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ORIGINAL RESEARCH

# Analysis of the aeromedical evacuation of victims from the Syria-Turkey earthquake in 2023

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## Abstract

A major earthquake occurred in Syria and Turkey on the 6th of February 2023. As part of the humanitarian response, the Royal Netherlands Air Force (RNAF) team was tasked to evacuate earthquake victims from the Kahramanmaraş region in Turkey. The aim of this study was to analyze the demographic characteristics and medical conditions of the earthquake victims who were transported during the aeromedical evacuation by RNAF C130 aircraft in February 2023. We retrospectively analyzed the transport records and other documents relating to 247 earthquake victims, 98 of whom were patients, including demographic data, symptoms, diagnoses, injury areas and survival. The mean age of the earthquake victims transported was 43.13 ± 19 years, the youngest passenger was 14 months-of-age and the oldest was 90 years-of-age. Of these, 98 (39.7%) were patients, 118 (47.8%) were relatives of patients, and 31 (12.6%) were health care and military personnel who were being relocated from the region. The majority of the transported patients (n = 72, 73.5%) had extremity injuries. The most frequent intervention applied to the patients was analgesia (n = 111, 11.2%). No deaths occurred during transfer and for the following three-month period. This study, the first from Turkey, analyzed the aeromedical evacuation of victims from the 2023 earthquake in Syria and Turkey. In order to prepare for aeromedical evacuation flights in the future, training exercises should be conducted, a communication plan should be developed, an in-flight patient placement plan should be prepared, and a special team of personnel should be formed.

## Keywords

Earthquake; Aeromedical evacuation; Natural disaster; Injury

## 1. Introduction

On the 6th of February 2023, two earthquakes with magnitudes of 7.8 ± 0.1 and 7.5 on the moment magnitude scale (MMS) occurred, nine hours apart, with the epicenter in the Kahramanmaraş province of Turkey. Official data reported that as a result of these earthquakes, at least 50,783 people lost their lives in Turkey and at least 8476 people in Syria. In total, more than 129 thousand people were injured. After the earthquakes, more than 40,000 aftershocks occurred with magnitudes up to 6.7 MMS [1].

The first earthquake was felt over a wide geographical region, including Turkey and Syria, as well as Lebanon, Cyprus, Iraq, Jordan, Iran and Egypt. In total, 13.5 million people were affected in an area of 1000 square kilometers in Turkey. More than 35,000 buildings were destroyed and almost 300,000 buildings were seriously damaged in Turkey. While more than 2 million people experienced housing problems following the disaster, and at least 5 million people were forced to migrate to different regions. The International Labor Organization (ILO) announced that 658,000 workers in Turkey and 170,000 workers in Syria lost their livelihoods as a result of the earthquakes. According to the report of the 2023 Parliamentary Earthquake Research Commission, the total cost of the earthquake in Turkey was $148.8 billion. This financial loss corresponds to 9% of Turkey's 2023 gross domestic product. The World Bank announced that the direct cost of the earthquakes to Syria was $5.1 billion in total. The earthquakes caused a total of $153.9 billion in financial damage in Syria and Turkey and were ranked third of all global earthquakes causing the most damage [2].

Aeromedical evacuation (AE) first began with hot air balloons during the Franco-Prussian War (1870–1871) and expanded to fixed-wing aircraft, although in small numbers, in World War I, the Korean War, the Spanish Civil War, and World War II. Furthermore, AE was increasingly used for transoceanic flights in World War II [3].

Only a very limited amount of literature is available relating to the AE of patients affected by natural disasters such as earthquakes. To the best of our knowledge, this the first study to investigate the sociodemographic characteristics and injury profiles of the victims of the Kahramanmaraş earthquake in terms of AE. It is vital that we improve future patient transport by examining the AEs performed during the 2023


  

earthquake in Turkey and Syria. Therefore, we analyzed the demographic characteristics and medical conditions of the earthquake victims who were transported during the AE carried out by the Royal Netherlands Air Force (RNAF) with a C130-type aircraft in February 2023 following the Kahramanmaraş earthquake. In addition, we evaluated the transfer process in terms of medical and aviation factors. Our findings will help to improve future AE disaster relief and contingency planning.

