Trauma care supported through a global telemedicine initiative during the 2023–24 military assault on the Gaza Strip, occupied Palestinian territory: a case series

Khaled Alser, Saad I Mallah, Yehya Rami Abu El-Oun, Mohammed Ghayada, Abd Al-Karim Sammour, Mads Gilbert, Simon Fitzgerald, Zarina Shaikh, Osaid Alser*

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*Lead author, whereabouts currently unknown

Department of Surgery, Nasser Hospital, Gaza Strip, occupied Palestinian territory (K Alser MD); **Barts Health NHS Trust, London, UK** (S I Mallah MB BCh BAO); **Faculty of Medicine, Islamic University of Gaza, Gaza Strip, occupied Palestinian territory** (O Alser MD, Y R A El-Oun, M Ghayada, A A-K Sammour); **Clinic of Emergency Medicine, The Arctic University of Norway, Tromsø, Norway** (Prof M Gilbert MD); **NYC Health and Hospitals/Kings County, Brooklyn, NY, USA** (S Fitzgerald FACS); **London, UK** (Z Shaikh FRCS[OMFS] MD)

Correspondence to: Osaid Alser, Faculty of Medicine, Islamic University of Gaza, Gaza Strip, occupied Palestinian territory **osaidalserr@hotmail.com**

Summary

Background Hospitals, patients, and health-care workers are legally protected by international humanitarian law and the Geneva Convention. However, since Oct 7, 2023, the health-care system in the Gaza Strip, occupied Palestinian territory, has been under unprecedented direct military attacks by Israel, with support for patients proving to be challenging for the remaining health-care workers. Peer-to-peer telemedicine holds promise for assisting surgeons in high-risk, low-resource environments, but might be of reduced utility in extremely austere settings.

Methods We present a patient case series of traumatic injuries shared in an international telemedicine group by the surgical team at Nasser Medical Complex, also known as Nasser Hospital, the largest remaining partially functioning hospital in Gaza. WhatsApp (Meta; Menlo Park, CA, USA), a widely available and user-friendly end-to-end encrypted smartphone application, was used to facilitate consultations for weapon-inflicted injuries. All the presented patient cases were shared after obtaining verbal consent from the patients and discussed through a multidisciplinary team approach. The group was developed into a community with more than 15 specialty and injury-oriented subgroups and over 1000 members who joined through non-targeted social media outreach followed by snowball recruitment. Prospective registration and formal ethics approval in Gaza was impossible because the Ministry of Health, including the local Helsinki Committee, had suspended all operations. In June, 2024, we obtained ethics approval from the local Helsinki committee in Gaza.

Findings We present 12 select patient case studies from a pool of hundreds of patients admitted to Nasser Hospital between Jan 28 and Feb 12, 2024. Four (33%) of the 12 patients were female and eight (67%) were male, with four patients (33%) being children (younger than 18 years). The age range was between 3 years and 70 years, with a median age of 25 years. Most patients presented with penetrating injuries (11 [92%] of 12), with six patients presenting with wounds secondary to fragment injury, and five patients presenting with wounds due to gunshots. One patient presented with a direct blast injury. The site of reported injuries included head and neck areas (four [33%] of 12), abdomen (four [33%] of 12), chest (three [25%] of 12), pelvis (two [17%] of 12), and limbs (one [8%] of 12). Most patients were lost to follow-up (11 [92%] of 12) and were affected by the invasion of the hospital by the Israeli Defense Forces, which subsequently rendered the hospital non-functional. One patient died following their injury.

Interpretation The health-care team at the now non-functioning Nasser Hospital in southern Gaza adapted their allocation and distribution of extremely low resources and relied on smartphones for specialised telemedicine outreach purposes. This enhanced the capability of the medical teams in management of mass casualties of military assaults that few are trained to work in. Nonetheless, the options available to a health-care system that is under-staffed, under-served, and under siege, are extremely constrained, regardless of such telemedicine initiatives.

Funding None.

Introduction

Delivering life-saving and timely trauma care in austere environments and war zones remains a unique challenge for any surgical team around the world. The Gaza Strip (henceforth referred to as Gaza) and the wider occupied Palestinian territory have been in a state of unrest since the events leading up to the establishment of the state of Israel, which displaced hundreds of thousands of Palestinians in 1948—an event that later became known as the Nakba (the Arabic word for catastrophe).[1] Recurrent cycles of increased tension between the two parties have continued ever since. More recently, on Oct 7, 2023, following the attacks on nearby Israeli settlements by Palestinian armed groups, including the abduction of 251 individuals, an Israeli military operation against Gaza was launched. Since then, as of June 19, 2024, at least 37 396 Palestinians have been killed in Gaza and

Research in context

Evidence before this study

We searched PubMed on May 1, 2024, for studies reporting on the use of telemedicine in patients with traumatic injuries in Gaza. We used the search terms "Gaza", "trauma", and "telemedicine", and applied no language or date restrictions. We identified only two relevant articles. The first article reported the use of telemedicine to enhance burn care teaching for surgeons in Gaza through a remote master's programme. The second article reported on the use of telemedicine to provide specialist care in cases of acute sequelae of psychological trauma in Gaza. Neither of the two articles reported on the use of telemedicine to assist in specialist care following traumatic injuries during any of the recent military attacks on Gaza.

Added value of this study

Our Article provides the first clinical report from Gaza during the 2023–24 military assaults, highlighting how a simple international group chat can be used to offer specialised telemedical input on various complex traumatic injuries. Inadvertently, this initiative shed light on the various clinical, technical, and logistical challenges that not only impede the provision of care for traumatic injuries but put the livelihood of the health-care workers attempting to provide care at risk. Despite the potential of specialist telemedical care in such austere environments and conflict zones, the scarcity of resources, inadequate staffing levels, poor internet connectivity, and targeting of health-care workers greatly reduces its usefulness.

Implications of all the available evidence

Telemedicine via a simple, peer-to-peer international group chat can be a valuable approach to the provision of crucial remote specialist trauma care in austere environments and conflict zones. Civilians of all ages in the Gaza Strip during the 2023–24 military assaults have faced traumatic injuries and insurmountable barriers to care. Likewise, health-care workers continue to operate with extremely low quantities of resources and under the threat of abduction and death. Remote and onçhe-ground support from the medical community is essential for the safeguarding of patients and colleagues.

85 523 have been injured, with over 50% of the fatalities and casualties being women and children according to the Ministry of Health in Gaza. There are also over 10 000 individuals reported as missing or under the rubble.[2] These Ministry of Health-reported numbers have been validated and are considered to be in compliance with most UN-gathered data.[3] Furthermore, according to a spatial analysis of infrastructure damage by Harvard University's François-Xavier Bagnoud Center for Health and Human Rights (Boston, MA, USA), 60·8% of health facilities within the first month of the military attacks sustained infrastructure damage, with 35·1% functionally destroyed.[4]

As per the UN, the Israeli Defense Forces (IDF) has conducted more than 1000 attacks on health-care centres in Gaza and killed at least 500 health-care workers as of June 19, 2024; this represents more than the total number of health-care worker deaths recorded across all countries in conflict in 2021 and 2022 combined.[5] According to a UN report, only 17 (47%) hospitals in the Gaza Strip were partially functioning at the end of June, 2024,[6] with an estimated average bed occupancy of 246%.[7] 19 (53%) hospitals remain out of service.[6]

Despite the unprecedented number of casualties, little is known about the pattern of injuries in Gaza in the current medical literature. Additionally, several initiatives from the global medical community have been launched to address the acute need for trauma care of those injuries both remotely and on the ground. However, the benefits and purpose of these initiatives are uncertain. We report an example of an international telemedicine group which discussed challenging traumatic injuries that presented at Nasser Medical Complex, also known as and referred to hereafter as Nasser Hospital. Nasser Hospital is located in Khan Younis City, and is considered the second largest hospital in Gaza, and the largest and most equipped in the south of Gaza.

