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Clinical patterns and hospital response following a point-source explosive mass casualty incident in Beirut, September 2024: a retrospective observational study.

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Abstract

Background: On 17 September 2024, a mass casualty incident occurred in Beirut following the simultaneous detonation of multiple pager devices, resulting in a distinctive pattern of blast-related injuries. Such point-source explosions pose unique clinical and operational challenges that are not fully captured by conventional mass casualty frameworks.

Methods: This retrospective observational study analysed patients presenting to the Emergency Department of Mount Lebanon Hospital University Medical Centre immediately following the incident. All patients were included for descriptive analysis of patient flow. Detailed clinical, surgical, and outcome data were collected for patients requiring hospital admission within 48 hours. Demographic characteristics, injury patterns, operative interventions, intensive care unit (ICU) admission, and in-hospital outcomes were extracted from electronic medical records. Data were summarised using descriptive statistics.

Results: A total of 184 adult male patients presented to the Emergency Department. Of these, 135 (73.4%) did not require hospital admission and were either transferred to other facilities, discharged after emergency management, or left without being seen. Forty-nine patients (26.6%) required admission, including 11 (22.4%) admitted to the ICU. Injuries predominantly involved the hands (83.7%) and eyes (59.1%), followed by thigh, abdominal, and intracranial injuries. More than half of admitted patients required finger or hand amputation, and one-fifth underwent eye enucleation. Multiple concurrent injuries were common, with over half of patients sustaining trauma to three or more anatomical regions. One in-hospital death occurred (2.0%).

Conclusions: Point-source explosive devices can generate highly concentrated patterns of severe extremity and ocular trauma, placing disproportionate strain on subspecialty services. These findings highlight limitations of standard triage systems and identify the need for adaptable mass casualty planning, subspecialty surge capacity, and integrated psychosocial support in disaster response.

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Introduction

On September 17, 2024, at 15:30 pm local time, Lebanon experienced a catastrophic mass casualty event due to the simultaneous detonation of approximately 3,000 pager devices. The incident resulted in over 2,750 injuries, including more than 200 critically injured individuals and at least 12 fatalities, among them children and healthcare workers. Injuries were primarily blast-related, varying by proximity to the device at detonation. A significant proportion of patients sustained ocular trauma, upper limb injuries, and facial wounds due to handling devices during activation. Approximately 60–70% of victims experienced permanent vision loss, with many requiring surgical interventions such as enucleation, globe repair, or upper extremity amputation. Traumatic brain injuries (TBIs) were observed, often associated with facial trauma and shrapnel-induced intracranial injuries. Survivors also developed neuropsychiatric complications, including post-concussive symptoms (PCS), cognitive impairment, fatigue, irritability, anxiety, and post-traumatic stress disorder (PTSD), consistent with blast-related TBI sequelae[1,2].

This incident placed an unprecedented strain on Lebanon's already fragile healthcare system. Mount Lebanon Hospital University Medical Center (MLHUMC), a tertiary referral hospital in Beirut, was among the first facilities to receive casualties, necessitating rapid activation of mass casualty protocols and immediate triage in the context of an evolving and highly atypical injury pattern. Beyond the immediate clinical burden, the event exposed important challenges related to triage, resource allocation, subspecialty availability, and surge capacity in a constrained healthcare setting. The aim of this study was to describe the spectrum and severity of injuries sustained following the pager explosion, to characterise the clinical management and early outcomes of affected patients, and to provide insights that may inform preparedness and response strategies for future mass casualty events involving point-source explosive devices.

Methods

Study design and setting

This retrospective observational study examined injury patterns, management strategies, and clinical outcomes of patients injured in the pager explosion that occurred in Beirut, Lebanon, on 17 September 2024. All patients presented to the Emergency Department of Mount Lebanon Hospital University Medical Centre (MLHUMC), a tertiary care teaching hospital affiliated with the University of Balamand. MLHUMC has approximately 200 inpatient beds and manages around 10,000 Emergency Department visits and 18,000 inpatient admissions annually.