## 2. Materials and methods

Between the 11th and 28th of February 2023, the RNAF had a C130 aircraft stationed in Antalya; these were used to perform AE flights. For optimum patient care, the minimum AE medical team consisted of a flight surgeon, a flight nurse and a nurse. If critically ill patients are to be transported during strategic AE, the French Military Medical Services recommend the presence of an onboard intensive care doctor to strengthen the AE team [3].

The Dutch C130 did not have an intensive care unit and carried a maximum of 30 patients on stretchers and 31 seated passengers (Fig. 1). The C130 was a fixed-wing aircraft designed for the transport of cargo and patients. The actual breakdown of the medical and technical team for each day-shift flight was one Dutch flight physician, two Turkish emergency medicine specialists, three Dutch flight nurses, one Turkish nurse and seven Dutch technical flight personnel as part of the crew. On night shifts, there was one Dutch flight physician and two Turkish emergency medicine specialists; the remainder of the personnel was the same as for day-shifts. The ratio of Dutch/Turkish personnel on each flight was 11:3 for day flights and 10:4 for night flights. In addition, for each shift, there were two Turkish emergency medicine specialists and two Turkish nurses who were not included in the flight but were waiting as backup as part of the ground services team. The teams worked for 12-hour shifts. The entire team featured three Dutch flight physicians, three Dutch flight nurses, 14 Dutch technical flight personnel, four Turkish emergency medicine specialists and six Turkish nurses. When necessary, teams could be combined and integrated into a single aircraft, or doctor and nurse support could be provided from Turkey. The plane featured patient transfer units, monitors, ventilators, emergency medicines and other supplies.

All cases were evaluated by a Turkish emergency medicine specialist and a Dutch flight doctor before the flight. Although physicians in all specialties can make AE decisions, there are no international guidelines determining patient selection in AE and expected patient care during flight. Furthermore, there is no guideline specifying the qualifications that a transport physician must have. When deciding whether a patient is suitable for flight, the physician considered various parameters, including flight conditions, the patient's condition, and the profit-loss ratio. Each case was evaluated on its own merits, weighing the advantage of the transfer to the patient against the possible harmful effects of the flight. Perfect and ideal planning may not be possible in crime scene interventions or emergency evacuations; therefore, aeromedical transfer teams usually have standard medical equipment and medications for these types of transfers [4, 5]. Based on this information; we considered the following criteria for patient selection (Table 1).