The situation in Nasser Hospital was unique compared with other hospitals, due to not only the mass casualty situation, but also the direct attacks it faced during the military operation and the severe depletion of resources. Medical personnel had been reduced to a single general surgeon (the lead author of this Article), one plastic surgeon, and two orthopaedic surgeons, with most other health-care providers remaining being either medical students, trainee doctors, or nurses. This was further aggravated by the abduction, detainment, and killing of many of the health-care workers by the IDF.

To provide a brief context, the Israeli siege of Nasser Hospital began on Jan 21, 2024. During the direct seige of Nasser Hospital, the facility was under extreme and unprecedented conditions, resulting in the surgical staff being unable to provide safe surgical care for the mass casualties. The electricity and water supplies were cut off, impeding refrigeration, ventilation, sterilisation, and functionality of certain specialist equipment. The siege also meant that relief supplies did not reach the hospital, and even basic, essential commodities such as clean water and disinfectants were difficult to access, making hygiene a substantial challenge.[8] Although the intensive care unit (ICU) was partially functional, the capacity was only four beds, with one nurse to care for four critically ill patients, rendering true intensive care impossible. For those patients who received a surgical intervention, postoperative follow-up after discharge was impossible due to the lack of safe routes for patients, staff, and relatives to and from the hospital. The hospital was heavily bombed and then militarily invaded on Feb 15, 2024. Consequently, patients, including children, faced the risk of either being abducted or targeted by sniper attacks by the IDF, even while inside the hospital buildings or its courtyard.[9,10] According to eyewitness accounts, the IDF then left the hospital on Feb 25, 2024, and invaded it again on March 21, 2024. The lead author of this Article was abducted by the IDF on March 24, 2024, alongside other health-care workers and patients, rendering the hospital non-functional since that date until June 4, 2024, when it was partially reopened with 450 beds (personal communication).[11,12] On April 20, 2024, mass graves were discovered at Nasser Hospital after the IDF withdrew from the hospital, containing health-care workers and patients—with their medical equipment still attached—handcuffed with signs of torture as seen on footage and reported by the UN.[13,14]

We present this report in the context of both the pre-existing challenges to health care before the siege of Nasser Hospital, and the unprecedented attacks on health-care facilities and health-care workers during the ongoing military assault on Gaza. This study aims to, first, present a case study on the use of a simple but efficient method for international telemedical support during the military assault on Gaza, a unique austere environment; second, to highlight the diversity of cases and multimodality of injury and the respective clinical and technical challenges faced while providing trauma care; and third, to highlight on the ongoing health crisis in Gaza and to encourage a global response from specialists and medical societies to urgently support the health-care system either remotely or on the ground while advocating for the safety of their fellow health-care workers.

Methods

Study design

We conducted a single-centre study including a case series of traumatic injuries presenting to Nasser Hospital between Jan 28 and Feb 12, 2024, and shared by the first author for expert opinion with a telemedicine group chat containing international surgical and non-surgical specialists. Data were prospectively collected while cases were being presented in the group chat.

KA is a specialist general surgeon at Nasser Hospital with less than a year of independent experience, and was the only remaining general surgeon at the hospital from early January, 2024. After a presentation at an international, virtual surgical education webinar in late January, 2024, a telemedicine group chat was formed from audience members and panellists. WhatsApp (Meta; Menlo Park, CA, USA) was used as it is widely available and one of the most used social media applications by health-care workers in the occupied Palestinian territory, is user-friendly, and is dual-end encrypted. Within the first 72 h of creation of the group chat, via call outs on social media, over 1000 health-care workers from across many time zones around the world joined the chat to offer their expertise, including surgeons, intensivists, and anaesthesiologists. International humanitarian aid workers and logisticians were present in various chats and times according to the needs presented to help coordinate any on-the-ground assistance in real time. The chat was moderated by a team of designated moderators who were administrators for the group to maintain a focus purely on medical cases and discussion.

To organise the chat and streamline the discussion, while simultaneously expanding its member capacity, the WhatsApp community feature was used. By setting up a primary announcements subgroup exclusively for five administrators from different country zones and restricting the chats to specific times when cases were shared, the group administrators ensured crucial clinical information and patient confidentiality was preserved; this was of particular importance to the local surgeons due to the limited internet access available and time constraints. Additionally, the administrators established 15 specialty and injury-specific subgroups (eg, neurosurgery, vascular surgery, maxillofacial surgery, anaesthesia, intensive care, and orthopaedics) for posting relevant cases including wounds, and radiological and operative images. Additionally, non-clinical subgroups, such as an open chat and news page, were created to allow for unrestricted discussions that would not distract from clinical information being shared and prioritised. This study has been reported in line with the PROCESS reporting guideline where possible regarding data availability.[15]

Participant selection

After removing patient identifiers, the clinical patient cases were shared by the lead author (KA) with the group members to comment on, sharing their expert opinions in support of the best possible practice in an austere, resource-constrained, and complex setting. Patient cases presented in the group chat were chosen at the discretion of the lead author, when he considered that the patients' presentation was complex and challenging, and needed specialist opinion to decide how to best manage them in that context. The patient cases included in this study include all the cases that were discussed in the group for advice. All the presented patients were anonymised and discussed through a multidisciplinary team approach.

Quality control of the group and the study

The credibility of the members and security of the overall group was ensured via a combination of both a private survey verifying roles and medical licences of members in addition to personal connections (eg, leaders in their field who did not need further verification) with the authors. Understandably, security concerns from members were raised; however, this process was judged necessary for both the overall group safety as well as medical integrity considering the confidential and privileged clinical information, the high-risk context that the local surgeons were operating in, and other fears secondary to the hostile doxxing (the publication of private or identifying information about an individual on the internet for malicious intent) environment globally.

Regarding the method of specialist input provision, we attempted to create a standardised template by which each specialist would organise their message (case, concern, aspect being discussed, advice, and specialty). However, this proved to be cumbersome and unrealistic, and so was not strictly adhered to. The advice was mostly provided as free text in response to the images and questions sent by the lead surgeon. However, all members made sure to sign off with their names, specialty, or both, and their location of practice.

Outcomes and follow-up

Our initial plan was to report on postoperative complications including mortality; however, as detailed in the Results, most patients were lost to follow-up, including the patients' medical records, due to the invasion of the hospital by the IDF rendering the hospital non-functional.

Ethics approval

Prospective registration and formal ethics approval in Gaza was impossible because the Ministry of Health, including the local Helsinki Committee, had suspended all operations. In June, 2024, we obtained ethics approval from the local Helsinki Committee in Gaza. We did not obtain written consent from all patients, but believe the situation meets all three conditions set out in the Committee on Publication Ethics 2008 statement that it "may be possible to publish without consent if the report is important to public health (or is in some other way important); consent would be unusually burdensome to obtain; and a reasonable patient would be unlikely to object to publication". Verbal consent was obtained from patients and from the hospital administration for documentation of these cases. All documented cases were anonymised to the best of our ability.

Role of the funding source

There was no funding source for this study.

Results

We present a series of 12 patients who were admitted to Nasser Hospital from Jan 28 to Feb 12, 2024. Four (33%) of the 12 patients were female and eight (67%) were male, with four patients (33%) being children (younger than 18 years). The age range was between 3 years and 70 years, with a median age of 25 years. Most patients presented with penetrating injuries (11 [92%] of 12), with six patients presenting with wounds secondary to fragment injury, and five patients with injuries due to gunshots. One patient presented with a direct blast injury. The site of reported injuries included head and neck areas (four [33%] of 12), abdomen (four [33%] of 12), chest (three [25%] of 12), pelvis (two [17%] of 12), and limbs (one [8%] of 12; table).

One patient died on the day of admission following their injury. Most patients were lost to follow-up (11 [92%] of 12) and were affected by the invasion of the hospital by the IDF.

We present an overview of the cases included in the study in terms of their presentation, hospital course, and some highlights of their outcomes.

