LJUBLJANA MARSHES HOT AIR BALLOON CRASH: A MULTIPLE CASUALTY INCIDENT

ACCIDENT DE MONTGOLFIÈRE DES MARAIS DE LJUBLJANA: UNE CATASTROPHE

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SUMMARY. On August 23rd, 2012 at 7:54 am a hot air balloon crashed in Ljubljana Marshes, leaving 32 injured on site. This case report analyses the biggest multiple casualty incident attended by University Medical Centre Ljubljana in recent history. Analysis of all segments regarding the incident was conducted: mobilisation, arrivals, triage, work-up, identification, public relations and outcome. Issues such as mobilisation, diagnostics, communication, documentation and intensive care unit space are discussed. Twenty-one patients arrived over 63 minutes, 8 of those were immediate resuscitation cases and 10 of those suffered burns. The average Injury Severity Score was 15.7 (ranging 3 to 50), 28.1 for admitted patients. 90% of patients had x-ray, 23% CT and 38% ultrasound diagnostic procedures. 33% of patients required urgent surgery and 60% of admitted cases required intensive care units. A relatives and media territory was established. CT location, loss of communication, inadequate documentation and intensive care bed space were most problematic. At 7-year follow up, we had a roughly 5% hospital fatality rate, 74% of patients gained full recovery and 21% good recovery. Even though the event occurred on a weekday during regular hours, it still exposed many weaknesses. A new radio frequency system for intra-hospital communication has been implemented, the multiple casualty incident protocol has been revised, and regular drills are now performed. Our emergency department is currently undergoing renovation to include CT diagnostics on the same floor. Plans have been made to ease documentation with dictation modules, whereas bed space remains unchanged.

Keywords: multiple casualty incident, triage, burns, injuries, emergency medical services

RÉSUMÉ. *Le 23 août 2012 à 7 h 54, une montgolfière s'est écrasée dans la marais de Ljubljana, causant 32 blessés. Nous analysons ici l'afflux massif le plus important de l'histoire récente pris en charge par le CHU de Ljubljana. Tout le déroulé des interventions a été passé en revue: mobilisation, présentation, triage, prise en charge initiale, identification, relations avec le public, évolution. Au niveau hospitalier, nous avons analysé la mobilisation, les diagnostics, la communication, la tenue des dossiers et les soins intensifs. Trente et un patients sont arrivés en 63 mn dont huit ayant besoin de réanimation et 10 brûlés. L'ISS moyen était de 15,7 (3 à 50) et de 28,1 pour les patients hospitalisés (60% d'entre eux en réanimation). 90% des patients ont eu une radiographie, 23% une TDM et 38% une échographie. Le tiers des patients a eu besoin de chirurgie en urgence. Un espace de communication avec les médias et les familles a été aménagé. Les principaux problèmes rencontrés ont été la localisation du scanner, le défaut de communication, les dossiers incomplets et la place en réanimation. A 7 ans, la mortalité hospitalière est de 5%, 71% des patients ont guéri sans séquelle et 21% ont une bonne récupération. Bien que survenu en semaine et aux heures ouvrables, nous avons constaté plusieurs faiblesses, nous ayant conduit à développer un nouveau système de communication intra- hospitalière, revoir le protocole d'afflux massif avec simulations régulières. Le service des urgences est en cours de rénovation, avec un scanner à proximité immédiate. Alors que les services n'ont pas été redimensionnés, un système de dictée électronique a été mis en place, dans le but d'améliorer l'exhaustivité des dossiers.*

Mots-clés : *catastrophe, triage, brûlés, blessés, service d'accueil des urgences*