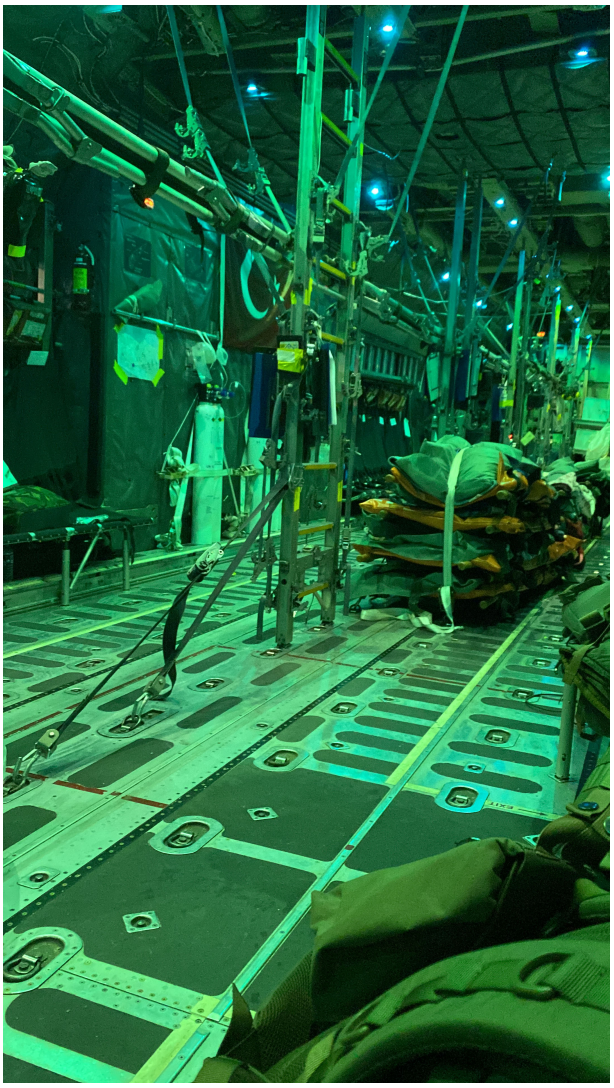

**FIGURE 1. Inside view of the aircraft.**

**TABLE 1. Criteria used to determine if patients were unfit to fly.**

| Exclusion Criteria |
|---|
| Vital Sign instability (BP, Heart Rate, $SpO_2$, Respiratory Rate) |
| ICU patient |
| GCS <12 |
| Risk of airway instability |
| Unstable Cardiac Rhythm (SVT, VT, *etc.*) |
| Pneumothorax, Pneumoperitoneum, Pneumocephalus, Ileus |
| Severe Anemia (Hb <7 g/dL) |
| Suspicion of Contagious disease |
| Supervisor Doctor Clinical Sense |

*BP: Blood pressure, $SpO_2$: Peripheral oxygen saturation, ICU: Intensive care unit, GCS: Glasgow coma scale, SVT: Supraventricular tachycardia, VT: Ventricular tachycardia, Hb: Haemoglobin.*

First, the flight crew carefully read the patient files, which were obtained previously, and evaluated the patient's medical condition. Them, the crew checked whether the necessary medical equipment was ready on the aircraft to ensure proper patient care. If these conditions were acceptable, then preliminary approval was given for the air evacuation of the patient. The patient, who was brought to the area by ambulance, was systematically evaluated by the flight physician before being taken to the plane and vital signs were checked. It was determined whether the patient was stable or not. Patients who were unstable and needed intensive care were not accepted on the plane. Next, stable patients were examined carefully. During the neurological examination, the patient's basal mental status and whether there was a history of seizures were ascertained. Then, the Glasgow coma scale (GCS) score was calculated. Patients with a GCS $<12$ was not accepted for flight. If the patient was receiving sedation, the amount of sedation the patient needed and the infusion doses were ascertained. During the cardiovascular system examination, the history of cardiac arrhythmia and blood pressure follow-ups were ascertained. By evaluating electrocardiography data acquired on the same day, patients with fatal rhythm disorders (supraventricular tachycardia, ventricular tachycardia, *etc.*), patients at risk of dysrhythmic attacks, and patients with hypertensive emergent and urgent conditions, were not accepted on the flight. During the pulmonary system examination, the main priority was to ensure that the patient had a safe airway throughout the transfer. Patients with a low risk of losing airway patency and those under mechanical ventilation were not accepted for flight. In addition, the possibility of pneumothorax was ruled out with a chest X-ray taken on the same day, before transferring the patient out of the hospital following discharge. Patients with pneumothorax were not accepted for the flight. During the examination of the skin and extremities, any wounds or pressure ulcers were evaluated. Damaged extremities were evaluated for the risk of compartment syndrome. The referring physician confirmed whether the patient had an infectious disease. Patients without infection verification were not accepted on flights due to the risk of contamination. Complete blood counts were performed on the same day by the hospital were carefully considered. Patients with hemoglobin values $<7.0$ g/dL were not accepted for flight. In addition, patients with pneumocephalus, barotrauma, pneumothorax, pneumoperitoneum and ileus were not accepted for flight.

Each patient was accompanied by as many relatives as possible. Each patient's fitness for flight, along with diagnosis and treatment processes, were planned and recorded on a transfer form. Subsequently, the medica crew ascertained how each patient's stretcher would be deployed in the aircraft according to the triage category and general condition of the patient, and all cases were placed on the plane accordingly. Thus, considering triage category, patients were provided with an area to intervene in the appropriate physical area.

In this study, we retrospectively analyzed transport records and other documents for each earthquake victims. These records were created by the flight physician during the process from the patient's boarding to the delivery of the patient to an ambulance team at the landing airport. Data from transport records were entered into SPSS 26 statistical software (SPSS Inc., Chicago, IL, USA). Demographic data, symptoms, diagnoses, injury sites and prognoses were analyzed for each patient. Injury sites were categorized according to the affected body area (head trauma, cervical spine injury, dorsolumbar vertebral injury, thoracic trauma, abdominal trauma, limb injury, burn and non-traumatic).