The first patient was a 15-year-old female who was brought to the emergency department by her mother, as there were no ambulances available at the time. According to her mother, who witnessed the attack, she had sustained a penetrating injury from an Israeli missile, causing pelvic fracture and colonic injury. A ballistic injury was identified in the left posterior lower back with fragments palpated subcutaneously. The patient had an intact airway, was haemodynamically stable with a Glasgow Coma Scale (GCS) score of 15, and did not have neurological deficits. She had no peritonitis. A CT of the abdomen and pelvis with intravenous contrast revealed that the fragments were located in the left iliac crest, causing a comminuted pelvic fracture and pneumoperitoneum, which was concerning for a possible hollow viscus injury. The telemedicine group discussed overall management of pelvic fractures in the setting of colonic injury, and agreed with the local team's approach.

The patient underwent an exploratory laparotomy demonstrating a partial-thickness sigmoid injury, which was primarily repaired using 3–0 Vicryl (Ethicon; Bridgewater Township, NJ, USA) sutures. The fragments were also successfully extracted. The left iliac wing fracture was treated conservatively due to lack of access to orthopaedic surgeons. The patient was admitted to the ward and started on broad-spectrum intravenous antibiotics for 7 days. The patient recovered well postoperatively and was discharged on postoperative day 7 with no follow-up.

The second patient was a 3-year-old female who presented to the emergency department following a fragment injury that was, according to eyewitnesses and the paramedics' report, secondary to an Israeli airstrike on Al-Aqsa University, where she and her family were taking shelter. On examination, the patient was noted to have an intact airway and was haemodynamically stable with a GCS of 15. She had a presumed entry wound in the left upper quadrant of her anterior abdomen with no exit wound. CTs on the abdomen and pelvis were done, showing pneumoperitoneum and an American Association for the Surgery of Trauma grade 4 splenic injury.

The patient underwent an emergent exploratory laparotomy (within 30 min of arrival) that revealed an anterior gastric perforation. There was no evidence of a posterior gastric injury. The patient underwent a splenectomy, and the gastric perforation was primarily repaired using 2–0 Vicryl in two layers. She was not given post-splenectomy vaccination, despite advice from the multidisciplinary telemedicine group, due to the unavailability of the required vaccines. The patient recovered well on the ward and was discharged on postoperative day 5 under the ongoing care of her family with no follow-up.

The third patient was a 35-year-old male operating room nurse from Nasser Hospital, who sustained a gunshot injury to the right side of the chest while on duty inside the hospital's operating room. According to eyewitness

	Sex	Age, years	Mechanism of injury	Timing of presentation	AAST organ injury severity grade	Operative intervention	Main resource limitation	Expertise requested or provided through telemedical support	Outcome
1	Female	15	Penetrating fragment	Likely delayed	Grade I sigmoid colon; comminuted pelvic fracture	Oversewing of sigmoid colon injury	Pre-hospital transport, orthopaedic care	Orthopaedic opinion of management of pelvic fracture in the setting of colonic injury	No outpatient follow-up possible
2	Female	3	Penetrating fragment	Unknown	Grade IV spleen, grade II stomach	Splenectomy, primary, two-layer gastrotomy repair	No access to post-splenectomy vaccines	General postoperative care	No outpatient follow-up possible
3	Male	35	Penetrating gunshot	Unknown	Grade III lung parenchyma	Tube thoracostomy	No adequate drainage canister, insufficient quantity of chest tubes, no radiologists	Troubleshooting the lack of wall suction to better drain air, and assistance with CT interpretation for tube location	Patient was abducted, tortured and chest tube dislodged; no obvious clinical sequelae. He was later released
4	Male	25	Penetrating fragment	Unknown	Tracheal ballistic injury, full thickness	Primary, two-layer repair of trachea	No access to pan-endoscopy or specialised ENT or maxillofacial services	Guidance on surgical exploration of penetrating neck injury	No outpatient follow-up possible
5	Male	30	Penetrating gunshot	Unknown	Grade III lung parenchyma, grade IV cardiac injury	Primary repair of heart, primary repair of lung with tube thoracostomy	No access to cardiothoracic or cardiology services	Bedside echo taught through shared online videos and tips	Patient lost to follow-up during siege
6	Male	40	Penetrating gunshot	Delay in presentation (2 weeks)	Grade II rectal injury—intra-peritoneal and extra-peritoneal; sacral fracture	Diverting loop then end colostomy; serial debridements, irrigations, and washouts	No access to vacuum assisted closure for wound care	Decisional support regarding ongoing purulence and sepsis, necrotising soft tissue infection including serial debridement in the operating room, and need for converting loop to end colostomy for better diversion	Patient lost to follow-up during siege*
7	Male	28	Penetrating fragment	Unknown	Penetrating brain injury, intra-cerebral haemorrhage, no herniation (GCS=15)	Conservative management	No access to neurosurgical services, limited access to repeat head CT	Support to limit secondary brain injury, substitutes in anti-seizure medication for prophylaxis	Patient lost to follow-up during siege
8	Male	18	Penetrating gunshot	Unknown	Grade II cervical vascular injury; injury to submandibular gland, posterior wall of oropharynx, soft palate	Neck exploration	No access to ENT or maxillofacial services	Support for postoperative management of salivary leak	Patient lost to follow-up during siege
9	Female	70	Penetrating fragment	Likely immediate	Penetrating brain injury, extensive intracerebral haemorrhage, subarachnoid haemorrhage, cerebral oedema (GCS=3)	Conservative management	No access to neurosurgical services, limited access to repeat head CT, no access to intracranial pressure monitoring	Support for neuroprognostication and futile operative intervention	Died within 1 h of admission
10	Male	15	Penetrating fragment	Delay in presentation (5 days)	Full-thickness laceration of the upper lip and left cheek with necrotic tissue over the wound edges; open fracture and loss of bone to the left upper alveolar process, hard palate, and left maxillary sinus were noted	Surgical debridement of necrotic tissue	No open reduction and internal fixation available as no plates were available, nor specialised maxillofacial services	Non-operative management of facial fractures	Patient lost to follow-up during siege

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	Sex	Age, years	Mechanism of injury	Timing of presentation	AAST organ injury severity grade	Operative intervention	Main resource limitation	Expertise requested or provided through telemedical support	Outcome
(Continued from previous page)									
11	Male	25	Penetrating gunshot	Unknown	Grade III abdominal vascular injury (right internal iliac artery); complex acetabular fracture; grade IV bladder injury	Surgical repair of iliac injury (suture ligation), single-layer repair of the bladder	No vascular surgery services, no orthopaedic surgical intervention available, no resources for on-table cystogram	Optimal management of bladder injury including two-layer repair and correct classification of the injury	Patient lost to follow-up during siege*
12	Female	9	Blast injury	Unknown	Mangled left arms and legs, both MESS=7	Guillotine above-elbow amputation of left arm and above-knee amputation of left leg	No specialised multidisciplinary services available for attempt at limb salvage	Calculating MESS score, arriving at decision to amputate versus limb salvage	Patient lost to follow-up during siege

Grades of AAST range from I to IV. AAST=American Association for the Surgery of Trauma. ENT=ear, nose, and throat. GCS=Glasgow Coma Scale. MESS=Mangled Extremity Severity Score. *Patient reported as abducted by family members to lead author.

***Table:* Summary of baseline characteristics, injuries, management, limitations, advice provided, and outcomes of trauma cases shared with the telemedicine group from Nasser Hospital**

accounts, the gunshot was from an Israeli sniper bullet and photographic evidence of the bullet damage to the hospital building was provided. One ballistic injury was just medial to the right deltopectoral groove and a second, presumed exit wound was to the upper border of the right scapula. On examination, the patient was haemodynamically stable but in obvious respiratory distress. Breath sounds were diminished on the right side for which an immediate 24 French chest tube (the only size available at that time) was placed, draining 750 mL of blood. A CT scan of the chest was then performed while the chest tube was mistakenly clamped by inexperienced personnel and showed a large right-sided haemopneumothorax with subcutaneous emphysema.