Study population

All patients presenting to the Emergency Department on the day of the incident and identified as victims of the pager explosion were eligible for inclusion. Identification was based on documentation within the hospital information system, including self-reported history of exposure, clinical features consistent with blast injury, or specific coding indicating pager detonation as the mechanism of injury.

Patients who were evaluated in the Emergency Department and subsequently discharged or transferred to other institutions were included for descriptive analysis of patient flow. Detailed clinical and outcome analyses were restricted to patients who required hospital admission within the first 48 hours following the event. Paediatric patients and female patients were not included, as all admitted patients were adult males.

Data collection

Demographic data, including age, sex, marital status, and past medical history, were collected for admitted patients. Clinical data included vital signs at presentation, Glasgow Coma Scale score, injury type and distribution, imaging findings, operative procedures, intensive care unit admission, and in-hospital outcomes. Data were extracted retrospectively from the electronic hospital information system. Injuries were classified by anatomical system. Eye injuries included globe rupture, retinal destruction, or other vision-threatening trauma confirmed clinically or radiologically. Hand injuries included soft tissue trauma requiring suturing or debridement, as well as partial or complete digital or hand amputations confirmed intraoperatively. Intracranial injuries were defined by radiological evidence of traumatic brain injury or clinical features of altered mental

status. Abdominal injuries were defined by operative or imaging findings requiring surgical intervention. Thigh injuries included soft tissue or musculoskeletal trauma documented clinically or radiologically.

Outcomes

The primary outcomes were the distribution of injury patterns, the need for major surgical interventions, intensive care unit admission, and in-hospital mortality among admitted patients. Secondary outcomes included the requirement for imaging, blood product transfusion, transfer to other facilities after admission, and the presence of multiple concurrent injuries involving more than one anatomical system.

Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics version 25.0. Continuous variables are presented as mean ± standard deviation. Categorical variables are presented as frequencies and percentages. Confidence intervals were calculated for key proportions and are reported selectively in the text. Missing data were handled using complete case analysis. Patients who left without being seen and had no available clinical documentation were excluded from outcome analyses.

Ethical considerations

Approval from the hospital's ethics committee was given for data collection, analysis, and publication. All data were anonymised prior to analysis, and the study was conducted in accordance with institutional and international ethical standards for research involving human participants. No patient-specific data is presented, and consent was deemed unnecessary for this retrospective study of routinely collected data.

Results

Patient flow and cohort composition

A total of 184 adult male patients presented to the Emergency Department following the pager explosion. Of these, 135 patients (73.4%) did not require hospital admission. Sixty-five patients (35.3% of all presentations) were evaluated and stabilised in the Emergency Department and subsequently transferred to other hospitals for specialised care. The remaining 70 patients (38.0%) were managed at Mount Lebanon Hospital and University Medical Center without inpatient admission. Within this group, 43 patients (61.4%) were treated and discharged after receiving the required emergency care, 14 patients (20.0%) underwent wound evaluation only and were discharged, and 13 patients (18.6%) left without being seen. These latter cases were classified as undocumented owing to incomplete clinical records during the mass casualty surge. Forty-nine patients (26.6%) required hospital admission and constituted the analytic cohort. Of these, 38 patients (77.6%) were admitted to medical-surgical wards, and 11 patients (22.4%) required intensive care unit admission.

Baseline characteristics of admitted patients

The mean age of admitted patients was 35.7 ± 12.4 years, and all were male. Most patients were married (67.3%). Thirty-one patients (63.3%) had no documented comorbidities, while 18 patients (36.7%) had at least one pre-existing medical condition, most commonly diabetes mellitus type 2 and hyperlipidaemia (Table 1).