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Introduction

A multiple casualty incident (MCI) is any incident in which emergency medical services (such as personnel and equipment) are strained, but not overwhelmed, by the number and severity of casualties.[1] In such events, organisational demands disclose weaknesses of the emergency medical system in place, making MCIs extremely challenging. On August 23rd, 2012, one of the world's largest serially manufactured hot air balloons crashed in the Ljubljana Marshes. At 07.40 (GMT+1) a thunderstorm forced the pilot to land. During his attempt, the basket got caught by wind shear, lifted and dropped onto the ground several times before finally hitting a nearby tree, igniting and crashing. Passengers were either thrown out of the basket or jumped voluntarily, hence leaving 32 injured in a 200m radius with active fire at the crash site. After receiving notice of the MCI at 07.55, the Emergency Medical Units (EMU), police and fire brigade were deployed. Four people were declared dead on site, 21 were transferred to University Medical Centre (UMC) Ljubljana, 5 to General Hospital (GH) Novo Mesto, 1 to GH Celje and 1 to GH Jesenice. Of all hot air balloon crashes, Ljubljana Marshes ranks at 1st place for number of injured and 5th place for number of fatalities: there were 13 fatalities in Alice Springs 1989, 11 in Carterton 2012, 19 in Luxor 2013, and 16 in Lockhart 2016. It is also the biggest MCI attended by University Medical Centre (UMC) Ljubljana in recent history.

Materials and methods

Hospital representatives ordered an analysis of the MCI after the event. A team was formed consisting of 3 independent members. Documentation was thoroughly inspected, the patients' clinical status rechecked, and interviews with medical personnel involved in the event were performed. The event itself was divided into several phases (mobilisation, arrivals, triage, work-up, identification, public relations and outcome) to facilitate the analysis.

Results

Mobilisation

Upon receiving the news, UMC Ljubljana Chief of the Trauma Emergency Department (ED) decreed an MCI meeting (08.00) with the chief anaesthesiologist, head nurse and the hospital public relations (PR) representative. Following this (08.10), UMC Ljubljana was declared for mobilisation. Firstly, all elective operations were cancelled and all non-urgent diagnostics delayed, thus enabling instant surgical and diagnostic procedures (e.g. urgent CT scan). Secondly, all hospital doctors, nurses and technicians were put at the ED's disposal – including nonsurgical departments, intensive care units (ICUs), internal medicine ED, etc. Additional equipment was put in all operating rooms within the ED and ED recovery rooms, providing 7 resuscitation areas (normally 2). A heads-up warning was given to the Department of Radiology, Blood Transfusion Centre of Slovenia and the in-house laboratory. Lastly, all ICU chiefs were asked to transfer patients to non-intensive wards if possible. At 08.25, 18 teams (surgeon, surgical resident, scrub nurses, anaesthesiologist and anaesthesiologist nurse) were mobilised.

Arrivals

Twenty-one patients arrived over 63 minutes (*Table I*). All were evenly distributed: 6 in 0-20 min (28.6%), 8 within 20-40 min (38.1%) and 7 over 40 min (33.3%). Five resuscitation patients arrived in 0-20 minutes (62.5%), 2 within 20-40 min (25%) and 1 over 40 min (12.5%) from first arrival.

Triage

Triage was done at the ED entrance by consensus between the ED chief of trauma, chief of anaesthesiology and a plastic surgeon. Seven cases were denoted as resuscitation cases (immediate group), 5 as major trauma (delayed group) and 9 as minor trauma (minor group). There was 1 case of up-triage from delayed to immediate. All patients were re-triaged by special teams: trauma surgeon team, plastic surgeon team and anaesthesiologist team.

Table I - Arrival times and triage

0 – 20 minutes (6 patients, 5 immediate)	
8.48	Immediate
8.54	Delayed (later up-triage to immediate)
8.59	Immediate
9.01	Minor
9.05	Immediate
9.05	Immediate
20 – 40 minutes (8 patients, 2 immediate)	
9.11	Delayed
9.12	Immediate
9.13	Minor
9.17	Minor
9.17	Minor
9.22	Delayed
9.24	Immediate
9.27	Minor
40+ minutes (7 patients, 1 immediate)	
9.30	Minor
9.35	Delayed
9.38	Delayed
9.40	Minor
9.43	Immediate
9.49	Minor
9.51	Minor