Statistical analyses were performed using Statistical Package for the SPSS version 26. Continuous variables are expressed as mean $\pm$ standard deviation and as medians with interquartile ranges. Categorical variables are expressed as numbers (n) and percentages (%). At check-in, the data was checked for compliance and corrected, if necessary, against the information given in the form fields or the in-flight data from the transport record. In case of missing information, the referring physician was contacted by telephone. In addition to patient transport records, further information was collected from patient transport requests, discharge hospitals, and physician referrals. In order to take this factor into account in the analysis, flight times documented by Airport Command were also included. Flight time was defined as the time between take-off and landing. If a patient had a second flight after a transfer, the flight times of the two flights were combined.

## 3. Results

Between the 10th of February and the 24th of February 2023, a total of 247 earthquake victims (passengers) were transported by the RNAF during air transportation operations based in Antalya. Of these, 101 (40.9%) were female and 146 (59.1%) were male. The mean age of the passengers was 43.13 $\pm$ 19 years, the youngest passenger was 14 months-of-age old and the oldest passenger was 90 years-of-age. The date with the highest total number of passengers (80; 32.4%) evacuated was 11 February 2023. The day with the highest number of patients evacuated in a single flight was 20 February 2023; 30 patients with stretchers were evacuated in a single flight. While the number of patients transported showed a downwards trend, the reason why this peaked again was the second earthquake (a magnitude of 6.4) that occurred later that same evening [1]. Although the damage from this earthquake was less extensive than the first, some of the already damaged hospitals became unusable and required emergency evacuation. The number of patients and passengers transported is shown in Table 2.

In total, 68 (27.5%) earthquake victims were evacuated during the daytime, while 179 (72.5%) earthquake victims were evacuated after 7:00 PM. In total, 129 (52.2%) of the earthquake victims were taken from Adana and 118 (47.8%) were taken from Adıyaman. These earthquake victims were transported to Ankara (151, 61.1%) Antalya (88, 35.6%) and İzmir (8, 3.2%). It is possible that international readers may not understand the specific relevance of this finding; therefore, it is necessary to explain the significance and differences between Adana, Adıyaman, Ankara, Antalya and İzmir. Adıyaman is the city closest to the earthquake's epicenter and was more affected by the earthquake than Adana. On the other hand, Adana is closer to Hatay province, which was the earthquake's epicenter. Since the highways and airports in Hatay province were also damaged, air evacuation could not be provided

**TABLE 2. Flights and the number of passengers and patients carried.**

| Flight Date and Flight Number | Carried Patient/Passenger Number (%) |
|---|---|
| 11 February 2023 | 17/80 (21.25) |
| Flight No: 1 | 6/38 (15.79) |
| Flight No: 2 | 11/42 (26.19) |
| 14 February 2023 | 3/36 (8.33) |
| Flight No: 3 | 3/36 (8.33) |
| 15 February 2023 | 22/34 (64.71) |
| Flight No: 4 | 1/12 (8.33) |
| Flight No: 5 | 17/18 (94.44) |
| Flight No: 6 | 4/4 (100) |
| 16 February 2023 | 25/51 (49.02) |
| Flight No: 7 | 6/8 (75) |
| Flight No: 8 | 19 /43(44.19) |
| 20 February 2023 | 30/41 (73.17) |
| Flight No: 9 | 30/41 (73.17) |
| 22 February 2023 | 1/5 (20) |
| Flight No: 10 | 1/5 (20) |

directly from Hatay province in the first stage; instead, the patients were transferred to Adana *via* a limited number of highways and were transferred to other provinces from airports in Adana.

Evacuations from the earthquake area were primarily made to large cities that were closest to the region but least affected by the earthquake. Subsequent evacuations were made to large cities that were far from the earthquake zone but where health service provision was easy. The city that was not affected by the earthquake and is closest to the earthquake zone is Antalya. Ankara is the capital city and İzmir is the second largest city in Turkey and has the largest number of health centers. For this reason, air evacuation was first carried out to Ankara, Antalya and İzmir. Flight information is shown in Table 3.

