AMI based on a rigid risk evaluation decision-making algorithm. The study emphasizes the need of thorough investigation and risk evaluation including exercise stress test or CAG prior to repatriation because patients in whom risk stratification was not performed more often were allocated to escorted repatriation. Many of these patients could probably have been safely repatriated unescorted. At the same time, the study identifies patients who need escort to be patients with post-AMI complications, comorbidity, and older patients.

Table 2 Variables influencing the mode of repatriation

<table>
<thead>
<tr>
<th>Factors influencing the need of escort during repatriation</th>
<th>Escort, n (%)</th>
<th>Unescorted, n (%)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>52</td>
<td>64</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Age</td>
<td>71</td>
<td>61</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>15 (29)</td>
<td>15 (23)</td>
<td>ns</td>
</tr>
<tr>
<td>Male</td>
<td>37 (71)</td>
<td>49 (77)</td>
<td></td>
</tr>
<tr>
<td>Type of injury</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STEMI</td>
<td>31 (60)</td>
<td>45 (70)</td>
<td>ns</td>
</tr>
<tr>
<td>Non-STEMI</td>
<td>21 (40)</td>
<td>19 (30)</td>
<td></td>
</tr>
<tr>
<td>Complications to infarction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arrhythmias</td>
<td>10 (19)</td>
<td>5 (8)</td>
<td>&lt;0.007</td>
</tr>
<tr>
<td>Postinfarction angina</td>
<td>6 (12)</td>
<td>5 (8)</td>
<td></td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>4 (8)</td>
<td>5 (8)</td>
<td></td>
</tr>
<tr>
<td>2 or more</td>
<td>12 (23)</td>
<td>5 (8)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>32 (62)</td>
<td>20 (37)</td>
<td></td>
</tr>
<tr>
<td>Preexisting disease</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ischemic heart disease, diabetes mellitus, chronic obstructive pulmonary disease</td>
<td>25 (48)</td>
<td>17 (26)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>No risk stratification performed</td>
<td>16 (33)</td>
<td>4 (11)</td>
<td>&lt;0.04</td>
</tr>
</tbody>
</table>

STEMI = ST-elevation myocardial infarction; ns = nonsignificant.

Figure 2 Numbers of patients with or without postmyocardial complications according to the level of assistance (from none to air ambulance) needed during repatriation. Patients with postmyocardial complications needed more assistance during repatriation (p < 0.02). Complications are arrhythmias, postinfarction angina, and congestive heart failure or a combination of these.
The key element in the algorithm employed is that patients with coronary heart disease need to be exercise stress tested prior to the decision of repatriation, and those patients with high risk of ischemic heart disease based on ESC guidelines are referred to further investigation locally when possible. This often requires a more active role of the physician responsible for the case handling in the assistance company in requesting and interpreting risk evaluation tests. The benefit from this rigorous risk stratification is that patients who can safely be repatriated unescorted can be identified. The present study does not address the timing of repatriation after AMI. Until this has been investigated, it is suggested that patients who have not been fully revascularized by PCI can be repatriated 14 days after the AMI, according to current guidelines.

In conclusion, it is recommended that AMI patients are handled and repatriated according to a risk stratification algorithm and that patients at low risk can safely be repatriated unescorted.

Acknowledgments
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Declaration of Interests
The authors state that they have no conflicts of interest.

References