Original article

Rural hospital mass casualty response to a terrorist shooting spree

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Background: **Civilian mass casualty incidents may occur infrequently and suddenly, and are caused by accidents, natural disasters or human terrorist incidents. Most reports deal with trauma centre management in large cities, and data from small local hospitals are scarce. A rural hospital response to a mass casualty incident caused by a terrorist shooting spree was evaluated.**

Methods: **An observational study was undertaken to evaluate the triage, diagnosis and management of all casualties received from the Utøya youth camp in Norway on 22 July 2011 by a local hospital, using data from the hospital's electronic records. Descriptive data are presented for patient demographics, injuries and patient flow.**

Results: **The shooting on Utøya youth camp left 69 people dead and 60 wounded. A rural hospital (Ringerike Hospital) triaged 35 patients, of whom 18 were admitted. During the main surge, the hospital triaged and treated 22 patients within 1 h, of whom 13 fulfilled the criteria for activating the hospital trauma team, including five with critical injuries (defined as an Injury Severity Score above 15). Ten computed tomography scans, two focused assessment with sonography for trauma (FAST) scans and 25 conventional X-rays were performed. During the first 24 h, ten surgical procedures were performed and four chest drains inserted. No patient died.**

Conclusion: **Critical deviation from the major incident plan was needed, and future need for revision is deemed necessary based on the experience. Communication systems and the organization of radiological services proved to be most vulnerable.**

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Introduction

A mass casualty incident is an event that taxes hospital resources to such an extent that the capability of available resources to provide optimal trauma care is exceeded[1–3]. Hospital handling of large mass casualty incidents, such as terrorist attacks on civilians[4,5], war casualty situations[6] and large civilian accidents[7], have been described previously, but most of such incidents have been handled by specialized trauma centres, often in large metropolitan areas[1]. Rural or minor local hospitals have far less training in the management of large mass casualty incidents in general and of violent mass casualty terrorist attacks in particular.

On 22 July 2011, two terrorist attacks – a bomb attack in the Oslo government district and a shooting attack on a political youth camp on Utøya Island 40 km from Oslo – were carried out by a single perpetrator. Of the 129 casualties on Utøya Island, 69 were killed and 60 wounded[8,9]. This created the largest mass casualty incident in Norway since World War II. Owing to its proximity to the casualty site, Ringerike Hospital, a small community hospital, became the principal trauma hospital for the Utøya shooting incident. After the island had been secured by police, the rapid prehospital casualty clearance created a surge of casualties arriving at the hospital. Such a surge is a fundamental issue in mass casualty care as it is important to take into account not only the numbers of patients who need treatment, but also the rate at which they arrive and use the available resources[1]. Surge capacity is the ability to maintain standards of high-level trauma care during a casualty surge, and if the capacity is exceeded the standard of trauma care will drop[1,10]. The ability to handle a mass casualty incident depends on hospital size,

resources available, organization and the quality of the hospital major incident plan.

This article describes the hospital's surge capacity and other factors of which to be aware, and from which to learn. In particular, the hospital major incident plan is analysed, highlighting both its strengths and weaknesses. Initial radiological procedures are discussed, especially the use of computed tomography (CT). Finally, a short summary is provided of improvements made to the major incident plan as a consequence of this analysis.

Methods

Hospital description and team resources

Ringerike Hospital is a small community hospital with 118 beds serving a population of about 75 000 inhabitants. The hospital is situated at the end of a long valley with heavily used roads and several nearby ski resorts. By road it is 50 km (a 50-min drive) from Oslo and 15 km (a 15-min drive) from the ferry site for Utøya Island.

The hospital is member of the Better and Systematic Trauma Care (BEST) Foundation[11]. The surgical department has monthly training of the trauma team; the team leader is a resident in general surgery and is required to have Advanced Trauma Life Support (ATLS™) course accreditation, before being allowed to be on-call. The hospital has five surgical residents, and the team is headed by the resident on-call. The team also consists of a resident orthopaedic surgeon, a consultant anaesthetist, anaesthetic nurses, emergency department nurses and operating room nurses, totalling between ten and 13 staff members.

The surgical consultants have all undergone the Definitive Surgical Trauma Care (DSTC) course. One nurse in the emergency department works 20 per cent of the time as a trauma coordinator, facilitating exercises, collecting trauma data, and organizing the agenda for the hospital trauma panel meetings held two to four times a year, at which the procedures for trauma care are revised continuously.

The trauma team is assembled in the emergency department via an emergency paging system. In 2010, the team was activated 98 times, receiving 120 patients, of whom 24 (20·0 per cent) were severely injured (defined as having an Injury Severity Score (ISS) greater than 15).