The multidisciplinary telemedicine team reviewed and reported on the CT imaging once the internet allowed for upload. Discussions were had regarding the severity of the haemopneumothorax in view of the volume of blood drained, the replacement versus furthering of the tube in the contexts of sufficient drainage, infection risk, and resource management, and improvised one-way flutter valve using surgical gloves.

After the chest tube was attached to wall-mounted suction, breath sounds were equal bilaterally and patient oxygen saturation improved to 99% on room air. The day after injury, the chest tube output was still bloody but remained at 900 mL per 24 h, with a small, persistent air leak.

A week later, the IDF invaded the hospital, detaining and taking the patient under Israeli custody after reportedly assaulting him in the head and chest area, according to the patient during an interview with the study team. As a result, his chest tube canister was damaged and the tube was dislodged completely. Nonetheless, upon release by the IDF the patient's respiratory status remained stable, and he did not require further interventions. The patient recovered from his chest injury but reported moderate to severe psychological distress from the incident, as confirmed by one of the authors who contacted him for an informal follow-up. He also reported weakness and numbness to his right upper extremity indicating a possible brachial plexus injury, new after the assault. However, the patient was unable to follow up with the treating team as the hospital was no longer functional.

The fourth patient was a 25-year-old male, who presented with a zone 3 anterior neck penetrating injury just to the right of the midline, secondary to apparent aerial bomb fragments. On arrival to the emergency department he was complaining of neck pain and haemoptysis. On examination, the patient was able to protect his airway, phonate, and breathe, and was haemodynamically stable with a GCS of 15 without focal neurological deficit. A 5 mm penetrating injury with no presumed exit or secondary injury was noted. There were no hard signs of penetrating neck trauma such as active arterial haemorrhage, expanding haematoma, any bruit or thrill, air bubbling through the wound, or unilateral paralysis. There were hard signs for aerodigestive tract or vascular injury noted for progressive neck swelling and diffuse subcutaneous emphysema with the haemoptysis. Urgent CT of the neck and chest with intravenous contrast to delineate the extent of fragmentation injury showed fragments at the left lung apex, but no occult pneumothorax, with a tract traversing the upper trachea, and signs of a possible full-thickness tracheal injury as well as potential injuries to the oesophagus and lung parenchyma. CT angiography ruled out any cerebrovascular injury.

The plan was to perform triple scopes, meaning direct laryngoscopy, bronchoscopy, and oesophagoscopy to rule out tracheobronchial or oesophageal injury. However, no ear, nose, and throat or maxillofacial surgeons were present in the hospital due to the dangerous conditions. For this reason, only direct laryngoscopy was performed by the anaesthesia team, which showed no signs of injury to upper airways. The patient then had an open neck exploration via a collar incision. After mobilisation of the lower portion of the right thyroid lobe, a 3–4 mm through-and-through perforation of the trachea was noted; this was primarily repaired using a 3–0 Vicryl suture. A Penrose drain was placed, and the incision was closed in layers. The fragment was located over the left lung apex on CT scan. Direct inspection of the cervical oesophagus revealed no injuries. The patient was intubated for 12 h postoperatively. After extubation, he progressed well, and the emphysema was decreasing with no new complaints reported. The drains were removed, and he was discharged on postoperative day 4. The patient was also lost to follow-up.

The fifth patient was a 30-year-old male who arrived at the hospital via ambulance after sustaining an explosive gunshot injury to the chest with inlet wound approximately at the right lower parasternal area between the sixth and seventh ribs. Upon arrival, the patient complained of severe chest pain and shortness of breath. He was stable, with a GCS of 15 and no neurological deficits. The patient had decreased breath sounds on the right side. Therefore, a right-sided chest tube was placed, air released, and a CT scan of the chest with intravenous contrast was done. A bullet fragment in the right ventricle along with pericardial effusion was seen. Ultrasound was not available.

The patient underwent an emergency right anterolateral thoracostomy. A pericardiotomy was then performed and revealed a 0·5 cm anterior right ventricular full-thickness injury, which was repaired using 3–0 Prolene sutures (Ethicon). The right lung was examined, and a lung perforation was found, which was also repaired with 3–0 Vicryl sutures. The primary surgeon (KA) decided not to extract the small fragment in the right ventricle because the surgical field was bloody, and the perforation was small. It should be noted that at this time, Nasser Hospital lacked access to cardiothoracic surgeons and cardiologists. The patient was subsequently transferred to the ICU for postoperative monitoring. The case was discussed afterwards in the telemedicine group chat concerning the need to go back and extract the fragment. Recommendations from cardiothoracic surgeons and cardiologists were to only observe it unless cardiac function deteriorated. The surgeon performed a bedside cardiac ultrasound after he was taught how to do it through a YouTube video that was sent to him and he was able to locate a functioning ultrasound. Due to the invasion of the hospital a few days postoperatively and removal or abduction of some of the staff and patients, the patient was unable to be located. His status, to date, remains unknown.

The sixth patient was a 40-year-old male who arrived by ambulance following a gunshot wound that had been sustained 2 weeks before presentation, with an explosive bullet type of projectile. The inlet wound was on the left side of the pelvis with an exit wound in the right gluteal area. The patient was stable and had a CT scan of his abdomen and pelvis. The axial imaging identified the bullet tract. The CT images indicated injury to the pelvis, rectum, and gluteal muscles.

The patient underwent an exploratory laparotomy. The operating room team found a low anterior rectal injury causing full-thickness damage of the rectum, both at the intraperitoneal and extraperitoneal portions. The posterior rectal wall was destroyed and filled with pus. The patient had also sustained a fracture of the sacral bone. Following pelvic dissection with closure of both the anterior and lateral walls, a closed loop colostomy was created.

The right gluteal wound was irrigated and packed with gauze, and broad-spectrum intravenous antibiotics were started. Due to the infected wound, the orthopaedic surgery team at Nasser Hospital decided to place skeletal traction as a temporising measure until the source of the infection was successfully controlled. The patient was taken daily to the operating room for washouts and dressing changes due to his inability to tolerate them at the bedside. 1 week after the operation, the colostomy started to function, and the patient remained haemodynamically stable but continued to have persistent leukocytosis and fever. He was bed-bound with no mobility due to his fractures and the unavailability of physical therapy resources. The patient then developed a necrotising soft tissue infection in his right gluteal wound and was taken back to the operating room for excisional debridement. After debridement of the necrotic and infected tissue, the sacral bone fracture and complete destruction of the posterior wall of the rectum was evident, and the wound was filled with a purulent discharge. The wound was irrigated and packed with saline-soaked gauze.

On postoperative day 11, despite the functional colostomy, copious amounts of purulent exudate and mucus were draining from the rectum daily. After presenting the case in the group chat and internal debate, the operating surgeon was advised to convert the loop colostomy to an end colostomy in order to achieve complete diversion, and to place a Malecot drain through the rectum for better drainage. On postoperative day 14 (3 days after postoperative day 11), the stoma was converted to an end colostomy, the wound was further debrided, and a three-way Foley catheter was placed in the rectum for drainage and continuous irrigation using saline. After discussing the benefit of rectal irrigation using a Foley catheter with the telemedicine group, the decision was made to discontinue irrigation 2 days later and keep the catheter in place for drainage only. The patient's cousin later reported that they had been abducted by the IDF, with their postoperative course unknown, but leaving concerns for risk of sepsis and eventually death.