Patient work up

Patients were predominately male, with 66.7% (n=14) opposed to 33.3% (n=7) women, and 9.5% of them (n=2) were paediatric. Mean age of the injured was 45 years (ranging from 14 to 73 years), excluding paediatric cases (7 and 8 years old). Both fractures and burns presented in 47.6% patients (n=10), with 60% (n=6) of fractured and 70% (n=7) of burned patients affected in multiple body regions. Of the two paediatric cases, one experienced a fracture, the other a severe burn. The average injury severity score (ISS) was calculated at 15.7, with values ranging from 3 to 50. All outpatients had an ISS of 6 or lower, whereas all inpatients had an ISS of 10 or higher (average 28.1). Those needing urgent surgery presented with an average ISS of 26.7. Nineteen patients (90.5%) received x-ray, 5 patients (23.8%) underwent CT scanning (all at minimally 2 body regions), and 8 patients (38.1%) received ultrasound diagnostics via focused assessment with sonography for trauma (FAST). Urgent surgery was needed in 7 patients (33.3%): 4 major burns, 1 complex spine injury, 1 pelvic injury and 1 complex foot injury. Primary work up finished at 17.00.

Injured identification & relatives

A “relatives’ territory” was set up, a contact person made available and 2 psychologists appointed for support and counselling. Most of the severely injured had been treated as “John Does” as identification was hampered by facial burns, passengers dead on site not being identified, and because personnel failed to obtain a name before intubation. A physician was appointed to identify all of the injured in cooperation with police, using selective/descriptive interviewing of the relatives (photographs, past medical records, bedside identification). All patients were identified within 12 hours of the event.

Public relations & information management

The media interest was immense. First official contact with the media came from the police representative on site. A medical press conference was held in the foyer designated as “media territory” during the MCI at 13.00. One clear live statement from leading doctors was given and relevant questions were answered. This was the only event with doctors present, as the hospital PR service took care of all other communications.

Outcome & 7-year follow up

Of the 21 patients treated, 12 (57.1%) were admitted, 7 (33%) required urgent surgery and 6 (28.6%) needed ICU (including 1 paediatric). Due to shortage of bed space in the ICUs, 2 (9.5%) patients were transferred to UMC Maribor. All of the 8 resuscitation cases (7 immediate group + 1 up-triage) were successful. At 7-year follow up, 1 person had died (5.3% MCI hospital fatality rate) - a 58-year old female with cerebral oedema and severe burns (ISS 50). Of the 18 surviving patients treated in UMC Ljubljana, 14 (73.7%) gained full recovery and 4 (21%) a good recovery (some pain still present).

Discussion

Mobilisation

The decision to mobilise UMC Ljubljana was made 15 min after the event had taken place. All of the measures, albeit standard, were critical for establishing mobilisation before the arrival of the injured. The time of MCI was optimal: morning shifts had been handed over, no elective surgery had begun, and part of the night shift staff had not left the hospital. Health Care Workers' (HCW) willingness to help over-hours was abundant and was quantified at 70%, a rate comparable to the one described in accessible literature (83%).[2] Patient arrival times disclose EMU work: an even distribution did not burden the ED heavily, but at the same time most of those urgently needing medical attention arrived very early. Principles of triage used were those nominated by Frykberg.[3] Effectiveness and accuracy of triage is best assessed by critical mortality rate (fatal outcome of the critically injured),[3] 12.5% in our case. Overtriage has shown a correlation with critical mortality,[4] as a consequence of misuse of resources, predominately in mass casualty incidents, but we reported no such case. There was one case of undertriage (7.8%). Our results are a consequence of the number of injured being within our capacity. This is common for such events - the injured place significant stress on, but typically do not overwhelm a local emergency system.[5] The results would have probably been worse with a far greater number of injured. Hirshberg presented a computer model assessing trauma workload in MCIs,[6] from which a model prediction on the time to saturation (TTS) can be formulated. Roughly calculated, with an injury severity distribution similar to the one described in this article, a single triage mode, 18 active trauma teams and a predicted triage accuracy of 80%, our ED would have sustained a TTS of around 180 min and thus not overflowing its capacity until several hours had passed. In other words - our trauma teams could work until our diagnostic department or ICU would have been saturated, making them the limiting factor of MCIs at UMC Ljubljana.