The individuals who lived in the region and had professions related to the rescue efforts (military personnel, police, firefighter, *etc.*), in addition to being disaster victims, played an important role in ensuring the continuity of health services during the earthquake, participating in rescue efforts when necessary, and restoring the psychological health of the society. Local public employees participating in rescue efforts faced the stress of having to carry out public services in the disaster area, as well as stresses such as the loss of a family member, aggravation of an existing psychiatric disease, the trauma of witnessing individuals being killed or injured in the earthquake, and damage to their home and financial losses. If this stress is not addressed in time, it can transform into depression, post-traumatic stress disorder (PTSD) [6–8]. Furthermore, compassion fatigue is a common negative outcome when working with trauma as rescuers and includes burnout and secondary traumatic stress. Research has also shown that compassion fatigue is generally associated with negative psychological outcomes [9]. In light of this information, it can be assumed that the rescue and medical teams working in the region before the disaster experienced a double disaster. To prevent this, the importance of family support as well as friend and peer support is clearly emphasized in the literature [10]. This is why we data relating to these personnel in the demographic data of our AE flights.

Of the earthquake survivors, 98 (39.7%) were patients, 118 (47.8%) were relatives, and 31 (12.6%) were health and military personnel who were being relocated from the region (Table 4). Health care and military personnel were only psychologically affected by the earthquake and were not classified as patients. In the second week of the earthquake, due to the psychological trauma they were exposed to, these personnel were transferred by ministry decision to other cities of their choice for a change of atmosphere in order to minimize trauma. In total, 46 (47%) of the patients were female and 52 (53%) were male. The mean age of the patients was 37.6 $\pm$ 21 years (Table 5). During the evacuations, a maximum of 30 patients on stretchers were transported on any single flight. There were ten flights in total. While 33 (33.7%) of the patients were evacuated during the day, 65 (66.3%) were evacuated at night.

Extremity injuries were present in the majority (73.4%, n = 72) of the transported patients. Other injuries are given in Table 5. Intravenous medication was administered to 16 patients during flight. The drugs given and the reasons for their administration are shown in Table 5.

All patients were in good general condition at the beginning of the flight, and their vital parameters were stable. No patient died within the first three months after the flight.

When considering injuries according to age, the most common extremity injury was seen in patients younger than 70 years-of-age. In the over 70 years' age group, the most common reason for evacuation was non-traumatic reasons (Table 6).

## 4. Discussion

This analysis of AE flights performed by the RNAF is the first analysis to present data relating to the AE of patients who needed a referral for any reason, their relatives, and military and medical personnel working in the earthquake area during the Kahramanmaraş earthquake. Our findings will help to understand the challenge faced by medical teams during flight, improve processes for transporting survivors following earthquakes, and optimize decisions relating to the selection of suitable patients for transport.

During the 2023 Kahramanmaraş earthquake relief operation, AE played a very important role in the transportation of the injured and ensured that the seriously injured were taken to surrounding hospitals within the first three days. There are several reasons why air evacuation plays a vital role in this process: ten major cities were affected by the earthquake, the roads leading to the epicenter were severely damaged, and the airport in Hatay, the city most affected by the earthquake, became unusable due to the earthquake. In addition, even after the Hatay airport was repaired, large fixed-wing aircraft and

**TABLE 3. Flights, airports, evacuated patient numbers, flight times and altitudes.**

| Date | 11 February 2023 | Date | 11 February 2023 |
|---|---|---|---|
| Aircraft | C130 | Aircraft | C130 |
| Patient number | 6 | Patient number | 11 |
| Flight time | 81 min | Flight time | 81 min |
| Altitude | 20,000 ft | Altitude | 20,000 ft |
| Cabin altitude | 8000 ft | Cabin altitude | 8000 ft |
| Date | 14 February 2023 | Date | 15 February 2023 |
| Aircraft | C130 | Aircraft | C130 |
| Patient number | 3 | Patient number | 1 |
| Flight time | 69 min | Flight time | 69 min |
| Altitude | 20,000 ft | Altitude | 20,000 ft |
| Cabin altitude | 8000 ft | Cabin altitude | 8000 ft |
| Date | 15 February 2023 | Date | 15 February 2023 |
| Aircraft | C130 | Aircraft | C130 |
| Patient number | 17 | Patient number | 4 |
| Flight time | 60 min | Flight time | 60 min |
| Altitude | 20,000 ft | Altitude | 20,000 ft |
| Cabin altitude | 8000 ft | Cabin altitude | 8000 ft |
| Date | 16 February 2023 | Date | 16 February 2023 |
| Aircraft | C130 | Aircraft | C130 |
| Patient number | 6 | Patient number | 19 |
| Flight time | 105 min | Flight time | 60 min |
| Altitude | 20,000 ft | Altitude | 20,000 ft |
| Cabin altitude | 8000 ft | Cabin altitude | 8000 ft |
| Date | 20 February 2023 | Date | 20 February 2023 |
| Aircraft | C130 | Aircraft | C130 |
| Patient number | 30 | Patient number | 1 |
| Flight time | 60 min | Flight time | 60 min |
| Altitude | 20,000 ft | Altitude | 20,000 ft |
| Cabin altitude | 8000 ft | Cabin altitude | 8000 ft |