The seventh patient was a 28-year-old male who was brought by ambulance following an explosive fragment injury to the head. He was conscious on arrival, without neurological deficit (GCS of 15). He complained of a mild headache, nausea, and vomiting. Following a full trauma evaluation, a CT scan of the head without contrast was performed. Investigation showed a haemorrhagic bullet tract starting from the left frontal lobe and extending to the left occipital lobe, with a fragment settled in the left occipital lobe. Intraparenchymal and intraventricular haemorrhage was present along the tract without midline shift. The team could not access neurosurgical specialists, and the patient was admitted for observation and conservative treatment. Antibiotics (ceftriaxone, metronidazole, and clindamycin) were prescribed, and a prophylactic anticonvulsant (carbamazepine) was administered in the absence of other preferred options due to the restricted pharmacological supply. Notably, vancomycin and more common anticonvulsants (eg, levetiracetam or phenytoin) were not available, despite favourable recommendations by the multidisciplinary telemedicine group. A follow-up CT scan was only able to be performed on day 5 after hospital admission (normally we repeat a scan 6 h later after admission), revealing partial haematoma absorption, slight cerebral oedema, and ventricular compression, but no obvious midline shift. The patient remained neurologically intact, but did start to have nausea and episodes of vomiting on post-admission day 1. Ondansetron was administered and the vomiting partly subsided. On day 7, the patient had to evacuate the hospital on foot due to the ground invasion of the hospital by the IDF;[16] as such, a follow-up appointment was impossible.

The eighth patient was an 18-year-old male who presented to the hospital following a gunshot injury to the left side of the neck at the angle of the mandible (zone 3), resulting in active arterial bleeding. On arrival at the hospital, the patient was promptly taken to the operating room. Upon examination, the wound was seen to extend to the posterior wall of the oropharynx. Further assessment revealed transection of the facial artery and a superficial injury to the submandibular gland.

The immediate surgical intervention included bleeding control by ligating the injured facial artery, followed by repair of the soft palate and uvula in layers with 3–0 Vicryl sutures. The mucosal closure was performed using 3–0 Vicryl from the inside. The submandibular gland capsule was closed followed by layer-by-layer closure of the muscles externally with 2–0 Vicryl sutures. The wound was then primarily closed. A Penrose drain was placed for drainage near the submandibular gland. A regional pressure dressing was applied to reduce the risks of a sialocele, as advised by the multidisciplinary telemedicine group.

Postoperatively, the patient remained stable and was kept fasting for 48 h. The patient's diet was advanced to clear liquids with no subsequent sialocele collection until he could start on a full liquid diet on postoperative day 5, without complications. Follow-up examinations after 7 days indicated satisfactory healing of the wound without any early complications. The patient was discharged without follow-up with the managing team.

The ninth patient was a 70-year-old female who was brought to the hospital via ambulance after experiencing head trauma due to fragments from an aerial bomb near her house. Upon arrival, she was haemodynamically unstable with a GCS of 3. The patient was intubated in the emergency department. A CT scan of the head showed extensive structural damage: the projectiles had entered from the left side as marked by the swollen left temporalis muscle and air in the tissue. The left temporal bone was fractured, and the wound tract originated in the left temporal lobe, heading upwards, across the basal ganglia, through the lateral ventricles, right basal ganglia, and to the cortex. A metal artefact in the right hemisphere appeared to indicate that the projectile had bounced off the inside of the cranium. There were also multiple fragments in the left temporal lobe with associated intracerebral haematoma and subarachnoid haemorrhage. She also had extensive intraventricular haemorrhage. Early cerebral oedema was clearly present.

The multidisciplinary telemedicine group concluded that, given the patient's age, the pattern of injury, and lack of access to specialist neurosurgical care, there was no acute surgical intervention that would change the already grave prognosis. Additionally, resources such as intracerebral pressure monitors were not available. Hypertonic saline had to be reserved for polytraumatic patients with traumatic brain injuries. The patient received neuroprotective treatment with controlled ventilation, intravenous levetiracetam, and antibiotics. She died on the same day.

The tenth patient was a 15-year-old male who presented with a 5-day-old fragment injury to his face that was, according to his family who witnessed the blast, secondary to an Israeli tank missile fired near him, which resulted in his injury. The patient also reported previous detainment by the IDF. Delay in accessing care was secondary to intense bombing in the area and besiegement of his neighbourhood. The patient could not eat or drink for 5 days following his injury. On examination, he had a full-thickness laceration of the upper lip and left cheek with necrotic tissue over the wound edges. Open fracture and loss of bone to the left upper alveolar process, hard palate, and left maxillary sinus were also present. The patient had no airway compromise and was breathing through his mouth exclusively.

The team performed debridement and closure with the help of the only plastic surgeon left in the hospital. Following debridement of necrotic tissue, mucus membranes were closed over the sinus.

No plates for maxillofacial surgery were available due to the siege, nor were maxillofacial surgeons available as they were unable to reach the hospital. Imaging was shared with remote maxillofacial surgeons via the telemedicine group. They advised a conservative fracture approach, citing the motto of one of the founders of modern war surgery, Sir Harold Gillies, "Thou shalt not do today what thou canst put off until tomorrow."[17] The patient recovered well, with decent aesthetic outcomes, albeit with psychological trauma from his reported detainment and injuries. He was discharged from the hospital, but was lost to follow-up

The 11th patient was a 25-year-old male with a gunshot wound to the right lower quadrant of his abdomen. On arrival at the hospital, he was haemodynamically unstable. His vital signs improved after fluid resuscitation with crystalloid, as blood was not available. A CT scan showed active bleeding to the right side of the pelvis with the bullet fragment seen to be lodged in his left acetabulum, causing a complex fracture. Following fluid resuscitation, he was taken emergently to the operating room for an exploratory damage-control laparotomy. An active bleed from the right internal iliac artery was identified and suture-ligated. An intra-peritoneal bladder injury was noted to the right side of the dome of the bladder. This injury was repaired with single-layer 2–0 Vicryl. A leak test was performed with an on-table cystogram using a Foley catheter with 200 mL of instilled saline, which was negative. Methylene blue was unavailable. The case was discussed in the telemedicine support group focusing on whether two-layered repair would be a better option than one-layer repair. Because the leak test had been negative, KA opted to continue with Foley catheter drainage. The patient was later abducted from the hospital by the IDF according to his relatives, and his subsequent postoperative course and treatment is unknown.

The 12th patient was a 9-year-old female who presented with severe soft tissue injuries to her left arm, left lower abdominal quadrant, left groin, and left thigh. The telemedicine group judged that her left arm and leg had a Mangled Extremity Severity Score of at least 7. The patient was in haemorrhagic shock and required intravenous fluid resuscitation. Blood products were in extremely short supply, and often not available, including in this instance. On further examination, her femoral artery was completely avulsed, along with the femoral vein. Comminuted fractures of the femur along with a displaced fracture of the humerus were visible. The multidisciplinary telemedicine group recommended guillotine amputation of the left upper and lower limbs (above-knee) owing to the severity and type of the injury, quantity of lost soft tissues, the risk of infection, scarcity of health-care workers available, and absence of standard postoperative care. The procedure was performed under general anaesthesia, as it was available in the hospital. As with other cases reported here, the child's postoperative course is unknown because the hospital was invaded a few days later and shut down by the IDF.

Discussion

We present the first detailed report of traumatic injuries and their management from the ongoing IDF assault on Gaza. We report 12 cases of military-type injuries over a wide range of ages, and the telemedical support each case received, while Nasser Hospital was under siege by the IDF between January and February, 2024.