Diagnostics

Although one of the most time-consuming tasks when evaluating non-urgent trauma patients are x-rays,[7] 19 of our 21 patients had them done. Use of the CT scanner should be limited initially to those few patients who need it for urgent management decisions:[7] in our case 5 people underwent CT including 2 full body scans. A true problem lay in the location of the CTs: they are located on the 1st floor opposed to the ED located on the ground floor, thus necessitating major transport of the often hardly stable patient. Our emergency department is currently undergoing renovation to include CT diagnostics on the same floor. Ultrasound may be applied to a broad category of trauma patients. FAST examination has proved to be highly accurate, sensitive and specific,[8-14] with certain value in treatment of patients involved in MCIs.[14-16] A total 38.1% of our patients needed FAST, which is similar to the 2008 Wenchuan earthquake (37.6%)[16] and 1999 Turkish earthquake (53.3%).[17] Fractures occurred in 47.6%, a rate comparable to bigger MCIs, e.g. the 2010 earthquake in Yushu, China (55.8%).[18] All burn casualties are not alike, so we should be cognizant of the different sequelae resulting from outdoor versus indoor disasters.[19] Specifically, outdoor fire disasters tend to have low on-scene and high hospital mortality rates, with many of the surviving victims having large body surface area burns. Indoor fire disasters, however, result in a higher cumulative death rate than outdoor disasters, with a greater proportion of these deaths occurring on scene.[20]

Communication

One major problem revealed was communication. The need for information accelerates during an MCI. Cell phones may be used to send broadcast messages to large numbers of people or 1 on 1 communication. Loss of communications structure hampers this ability[21] and that is exactly what happened in our case. Because of bad cell-phone reception in several parts of the hospital (e.g. Department of Radiology) and constantly busy local lines, communication and information mediation was disabled. With the intra-hospital communication between teams down, this presented a great time-consuming factor delaying cooperation. There was room for improvement, and since the event a new two-way radio transceiver system has been implemented.

Documentation

Written documentation of triage decisions and casualty management is an essential tool for maintaining continuity of care during an MCI. The chaotic environment can easily lead to losing track of casualties, and to critical omissions of treatment or redundant triage and management, as casualties move to successive echelons of care.[3] For obvious reasons, documentation may not have the highest priority when medical facilities are confronted with a large number of victims,[22] as was seen in our case, where the written documentation of diagnosis and treatment proved inadequate. We found a discrepancy between the actual management and documentation of patients in 13 out of 21 cases (62%): all of those were noted as insufficient documentation, and no falsely switched documentation was found. This is consistent with experiences reported in evaluations of previous disasters.[23,24] Plans have been made to ease documentation with dictation modules, which could enable more accurate transcription of records at a later time. This idea has yet to be clinically implemented.

ICU space

Another big problem lay in ICU space, as we were forced to transfer two patients to UMC Maribor. Davis performed a prospective assessment of hospital bed capacity in the hypothetical event of an MCI, revealing that approximately a third of patients were dischargeable within 24 hours, and about 25% were assessed as being transferable to a hypothetical on-site nursing facility. Physicians were however less aggressive in transferring or discharging ICU patients,[25] revealing a problem similar to ours - the beds most needed in an MCI are in the ICU, but forcibly discharging previous patients is deemed risky on many occasions. Lynn set up a critical boundary for maximal number of victims that any hospital is reasonably capable of absorbing during an MCI at 20% of registered beds.[26] Our ICU bed space remains unchanged due to on-going financial and personnel issues.

Planning

MCIs require regional training exercises and post event-debriefing sessions for continued improvements.[27] As learned from Hurricane Katrina, comprehensive and realistic plans are of utmost importance.[28] Planning for an MCI or bigger disaster must therefore incorporate every aspect and regional characteristic that has already proven important. Only by doing so can one establish a response maximizing outcome for all the injured. This philosophy is confirmed by Feliciano and his co-workers. They stated that in reviewing the Centennial Olympic Bombing incident in Atlanta 1996, their excellent outcomes were attributed, at least in part, to the extensive preparations and drills performed prior to the event.[29] We have revised our MCI protocol and regular MCI drills are now performed with all-level personnel rotations.

Conclusion

The Ljubljana Marshes was a good 'drill case' MCI for UMC Ljubljana as it occurred on a weekday during regular working hours. It exposed strength in mobilisation, coordination and cooperation. Weaknesses were found in intra-hospital communication, remote diagnostics, low ICU bed space and poor documentation. Investments in equipment were made, some solutions implemented, but additional infrastructure is still needed. Our MCI protocol was revised and updated. With these adjustments and regular MCI drills, our centre hopes to be better able to meet the challenges of future MCIs.

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