*min: minute, ft: feet.*

**TABLE 4. Sociodemographic characteristics of the passengers.**

| Passenger type | Number (%) |
|---|---|
| Personnel (health care or military) | 31 (12.5%) |
| Earthquake victim's relatives | 118 (47.8%) |
| Patients | 98 (39.7%) |
| Median Age (IQR) | 38 (25–47) |
| Male Patients | 52 (53%) |
| Female Patients | 46 (47%) |
| Flight Time | |
| Day shift | 33 (33.7%) |
| Night shift | 65 (66.3%) |
| Total Patients | 98 (100%) |

*IQR: Interquartile range.*

heavy tonnage aircraft were not allowed to land [1].

Firstly, trauma patients were evacuated from the earthquake area, followed by those in need of care due to other reasons, whose treatment continued in hospitals. These patients were referred to hospitals in other provinces within the country. The evacuation was carried out by ambulances on land, military ships by sea, and by air using both helicopters and airplanes. Considering earthquake victims who were evacuated by air, most earthquake victims were transported (n = 80, 32.4%) on 11 February 2023. Most patients were transferred on 22 February 23, 30 patients at one time. Existing literature states that most patients or passengers are transported in the first few days after earthquakes [11–14]. Similarly, in our case, most passengers were transported within the first five days after the earthquake. However, the second peak occurred on the 22nd of February 2023. The reason for this was the collapse of many damaged buildings as a result of a significant aftershock on the evening of the 22nd of February, and the decision to evacuate Balçalı State Hospital, one of the largest hospitals in the region,

**TABLE 5. Injury sites and medications administered during flight.**

| Injury type | Number (%) |
|---|---|
| Head trauma | 8 (8%) |
| Isolated head trauma | 1 |
| With other injuries | 7 |
| Cervical vertebrae injury | 2 (2%) |
| Dorsolumbar vertebrae injury | 2 (2%) |
| Thoracic trauma | 1 (1%) |
| Abdomen trauma | 1 (1%) |
| Extremity injury | 64 (65%) |
| Lower extremity | 43 |
| Upper extremity | 19 |
| Together | 10 |
| Burn | 1 (1%) |
| Others | 19 (20%) |
| Decompensated heart failure | 5 |
| Acute organ failure (liver/kidney) | 4 |
| Pneumonia and COPD | 3 |
| Palliative care patient | 2 |
| Anemia | 1 |
| Diabetic foot | 1 |
| Epilepsy | 1 |
| Penile fracture | 1 |
| Psychosis x | 1 |
| Injured organ number | |
| No trauma | 17 (17.3%) |
| 1 region | 60 (61.2%) |
| 2 regions | 20 (20.4%) |
| 3 regions | 1 (1.1%) |
| Crush injury | |
| Yes | 19 (19.4%) |
| No | 79 (80.6%) |
| Administered drugs during flight | |
| No medication | 82 (83.7%) |
| IV Paracetamol | 6 (6.1%) |
| IV Fentanyl | 5 (5.1%) |
| IV Haloperidol | 3 (3.1%) |
| IV Furosemide | 1 (1%) |
| IV Antibiotic | 1 (1%) |
| Total | 98 |