Our patient case studies are diverse in their complexity, anatomical locations, and age groups; from the 3-year-old girl with intra-abdominal organ injuries secondary to bomb fragments to the 70-year-old woman fatally shot in the head. These represent a very small, but representative cohort of the thousands of patients who presented to the same hospital in unprecedented numbers, overwhelming capacity in a continuous mass casualty scenario. More patient cases could not be discussed after Feb 12, 2024, due to a loss of internet connectivity and communication with KA, the surgeon and primary author of this Article. Communication was regained briefly in late February before terminating once again in March, when KA was abducted on March 24, 2024. These 12 cases represent the most comprehensive patient case discussions we have available to share. Gaza's health-care system was facing severe and debilitating manufactured constraints even before Oct 7, 2023, because of the ongoing sanctions on basic food, supplies, and medicines by Israel.[18] The availability of medications on the WHO Essential Drug List were down to 55% before Oct 7, 2023.[19] Many medical specialty treatment options were also deficient due to the siege and restrictions on travel of health-care workers and patients between hospitals.[19] Comprehensive resources for cancer diagnostic and treatment services, for instance, required outside referral, which would often be delayed or denied without cause, contributing to unnecessary mortality.[20] According to UN data, over half of the population of Gaza was living in poverty, with 80% of the population dependent on foreign aid even before the most recent assaults on Gaza.[19,21]

The ongoing 2023–24 military attack created an acute crisis and unprecedented strain on the already chronic restrictions on the health-care infrastructures, leading many well regarded organisations to refer to it as a collapsed health-care system.[22] As of Sept 28, 2023, according to unpublished results from the first occupied Palestinian territory's surgical capacity assessment (SCALPEL) study done by the corresponding author (OA), Nasser Hospital had 307 beds, with nine board-certified general surgeons, seven non-board-certified general surgeons (who have completed residency but were in the process of getting certified), two plastic surgeons, eight general surgery residents, and three junior doctors. Additionally, it had seven anaesthesiologists and four anaesthesia residents. This number had dropped substantially by February, 2024, to only one general surgeon, two anaesthesiologists (who were also later detained by the IDF), one plastic surgeon, and two orthopaedic surgeons, with only a few junior doctors and medical students remaining. The shortage of medical personnel represented a huge challenge for the surgical team in terms of managing the mass casualties overwhelming the hospital.

A spatial analysis of damage to infrastructure in Gaza within the first month of the military assault found no difference in the odds of damage detected between medical complexes and all other buildings.[23] Another study found that the high degree of damage clustering at health facilities (>60%) indicated the likelihood of such damage occurring by random chance was less than 1%.[4]

By Feb 14, 2024, fuel reserves in the Nasser Hospital generator were depleted. Previous requests for WHO's assistance to try to mitigate this had been blocked several times previously, and hence the electricity supply came to a complete halt in the complex.[24] The telemedicine group assisted by contacting key organisations to arrange the emergency evacuation of the most critically unwell patients, with the assistance of WHO, the Palestine Red Crescent Society, and the UN Office for the Coordination of Humanitarian Affairs. Despite the efforts of the team at Nasser Hospital, at least five patients died in ICU as their ventilators ceased to work without electricity;[24] an unconscionable, and preventable with appropriate support, loss of life reminiscent of the three infants in the ICU at Al-Nasr Hospital (Gaza City, occupied Palestinian territory) who were found decomposed following forced evacuation orders.[25]

A common theme among all patient cases presented here is the loss to follow-up, which was due to multiple factors, such as the bombardment of the hospital including the outpatient department, the life-threatening dangerous situation outside and inside the hospital compound (including direct shooting at anyone moving around), and detention of staff and patients (eg, the sixth and 11th patient after the IDF invaded the hospital). At the time of writing our primary author, KA, remains in Israeli custody with recent news of potential torture from a released individual, but his exact whereabouts are still unknown. There have been multiple reports of torture from detained health-care workers.[26] It is worth noting that Adnan Al-Bursh, head of the Orthopaedics Department at Al-Shifa Hospital, died in Israeli detention on April 19, 2024, secondary to multiple reports of torture.[27] Subsequently, it was also reported that Iyad Rantisi, the head of a women's hospital in Beit Lahia, northern Gaza, was also arrested and declared dead on Nov 17, 2023, although the news was not made public until June 18, 2024.[28]

Functionality of our telemedicine group largely depended on internet access, which was not initially available and became increasingly erratic as time progressed. By February, 2024, the lead author required several eSIM cards to maintain his internet access, which necessitated access to the roof of the hospital for an internet signal. One man who attempted to access the internet on the roof was shot in the head by a sniper of the IDF as witnessed by the lead author; therefore, access continued to remain restricted as the health-care workers inside the hospital refrained from going to the roof or any open area within the hospital. When time and internet permitted, and with the help of the group administrators' discussion moderation, KA sent patient cases, images, and clinical questions to the group to gather expert advice. Alternate internet providers such as Starlink (SpaceX; Redmond WA, USA) were not available to any of Gaza's hospitals, despite it being reported that the company would support communication links in Gaza with "internationally recognized aid organizations".[29]

It is also paramount to understand the extent to which a hostile party can undermine or destroy the communication capacities of a whole health-care system. In Gaza, this communication breakdown was not only caused by incapacitating internet access, but also other communication systems, such as radio communication between the public emergency number, the ambulance dispatch centre, and the individual ground ambulances, which caused major communication difficulties in the prehospital emergency system. This made prewarning of patients en route to hospitals impossible.

In the face of such adversity, the deployment of remote telemedicine support has emerged as a vital lifeline for health-care workers on the ground, allowing for the provision of multispecialty advice for complex patient cases in an unprecedented environment that strained most normal medical protocols to their limits. With the help of this telemedicine group chat, the primary author (KA) was able to make decisions in real-time (albeit with some delay at times due to constant interruption in electricity and internet access) that might have improved patient outcomes. Additionally, the remaining staff appreciated feeling supported to some extent by specialists who dedicated their time and efforts for remote medical support, acknowledging the difficulty of their situation. This innovative approach to health-care delivery has been crucial in an area where over 500 health-care workers have been killed, abducted, or tortured, and targeted killings of community aid workers along with blockades on the delivery and supply of crucial medical resources have further impeded the ability to provide care.[2,30–32] The focused attack on health-care workers and the prevention of normal care pathways due to high-risk travel and the ignoring of international law highlight the urgent need for a re-evaluation of current strategies to support those in need.

An additional inadvertent success from the group chat was the vast network it facilitated, connecting a range of stakeholders including health-care professionals, non-governmental organisation leaders, humanitarian aid workers, and media-affiliated individuals. This allowed for multiple press releases,[33] as well as on-the-ground coordination for aid supply and medical evacuations, including through initiatives such as Gxza Health. One of the group chat members, Mark Perlmutter—an orthopaedic surgeon in the USA, current President of the World Surgical Foundation, and past Vice-President of the International College of Surgeons—was able to coordinate a life-saving visit to Gaza after another group member and

For **Gxza Health** see http://gxzahealth.org/

international volunteering trauma surgeon sent an x-ray of a fracture for management advice. Perlmutter spoke at length about his experience, and the degree of violence he witnessed, especially that directed at children.[34]

Telemedicine interventions are not new to the region.[35] A systematic review of such interventions in six conflict-affected countries in the WHO Eastern Mediterranean region reported on 24 different studies, only one of which pertained to Gaza, referring to a dedicated telemedicine platform for rehabilitation medicine.[35] Overall, 14 of the included studies relied on electronic referral systems (including email systems and dedicated platforms), while eight used social media applications (including WhatsApp, Facebook, Telegram, Viber, and Skype).[35] Despite the absence of functionality-tailored features, the cited benefits for the use of generic social media applications included their low cost, low internet bandwidth use, minimal training, and easy access to hardware.[35]

The IDF's invasion and near occupation of Gaza has directly resulted in ongoing human rights violations against a besieged civilian population, with the health-care system at the brink of total collapse amid a humanitarian crisis that demands immediate international attention. Patient cases presented in this Article show the use of multi-modality military weaponry against a densely populated and unprotected civilian population, which also has a particularly young demographic (over half of the population is aged <20 years).[36] Several reports from international volunteer doctors in Gaza indicate the probable targeting of civilians and children by the IDF (personal communication).[10] This suggests actions that are in direct contravention of International Court of Justice rulings, the Geneva Conventions, and international humanitarian law.[37–39] The injuries presented here were encountered by a surgical team who did not have physical access to many of the specialists and resources that trauma centres normally rely on. Adding to the fragile situation was the predominance of general malnutrition, common infectious diseases, nutritional anaemia, and an increased burden of disease in the general population.[40] The severity of the injuries and situation observed among a wide demographic range emphasise the brutal nature of the military assault and its disregard for human life. There is a pressing urgency to support and rebuild the remaining health-care infrastructure and educational systems to ensure that patient care and follow-up can continue, and to prepare the next generation of health-care workers.