Table 1: Baseline characteristics of admitted patients (n = 49)

Characteristic	Value
Age, years, mean ± SD	35.7 ± 12.4
Male sex	49 (100)
Married	33 (67.3)
Single	16 (32.7)
No comorbidities	31 (63.3)
≥1 comorbidity	18 (36.7)
– Diabetes mellitus type 2	7 (14.3)
– Hyperlipidaemia	6 (12.2)
– Hypertension	3 (6.1)
– Coronary artery disease	2 (4.1)

Injury patterns and major interventions

Injuries predominantly involved the extremities and eyes. Hand injuries, with or without amputation, were the most frequent, affecting 41 patients (83.7%). Ocular trauma occurred in 29 patients (59.1%), followed by thigh injuries in 26 patients (53.1%), abdominal injuries in 21 patients (42.9%), and intracranial injuries in 9 patients (18.4%) (Table 2). Severe trauma necessitated major surgical intervention in a substantial proportion of patients. Finger or hand amputations were performed in 27 patients (55.1%), eye enucleation in 10 patients (20.4%), abdominal surgery in 15 patients (30.6%), and decompressive craniectomy in 5 patients (10.2%). Surgery for thigh injuries was required in

21 patients (42.9%) (Table 2).

Table 2: Injury patterns, major procedures, and in-hospital outcomes (n = 49)

Variable	n (%)
Injury patterns	
Hand injury (± amputation)	41 (83.7)
Eye injury	29 (59.1)
Thigh injury	26 (53.1)
Abdominal injury	21 (42.9)
Intracranial injury	9 (18.4)
Major procedures	
Finger/hand amputation	27 (55.1)
Eye enucleation	10 (20.4)
Decompressive craniectomy	5 (10.2)
Abdominal surgery	15 (30.6)
Surgery for thigh injury	21 (42.9)
In-hospital course	
ICU admission	11 (22.4)
Imaging required	42 (85.7)
Prophylactic antibiotics	49 (100)
Tetanus vaccination	49 (100)
Blood product transfusion	6 (12.2)
Transfer after admission	5 (10.2)
In-hospital death	1 (2.0)

Hand and ocular injury outcomes

Among patients with hand injuries, 14 patients (28.6%) underwent suturing or debridement without amputation, while 27 patients (55.1%) required finger or hand amputation. Amputations involved the right hand in 11 patients, the left hand in 8 patients, and were bilateral in 8 patients (Table 3).

Ocular injuries were unilateral in 13 patients and bilateral in 16 patients. Confirmed permanent blindness was documented in 11 patients (22.4%), including bilateral blindness in 8 patients and unilateral blindness in 3 patients. An additional 4 patients (8.2%) were classified as having possible permanent blindness. Eye enucleation was required in 10 patients. Eight patients had incomplete follow-up or unknown final ocular outcomes (Table 3).

Multiple injury patterns

Most admitted patients sustained injuries involving more than one anatomical system. Only 4 patients (8.2%) presented with an isolated injury, all of which were limited to the thigh. Nineteen patients (38.8%) sustained injuries affecting two anatomical regions, most commonly involving

Table 3: Hand and eye injury outcomes (n = 49)

Outcome	n (%)
Hand injuries	
Suturing/debridement without amputation	14 (28.6)
Finger/hand amputation	27 (55.1)
– Right	11 (22.4)
– Left	8 (16.3)
– Bilateral	8 (16.3)
Eye injuries	
Any eye injury	29 (59.1)
– Unilateral	13 (26.5)
– Bilateral	16 (32.7)
Confirmed permanent blindness	11 (22.4)
– Unilateral	3 (6.1)
– Bilateral	8 (16.3)
Possible permanent blindness	4 (8.2)
Eye enucleation	10 (20.4)
Lost to follow-up / unknown outcome	8 (16.3)

combinations of hand and thigh injuries or hand and ocular injuries. The majority of patients, 26 (53.1%), suffered from three or more concurrent injury types. The most frequent multi-system pattern involved combined abdominal, ocular and hand injuries. More extensive patterns, including four or five affected systems, were also observed, reflecting the severity and complexity of trauma sustained following the blast (Table 2).

In-hospital course and outcomes

All admitted patients received prophylactic antibiotics and tetanus vaccination. Imaging studies were required in 42 patients (85.7%) to assess the extent of injury. Blood products were administered to 6 patients (12.2%). Five patients (10.2%) were transferred to other facilities after admission for further specialised care. One patient died during hospitalisation, corresponding to an in-hospital mortality rate of 2.0% (Table 2).