*COPD: Chronic obstructive pulmonary disease; IV: Intravenous.*

**TABLE 6. The most common injury sites by age group.**

| Age Group | Diagnosis | Number (Percentile) |
|---|---|---|
| 0–14 | | |
| | Multiple injury | 3 (20) |
| | Non-Traumatic | 2 (13.3) |
| | Extremity injury | 10 (66.7) |
| | Total | 15 |
| 15–29 | | |
| | Multiple injury | 2 (12.5) |
| | Non-Traumatic | 1 (6.3) |
| | Extremity injury | 13 (81.3) |
| | Total | 16 |
| 30–44 | | |
| | Thorax injury | 1 (2.6) |
| | Head Trauma | 1 (2.6) |
| | Cervical vertebrae injury | 2 (5.1) |
| | Multiple injury | 2 (5.1) |
| | Non-Traumatic | 2 (5.1) |
| | Extremity injury | 30 (76.9) |
| | Burn | 1 (2.6) |
| | Total | 39 |
| 45–59 | | |
| | Non-Traumatic | 6 (50) |
| | Extremity injury | 6 (50) |
| | Total | 12 |
| 60–74 | | |
| | Dorsolumbar Vertebrae injury | 2 (20) |
| | Non-Traumatic | 3 (30) |
| | Extremity injury | 5 (50) |
| | Total | 10 |
| 75+ | | |
| | Abdomen injury | 1 (16.7) |
| | Non-Traumatic | 5 (83.3) |
| | Total | 6 |
| 0–14 | | |
| | Multiple injury | 3 (20) |
| | Non-Traumatic | 2 (13.3) |
| | Extremity injury | 10 (66.7) |
| | Total | 15 |
| 15–29 | | |
| | Multiple injury | 2 (12.5) |
| | Non-Traumatic | 1 (6.3) |
| | Extremity injury | 13 (81.3) |
| | Total | 16 |

**TABLE 6. Continued.**

| Age Group | Diagnosis | Number (Percentile) |
|---|---|---|
| 30–44 | | |
| | Thorax injury | 1 (2.6) |
| | Head Trauma | 1 (2.6) |
| | Cervical vertebrae injury | 2 (5.1) |
| | Multiple injury | 2 (5.1) |
| | Non-Traumatic | 2 (5.1) |
| | Extremity injury | 30 (76.9) |
| | Burn | 1 (2.6) |
| | Total | 39 |
| 45–59 | | |
| | Non-Traumatic | 6 (50) |
| | Extremity injury | 6 (50) |
| | Total | 12 |
| 60–74 | | |
| | Dorsolumbar Vertebrae injury | 2 (20) |
| | Non-Traumatic | 3 (30) |
| | Extremity injury | 5 (50) |
| | Total | 10 |
| 75+ | | |
| | Abdomen injury | 1 (16.7) |
| | Non-Traumatic | 5 (83.3) |
| | Total | 6 |

as it became unusable.

There is no clarity in the literature relating to the optimum number of personnel during AE flights. We found no specific information except that it would be appropriate for the AE team to consist of at least one nurse and one doctor, and to work in shifts to ensure that the rest of the team eat, sleep and rest [13]. There were seven technical personnel in our aircraft, including one flight physician, two emergency medicine specialists, three flight nurses and one nurse. The personnel also had the chance to rest in 12-hour shifts. The high number of doctors and nurses in our team helped to reduce the level of fatigue experienced by the team. Frequent vital monitoring, especially on multi-patient flights, provided patients with quick access on board and more effective observation opportunities. In this way, we had the opportunity to use our aircraft at full capacity. Transferring 30 stretcher patients at once gave the team insight and confidence to test their capacity. The coordination and efficient work of the Turkish and Dutch medical teams made a significant contribution to the efficiency and quality of this process.

One article, comprehensively described the control and coordination of the central government's disaster medical transport process after the Great East Japan Earthquake and Fukushima Daiichi Nuclear Power Plant Accident; in total, 633 patients were transported by air from an area of 20 to 30 km [14]. This report stated that the national government, local government, police and fire departments play an important role in mutual communication and cooperation, and that medical facilities should have an evacuation plan. In addition, it has been suggested that hospital evacuation should be supervised by emergency physicians in disaster environments and it should be carried out by disaster specialists who are accustomed to transporting patients daily [14]. In our organization, the patient transfer process is coordinated by the units of the Ministry of Health. However, the fact that the aircraft used was a military aircraft and the process had to be coordinated with the relevant units of the Armed Forces caused delays from time to time.

The lessons learned from the 2008 Wenchuan earthquake were repeated in the 2023 Kahramanmaraş earthquake [15]. Accordingly, new medical rescue theories should be developed, experts should be trained, military-civilian coordination should be ensured, telemedicine applications should be expanded for referral and consultation, and international cooperation should be ensured. Medical recovery following a disaster requires not only military-civilian cooperation but also international cooperation and support. This cooperation is important to improve the prognosis of all types of trauma, especially in the first 72 hours, which is defined as the golden hour in trauma.