There are several limitations to this case series. First, we were limited by presenting the results of only 12 selected cases with sparse clinical details. There were multiple reasons for this, including the challenging access to electricity and internet, the high-risk security situation, and the abduction of health-care workers. Another limitation to our approach was the unforeseen volume and chatter of clinical support by physicians and surgeons on our WhatsApp chat. There was an overwhelming response of over 1000 clinicians who joined or requested to join our group. We have discussed in the Methods our approach to moderate the discussions to limit non-clinical distractors and verify member credentials.

Additionally, a limitation of any such telemedicine initiative is that it is restricted by what is available on the ground. In many instances, the specialist input to improve patient care requires resources that are not available. As such, feelings of helplessness among both doctors on the ground and in the chat might be overwhelming. In such situations, we took note of the resources that could be of use and conveyed them to aid organisations or medical volunteers that were planning on visiting Gaza in the near future. Additionally, it was important to emphasise to group members that all advice must take into consideration the limitations of such austere settings, and should preferably be made by those with experience in rural, war, and global surgery.

Finally, we, the authors, are fearful that an unintended consequence of our communications was to place KA at increased risk. Despite the altruistic motivation to create a smartphone-based telemedicine support group for our surgical colleagues engaged in real-time patient care (as was requested by KA himself), our actions might have been inadvertently harmful. As mentioned, our case series was cut short as we lost contact with first author KA for a short period during the siege of Nasser Hospital by the IDF. Although contact was re-established several days later, it was once again interrupted with information that KA was abducted by the IDF. Although we know that the abduction, harassment, and killing of health-care workers has not been unusual during the siege of Gaza, we are uncertain whether our ongoing contact with KA, as a large group of international surgeons, inadvertently led to his detection, surveillance, and ultimately disappearance. It is worth noting that despite software end-to-end encryption, this does not prevent forced hardware access, a tactic practised by the IDF.[41] This is a limitation that should be strongly considered by other groups providing remote support in high-risk conflict zones.

In conclusion, this study provides a brief initial report, albeit one with valuable insights into the demographics, patterns of injury, management, and outcomes of selected patients with traumatic injury following the ongoing military attacks on Nasser Hospital. It also presents a detailed case study on the practicalities of creating a simple, cost-effective, and efficient international telemedical support group. We have shown in this report that in extreme crisis and mass casualty situations during the military occupation and invasion of Gaza, an innovative telemedicine-based consulting approach can augment the capacities of even small teams of dedicated health-care workers, and provide important psychosocial support to ease individual and team helplessness and isolation during extreme situations. While offering support to a rudimentary and overwhelmed surgical service, our records also demonstrate that the limitations imposed by the military siege made the standard of care for trauma patients in Gaza impossible. The exercise in telemedicine became one of forensic anthropology as the exchanges became crucial, not only for clinical feedback and advice, but for the documentation and communication of the violence suffered by Nasser Hospital and its health-care workers as it was systematically rendered non-functional by the military assault. As this Article is completed, the whereabouts of the detained lead author, Khaled Alser, remain unclear, but this Article stands as a testament to his unwavering commitment to his community and patients.

Contributors

The corresponding author and analysis group had full access to all the data in the study, and the corresponding author and all other authors had final responsibility for the decision to submit for publication. KA provided the case write-ups. KA, SIM, YRAE-O, MGh, AA-KS, MGi, SF, ZS, and OA contributed to drafting and revising the manuscript. OA, SIM, and MGi edited the final draft for content, language, and clarity. OA and SIM formatted the manuscript. OA supervised the research project and is the overall guarantor. All authors approved the final version of the manuscript (with the exception of KA, who was uncontactable).

Declaration of interests

OA studied medicine in Gaza and subsequently worked in many of its hospitals, including Nasser Hospital and Shifa Hospital. After he left Palestine, he co-founded OxPal 2.0 to support medical education in Palestine through partnership with consultants from the University of Oxford, Oxford, UK, and other medical schools in the UK and the USA. MGi has been a researcher in Gaza since 2009; has had papers and abstracts with *The Lancet* and other journals on medical and medico-legal topics; and two books on medical conditions in Gaza published. He is a member of the *Lancet* Palestinian Health Alliance (LPHA; a network of Palestinian, regional, and international researchers who are committed to the highest scientific standards in describing, analysing, and evaluating the health and health care of Palestinians, to contributing to the international scientific literature, and to developing local evidence-based policy and practice), and has served as a peer reviewer for submitted papers to the annual LPHA meetings. All other authors declare no competing interests.

Data sharing

Further information on any of the cases shared in this manuscript is limited due to the loss to follow-up, and the absence of documentation from the hospital that has been rendered non-functional following the ground invasion and bombing of its main buildings. Anonymised radiographic and photographic images for all cases that we included are available on reasonable request to the corresponding author.

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References

1 UN. About the Nakba – the question of Palestine. https://www.un.org/unispal/about-the-nakba/ (accessed May 26, 2024).
2 UN Office for the Coordination of Humanitarian Affairs. Hostilities in the Gaza Strip and Israel - reported impact | day 213. United Nations. https://www.ochaopt.org/content/hostilities-gaza-strip-and-israel-reported-impact-day-213 (accessed May 9, 2024).
3 Huynh BQ, Chin ET, Spiegel PB. No evidence of inflated mortality reporting from the Gaza Ministry of Health. *Lancet* 2024; **403:** 23–24.
4 Asi Y, Mills D, Greenough PG, et al. 'Nowhere and no one is safe': spatial analysis of damage to critical civilian infrastructure in the Gaza Strip during the first phase of the Israeli military campaign, 7 October to 22 November 2023. *Confl Health* 2024; **18:** 24.
5 Medical Aid for Palestinians UK. "There are no more words" – six months of Israel's total siege and bombardment of Gaza leaves tens of thousands dead, the healthcare system in ruins, and a starving population. 2024. https://reliefweb.int/report/occupied-palestinian-territory/there-are-no-more-words-six-months-israels-total-siege-and-bombardment-gaza-leaves-tens-thousands-dead-healthcare-system-ruins-and-starving-population (accessed May 9, 2024).
6 UN Office for the Coordination of Humanitarian Affairs. Reported impact snapshot | Gaza Strip (26 June 2024). United Nations. June 26, 2024. https://www.ochaopt.org/content/reported-impact-snapshot-gaza-strip-26-june-2024 (accessed July 3, 2024).
7 WHO. oPT emergency situation update. Issue 29 (7 Oct 2023–30 Apr 2024). World Health Organization. April 30, 2024. https://www.emro.who.int/images/stories/palestine/Sit-rep-29.pdf?ua=1 (accessed May 9, 2024).
8 British Red Cross. Gaza: there is nowhere safe for people to go. 2024. https://www.redcross.org.uk/stories/disasters-and-emergencies/world/whats-happening-in-gaza-humanitarian-crisis-grows (accessed March 31, 2024).
9 Médecins Sans Frontières. Gaza: displaced people sheltering at Nasser Hospital forced to evacuate. Médecins Sans Frontières. 2024. https://msf.org.uk/article/gaza-displaced-people-sheltering-nasser-hospital-forced-evacuate (accessed March 31, 2024).
10 McGreal C. "Not a normal war": doctors say children have been targeted by Israeli snipers in Gaza. The Guardian, April 2, 2024. https://www.theguardian.com/world/2024/apr/02/gaza-palestinian-children-killed-idf-israel-war (accessed April 7, 2024).
11 WHO. Gaza hostilities 2023/2024 - emergency situation reports. World Health Organization. https://www.emro.who.int/opt/information-resources/emergency-situation-reports.html (accessed May 9, 2024).
12 Al Jazeera. Gaza's Nasser Hospital "completely out of service" as Israeli attacks mount. Al Jazeera. Feb 18, 2024. https://www.aljazeera.com/news/2024/2/18/gazas-nasser-hospital-completely-out-of-service-as-israeli-attacks-mount (accessed March 31, 2024).
13 UN. Mass graves in Gaza show victims' hands were tied, says UN rights office. UN News. April 23, 2024. https://news.un.org/en/story/2024/04/1148876 (accessed May 9, 2024).
14 Pietromarchi V, Adler N, Najjar F. Israel's war on Gaza updates: evidence of torture, executions in mass grave. Al Jazeera. April 25, 2024. https://www.aljazeera.com/news/liveblog/2024/4/25/israels-war-on-gaza-live-calls-grow-for-gaza-mass-graves-investigation?update=2859037 (accessed May 9, 2024).
15 Agha RA, Sohrabi C, Mathew G, et al. The PROCESS 2020 guideline: updating consensus Preferred Reporting of CasE Series in Surgery (PROCESS) guidelines. *Int J Surg* 2020; **84:** 231–35.
16 Médecins Sans Frontières. Displaced people forced to evacuate Nasser Hospital have nowhere to go in Gaza. ReliefWeb. Feb 14, 2024. https://reliefweb.int/report/occupied-palestinian-territory/displaced-people-forced-evacuate-nasser-hospital-have-nowhere-go-gaza-enar (accessed March 31, 2024).
17 Friedman O. Millard and Gillies' 8th Commandment of Plastic Surgery: "thou shalt not do today what thou canst put off until tomorrow." PRS Resident Chronicles. 2021. https://prsresidentchronicles.wordpress.com/2019/08/06/millard-and-gillies-8th-commandment-of-plastic-surgery-thou-shalt-not-do-today-what-thou-canst-put-off-until-tomorrow/ (accessed April 6, 2024).
18 UN Office for the Coordination of Humanitarian Affairs. The Gaza Strip: the humanitarian impact of 15 years of blockade - June 2022. UNICEF. https://www.unicef.org/mena/documents/gaza-strip-humanitarian-impact-15-years-blockade-june-2022 (accessed April 8, 2024).
19 WHO. Right to health: barriers to health and attacks on health care in the occupied Palestinian territory, 2019 to 2021. World Health Organization. 2023. https://www.un.org/unispal/document/right-to-health-barriers-to-health-and-attacks-on-health-care-in-the-opt-2019-to-2021-who-report/ (accessed March 31, 2024).
20 Bouquet B, Barone-Adesi F, Lafi M, et al. Comparative survival of cancer patients requiring Israeli permits to exit the Gaza Strip for health care: a retrospective cohort study from 2008 to 2017. *PLoS One* 2021; **16:** e0251058.
21 UN. Report on UNCTAD assistance to the Palestinian people: developments in the economy of the occupied Palestinian territory. United Nations Conference on Trade and Development. 2023. https://unctad.org/system/files/official-document/tdbex74d2_en.pdf (accessed March 31, 2024).