Discussion

This incident represents a rare and insidious form of mass casualty trauma, characterised by point-source explosions delivered through handheld devices presumed to be harmless. Unlike conventional blast events, the pager detonations resulted in a distinctive injury pattern dominated by severe hand, ocular, and facial trauma, reflecting proximity to the device at the moment of detonation. While Lebanon has previously

experienced large-scale blast trauma, most notably during the 2020 Beirut Port Explosion, the pager incident posed a different set of clinical and operational challenges, with a disproportionate demand for highly specialised surgical and ophthalmological care.

Among visceral blast injuries, ocular and upper limb trauma were particularly prominent, mirroring patterns described in military and blast-related civilian trauma literature[1,2]. The concentration of complex hand injuries and vision-threatening ocular trauma required immediate access to microsurgical expertise and prolonged operating room utilisation. This shifted the resource burden away from general trauma management towards subspecialty services, testing the flexibility of established mass casualty response frameworks. Such injury distributions are poorly accounted for in standard triage algorithms, which often prioritise physiological instability over the potential for catastrophic functional loss.

This discrepancy was evident in the application of existing triage systems. Although many patients were initially ambulatory and categorised as non-critical according to WHO triage criteria, subsequent evaluation revealed injuries requiring urgent surgical intervention[3,4]. This highlights an important limitation of current mass casualty triage protocols when applied to point-source explosive events, in which victims may appear haemodynamically stable despite sustaining severe, function-threatening injuries. Adaptation of triage systems to account for high-risk injury mechanisms and anatomical vulnerability may therefore be warranted[5].

The incident also unfolded against the backdrop of a prolonged national healthcare crisis. Lebanon's health system has been severely weakened by the economic collapse beginning in 2019, the COVID-19 pandemic, and the cumulative impact of prior mass casualty events, leading to chronic shortages of staff, equipment, medications, and critical care capacity[6-8]. Despite these constraints, prior disaster preparedness initiatives, including structured training programmes and simulations coordinated by the Ministry of Public Health and the World Health Organization, contributed to an effective initial response. Experience gained during the 2020 Beirut Port Explosion was repeatedly cited by healthcare workers as instrumental in enabling rapid mobilisation and coordination.

Nevertheless, substantial operational challenges persisted. Intensive care capacity was rapidly exceeded, necessitating expedited transfers, early discharges, and expansion into alternative critical care areas. Operating theatres functioned continuously for several days, with elective activity suspended. The ophthalmological workload was particularly overwhelming, with some surgeons reporting an unprecedented number of enucleations performed within a short time frame[9]. These demands underscored the vulnerability of subspecialty services during mass casualty incidents and the need for contingency planning that extends beyond general trauma care.

In addition to physical injuries, the psychological burden on both patients and healthcare workers was profound. Many clinicians described scenes reminiscent of previous national tragedies, triggering emotional distress and symptoms consistent with post-traumatic stress disorder[10]. The long-term implications for survivors, including permanent visual impairment, limb loss, and associated neuropsychiatric sequelae, represent a substantial and ongoing public health challenge that extends well beyond the acute phase of care.

This study has several limitations. Survivorship bias is inherent, as only patients who reached MLHUMC were included, potentially excluding those who died prior to hospital arrival or were treated elsewhere. Transfer bias limited outcome ascertainment for patients moved to other facilities, and incomplete documentation during The surge resulted in missing data for a subset of cases. The retrospective design and focus on acute hospital outcomes precluded assessment of long-term functional recovery, quality of life, and psychological outcomes.

Despite these limitations, this analysis provides valuable insight into the clinical and operational consequences of an unprecedented mass casualty mechanism. The findings highlight the need for adaptable triage systems, robust subspecialty surge capacity, and integrated mental health support in disaster response planning. As the use of unconventional explosive delivery mechanisms

increases globally, lessons from this event may inform preparedness strategies in similarly resource-constrained settings and contribute to more resilient healthcare system responses in future mass casualty incidents.

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Data Availability: De-identified summary data and variable dictionaries for the tables are available upon reasonable request from the corresponding author.

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