One room in the emergency department with a ventilator is designated for injured patients. Plain X-rays are taken with a portable X-ray machine; no ultrasound apparatus is stationed in the emergency department. The radiology department has one 64-slice CT scanner, one portable and three fixed X-ray machines, and one ultrasound scanner, in addition to one magnetic resonance imaging (MRI) scanner, which was not in use on 22 July 2011.

Major incident plan

The major incident plan of the hospital is developed and organized in cooperation with the hospital trauma panel. There are two levels of alert: a yellow alert, which allows for up to three severely injured patients, and a red alert for more than three severely injured patients. During a red alert, a surgical consultant is in charge of the mass casualty incident handling and personnel dispersal. The initial triage is done by a surgical consultant positioned at the entrance to the emergency department. According to the major incident plan, patients are to be triaged in one of four categories: patients in need of immediate operation; patients in need of stabilization of vital functions; stable patients; and 'walking wounded'. It is a goal that a patient should spend as little time as possible in the emergency department, so that space and personnel can be freed to handle new patients. The plan includes sending out personnel to the scene of the accident.

Data retrieval

Patient data were obtained from the hospital electronic journal system (DIPS, Bodø, Norway) and electronic X-ray system (Picture Archiving and Communication System). The ISS was calculated, and critically injured patients were defined as those with a score above 15[12].

Ethics approval

The study was approved by the Data Protection Official for Research for Vestre Viken HE Ringerike Hospital as a quality improvement project. Patient data were collected and the study was conducted in accordance with the guidelines for such a project. The study was also reported to the Research Director of Vestre Viken HE and the Norwegian Directorate of Health.

Statistical analysis

Reported data are descriptive only; no attempt was made at formal statistical analysis.

Results

Timeline

At 15.25 hours on 22 July 2011, a bomb was detonated in the Oslo government district. This did not directly affect Ringerike Hospital, but put a strain on Oslo University

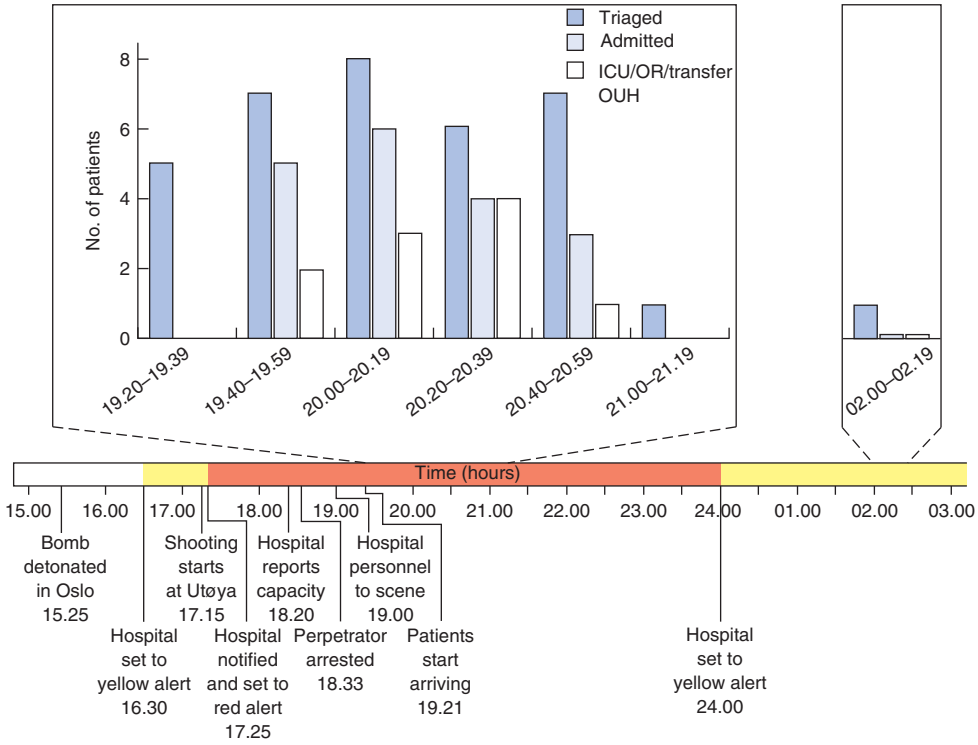

Fig. 1 Schematic presentation of the timeline of the terrorist attacks with number of patients triaged at and admitted to Ringerike Hospital. The main surge of patients occurred between 19·40 and 20.40 hours when the hospital received 22 patients in 1 h. A total of 35 patients were triaged. The most resource-demanding patients were in the intensive care unit/operating room/transfer Oslo University Hospital (ICU/OR/transfer OUH) category

Hospital, the major trauma centre in Norway. Ringerike Hospital was set to yellow alert at 16.30 hours, to be able to relieve Oslo University Hospital if needed (*Fig. 1*). At approximately 17.15 hours the perpetrator started shooting victims at Utøya island youth camp, and continued doing so until arrested by the police at 18.33 hours[13].