22 UN. Lifesaving medical care collapsing under assault in Gaza: WHO. UN News. 2024. https://news.un.org/en/story/2024/02/1146632 (accessed March 31, 2024).

23 Poole DN, Andersen D, Raymond NA, et al. Damage to medical complexes in the Israel–Hamas war: a geospatial analysis. *BMJ Global Health* 2024; **9:** e014768

24 WHO. WHO transfers critical patients out of Nasser Medical Complex, fears for safety of remaining patients. World Health Organization. 2024. https://www.who.int/news/item/20-02-2024-who-transfers-critical-patients-out-of-nasser-medical-complex--fears-for-safety-of-remaining-patients (accessed March 31, 2024).

25 Goodwin A, Karadsheh J, Salman A, Davey-Attlee F, Melwani M. Infants found dead and decomposing in evacuated hospital ICU in Gaza. Here's what we know. CNN. Dec 8, 2023. https://edition.cnn.com/2023/12/08/middleeast/babies-al-nasr-gaza-hospital-what-we-know-intl/index.html (accessed April 8, 2024).

26 Cuddy A. Gaza medics tell BBC that Israeli troops beat and humiliated them after hospital raid. BBC News. March 12, 2024. https://www.bbc.co.uk/news/world-middle-east-68513408 (accessed March 31, 2024).

27 UN. UN expert horrified by death of Gazan orthopedic surgeon in Israeli detention. UN Office for the Coordination of Humanitarian Affairs. May 16, 2024. https://www.ohchr.org/en/press-releases/2024/05/un-expert-horrified-death-gazan-orthopedic-surgeon-israeli-detention (accessed June 19, 2024).

28 Middle East Eye. Senior Gaza doctor died while under Israeli interrogation: report. June 18, 2024. https://www.middleeasteye.net/live-blog/live-blog-update/senior-gaza-doctor-died-while-under-israeli-interrogation-report (accessed June 19, 2024).

29 Rose E, Baranjot K. Musk says Starlink will provide Gaza connectivity for aid groups. Reuters. Oct 28, 2023. https://www.reuters.com/world/middle-east/musk-says-starlink-provide-connectivity-gaza-through-aid-organizations-2023-10-28/ (accessed May 9, 2024).

30 @HCWWatch. March 12, 2024. https://twitter.com/HCWWatch/status/1767666330252009517 (accessed April 8, 2024).

31 Médecins Sans Frontières. Attacks on humanitarian workers in Gaza make vital assistance nearly impossible. Médecins Sans Frontières International. Feb 27, 2024. https://www.msf.org/attacks-humanitarian-workers-gaza-make-vital-assistance-nearly-impossible (accessed April 8, 2024).

32 World Central Kitchen. 7 WCK team members killed in Gaza. World Central Kitchen. April 2, 2024. https://wck.org/news/gaza-team-update (accessed April 8, 2024).

33 Alser O, Fitzgerald S. We started a group chat to help fellow doctors in Gaza. then it went quiet. The Guardian. Feb 25, 2024. https://www.theguardian.com/world/2024/feb/25/we-started-a-group-chat-to-help-fellow-doctors-in-gaza-then-it-went-quiet (accessed May 10, 2024).

34 Sidhwa F, Perlmutter M. American surgeons call for end of U.S. culpability in genocide in Gaza. Democracy Now. April 11, 2024. https://www.democracynow.org/2024/4/11/surgeons_in_gaza (accessed May 10, 2024).

35 Olsen J-H. Palestinian telemedicine rehabilitation network: project report. Norwegian Centre for Integrated Care and Telemedicine, University Hospital of North Norway. 2010. https://ehealthresearch.no/files/documents/Rapporter/NST-rapport_2010-03_Palestine_Telemedicine_Rehabilitation_Network.pdf (accessed March 31, 2024).

36 Parkes P, Pillay TD, Bdaiwi Y, et al. Telemedicine interventions in six conflict-affected countries in the WHO Eastern Mediterranean region: a systematic review. *Confl Health* 2022; **16:** 64.

37 Statista. Gaza: breakdown of population by age group 2023. Statista. 2023. https://www.statista.com/statistics/1423040/gaza-age-structure-of-population/ (accessed March 31, 2024).

38 International Committee of the Red Cross. The Geneva Conventions of 1949 and their additional Protocols. International Committee of the Red Cross. 2010. https://www.icrc.org/en/doc/war-and-law/treaties-customary-law/geneva-conventions/overview-geneva-conventions.htm (accessed April 7, 2024).

39 Euro-Med Monitor. Fifteen days after ICJ ruling, Israel's genocide in Gaza Strip continues on the same scale. ReliefWeb. Feb 11, 2024. https://reliefweb.int/report/occupied-palestinian-territory/fifteen-days-after-icj-ruling-israels-genocide-gaza-strip-continues-same-scale-enar (accessed April 7, 2024).

40 WHO. Lethal combination of hunger and disease to lead to more deaths in Gaza. World Health Organization. Dec 21, 2023. https://www.who.int/news/item/21-12-2023-lethal-combination-of-hunger-and-disease-to-lead-to-more-deaths-in-gaza (accessed April 8, 2024).

41 Amnesty International. Devices of Palestinian human rights defenders hacked with NSO Group's Pegasus spyware. Nov 8, 2021. https://www.amnesty.org/en/latest/research/2021/11/devices-of-palestinian-human-rights-defenders-hacked-with-nso-groups-pegasus-spyware-2/ (accessed Aug 8, 2024).