Although our findings are generally consistent with other studies reporting the epidemiology of injury after earthquakes [16, 17], the other studies reported a higher incidence of orthopedic injuries, especially lower extremity injuries. The most frequently injured anatomical sites were the lower extremities (65%) and the head (8%), followed by the spine (4%). In the literature, the lower extremities and pelvis are known to be the highest risk areas for injuries in earthquakes [16]. The incidence of head trauma and chest injuries (reaching 14% and 8%, respectively), showed that such injuries should not be neglected when we give more importance to the treatment of extremity and pelvis injuries.

It has been reported in the literature that the transported wounded generally have multiple injuries [16, 17]. However, we observed a low rate of multiple injuries in our patients (13.3%). This may have been because the team only carried patients with mild to moderate severity. Multiple injuries are always more serious, and at high altitudes, a patient's general condition might deteriorate quickly and could possibly lead to multiple organ failure, thus necessitating intensive care. We encountered this rate because there was no intensive care facility on the aircraft.

Crush syndrome is one of the most common of all injuries from an earthquake. Following the 1995 Hanshin-Awaji earthquake, 372 (6.09%) cases of crush syndrome were reported. Following the 1999 Marmara earthquake, the incidence of crush syndrome in hospitalized patients was reported to be 33%. Following the 2013 Lushan earthquake, only six patients (1.2%) were found to have significant crush syndrome [16]. In a study examining the 2010 Yushu earthquake, the rate of crush syndrome was reported to be 0.89% [16]. In our study, this rate was 19.4%. The proportion of true crush syndrome following the 2023 earthquake was probably higher because our patients had low and mild-severity conditions. Crush syndrome patients usually require intensive care. If other flights with

intensive care facilities were included, this proportion would probably be even higher. Apart from this, one of the factors that can cause crush syndrome in the literature may be the building construction and material type. Although traditional mud or adobe constructions are destroyed even with poor seismic resistance, as in the Lushan earthquake, victims are easier to rescue in such constructions or can save themselves soon after the disaster. While similar effects were observed in the Nicaragua earthquake and the Guatemala earthquake, more crush syndrome victims were seen following the collapse of high-rise buildings [17].

## 5. Limitations

The present study has several limitations. In our study, most of the epidemiological data of earthquake patients were obtained under chaotic disaster conditions. However, detailed medical records of all hospitalized patients were often lacking due to initial disorientation. This study included only the flights provided by the RNAF; flights involving the Norwegian and British AE teams were not included in our analysis. In this respect, our findings cannot be generalized to all AE flights.

## 6. Conclusions

This is the first analysis of patients, relatives and personnel transported during the AE following the 2023 Kahramanmaraş earthquake, and is also the first study related to AE in Turkey. This study provides the first data for our country on cases that can be evacuated by air in case of disaster and is important in terms of gaining insight. Accordingly, we observed that the highest number of passengers were evacuated by air in the second week of the earthquake. When considering the patients evacuated by air, the most common reasons were extremity trauma cases and cases that were referred from hospitals that needed to be evacuated due to building damage in the region, whose treatment started before the earthquake and needed to be continued. To prepare for AE flights, training exercises should be conducted, a communication plan should be developed, an in-flight patient placement plan should be generated, and a special personnel team should be formed.

### AVAILABILITY OF DATA AND MATERIALS

The data, code and materials are available on request from the corresponding author.

### AUTHOR CONTRIBUTIONS

AA, RS, MK—performed the study design, data collection and analysis; AA, MK—performed the study design, data collection; RS, AA—performed the statistically analysis and article's drafting and all authors approved the study.

### ETHICS APPROVAL AND CONSENT TO PARTICIPATE

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee. (Local ethics committee approval: University of Health Science, Antalya Training and Research Hospital Clinical Research Ethics Committee, Approval number: 6/26, approval date: 04 May 2023) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors. Informed consent to participate and for publication were obtained from all of the participants.

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### CONFLICT OF INTEREST

The authors declare no conflict of interest.

### SUPPLEMENTARY MATERIAL

Supplementary material associated with this article can be found, in the online version, at https://oss.signavitae.com/mre-signavitae/article/1760930951542521856/attachment/Supplementary%20material.docx.

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