Ringerike Hospital was notified of the shootings at 17.25 hours, and the hospital was immediately set to red alert, which included calling in extra personnel. At 18.20 hours, the hospital was well organized and notified the prehospital services that it could take care of up to four severely injured patients and ten with minor injuries. In accordance with the hospital's major incident plan, health personnel including one consultant surgeon and one consultant anaesthetist were sent out to assist at the scene at 19.00 hours. They were used at a secondary triage station, handling mostly 'walking wounded'. Between the arrival of the first patient at 19.21 hours and 21.05 hours (1 h 44 min), the hospital received 34 patients. The last patient arrived at 02.09 hours on 23 July 2011 (*Fig. S1*, supporting information). At 24.00 hours on 22 July, the alert level was adjusted to yellow and surplus personnel were sent home.

The main patient surge occurred between 19.40 and 20.40 hours, when the hospital received 22 patients in 1 h (*Fig. 1*). The extent of the incident, and the approximate number of patients that could be expected, was not known during the evening of 22 July. The number of patients that the hospital had agreed to handle was surpassed after 40 min, at 20.01 hours, and hospital surge capacity was thus exceeded.

Organization of the hospital and dispersal of personnel

When the first patients arrived, three of five surgical consultants and one of two surgical residents were available to lead the trauma teams. One of the five consultants performed triage (*Fig. 2*) and one was sent to the scene. The surgical resident on-call was unable to treat any patients owing to the greatly increased organizational duties from the mass casualty incident. Incidentally, there was only one regular acute admission from 15.00 hours until noon the next day. Two orthopaedic consultants and four orthopaedic residents were present. Of the four anaesthetists present, one was sent out to the scene. In

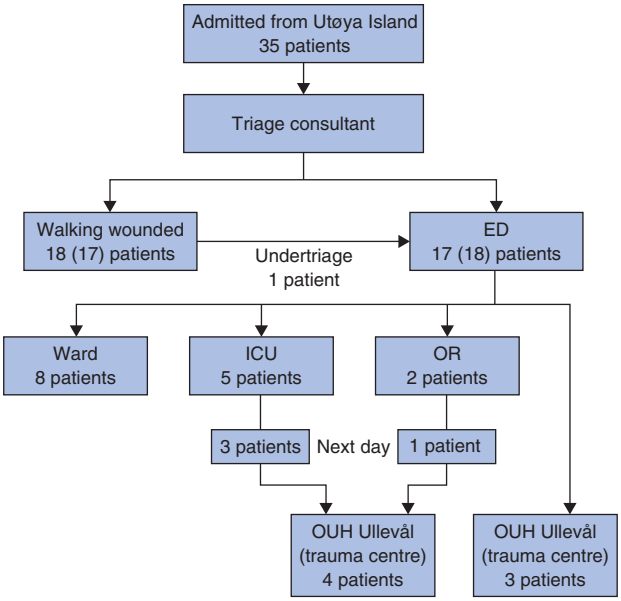

Fig. 2 Outline of in-hospital patient flow. Initial triage was performed by a surgical consultant. Patients were triaged into two categories: minor injury ('walking wounded') or moderate to severe injury. The outpatient clinic was staffed with medical consultants, residents and interns. The emergency room was staffed with surgical and orthopaedic consultants, residents and interns. ED, emergency department; ICU, intensive care unit; OR, operating room; OUH, Oslo University Hospital

addition, there were 11 doctors from the medical department, and gynaecologists were also available. Non-surgical personnel took care of the less badly injured patients.

The triage consultant classified the patients into two categories, not four as stated in the hospital's major incident plan. This was an *ad hoc* decision made by the triage consultant as the extent of the incident became evident. Patients with minor injuries were sent to the outpatient department staffed by medical doctors, and moderately to severely injured patients were sent to the emergency department (*Fig. 2*).

Owing to a lack of general surgeons, who normally would assess all injured patients, those with apparently isolated extremity injuries were taken care of by an orthopaedic surgeon, while patients with head and torso injuries were placed under the care of a general surgeon. With the greatly strained resources, the trauma team generally consisted of a surgeon/orthopaedic surgeon, an anaesthetist nurse, an emergency department nurse and an operating room nurse. Anaesthetists were prioritized to the most severely injured patients and to patients requiring immediate surgery.

The information provided from prehospital services before the patients arrived was at times very sparse. Several of the patients admitted to Ringerike Hospital were triaged at the incident site to go to Oslo University Hospital, but the ambulances transporting them to the helicopter site overshot the exit and continued to Ringerike Hospital instead[14].

Emphasis was placed on patients spending no more time than was necessary in the emergency department, so that space could be freed for new patients. At one point, all nine rooms in the emergency department were occupied.

The intensive care unit had physically spare capacity, but there was a lack of anaesthetists to staff the unit. Four operation rooms were ready, but no more than two were in use at any one time.

With the modified two-tiered triage system practised, there was one undertriaged patient who had a graze gunshot wound to the head with a small subdural haematoma and small subarachnoid bleed (*Fig. 2*).

The patients and treatment

Of the 35 patients triaged at Ringerike Hospital, 17 (49 per cent) were handled as outpatients and released from the hospital within 6 h. The remaining 18 required hospital admission (*Figs 1* and *2*). Seven of these 18 patients were transferred to Oslo University Hospital for further care, and a further seven patients were transported to their local hospital over the next 2 days. No patient died at Ringerike Hospital.

Of the 18 patients admitted, a total of 14 fulfilled the criteria that would normally activate the hospital trauma team; 13 of these patients arrived during the main surge (*Fig. 1*). The trauma team activation criteria are identical to the ATLS™ criteria for transport to a trauma centre. Five of the admitted patients had an ISS above 15. Two patients were found to have no physical injuries.

Fourteen patients received a total of 28 gunshot wounds (*Appendix S1*, supporting information), ranging from one to four gunshot wounds per patient (*Table S1*, supporting information). Eight patients had torso injuries (1 only a graze), all of which were gunshot wounds. Three patients had head injuries (2 gunshot wounds, 1 blunt injury), and ten patients had a total of 16 injuries to their extremities. Within the first 24 h, ten surgical procedures were performed on seven patients (*Table S1*, supporting information), including one emergency laparotomy, two external fixations of fractured extremities and seven debridements of gunshot wounds. In addition, four chest tubes were inserted in three patients. The mean age of the wounded was 18.3 years, and 15 (43 per cent) of the 35 patients were female.

Only 12 patients had temperature recordings. The mean temperature of these patients was 36·4°C, and no patient had a recorded temperature below 35°C[15].

Table 1 Radiological investigations performed the first 24 h after admission

	Immediate	Next 24 h	Total
Plain films*			
Chest	3	0	3
Pelvis	0	0	0
Spine	1	0	1
Extremities	21	7	28
Ultrasonography			
FAST	2	0	2
Abdomen	1	0	1
Computed tomography			
Trauma protocol†	4	0	4
Cervical spine/chest/abdomen/pelvis	3	0	3
Head/cervical spine	0	1	1
Head	2	1	3
Cervical spine	0	1	1
Chest	1	0	1

*Most plain films were taken in the radiology department, not the emergency department. †Head/cervical spine/thorax/abdomen/pelvis. FAST, focused assessment with sonography for trauma.

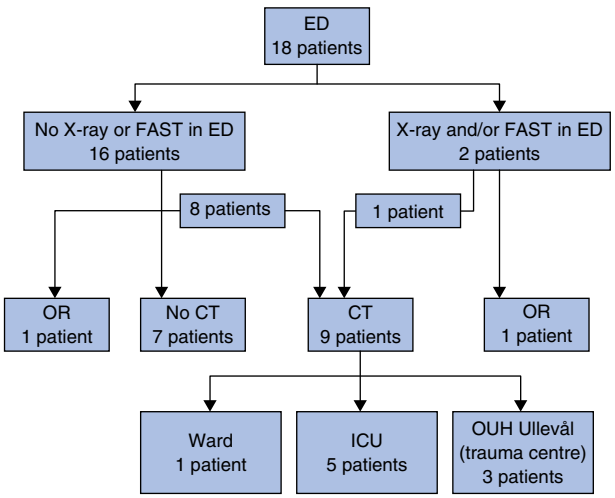

Fig. 3 Outline of radiological work-up on admitted patients. Few patients were subjected to radiological examinations in the emergency department (ED). The most injured patients, except for one, all underwent computed tomography (CT) before further treatment or transfer to Oslo University Hospital (OUH). FAST, focused assessment with sonography for trauma; OR, operating room; ICU, intensive care unit

Only 18 patients had haemoglobin levels measured; the lowest reading was 11·1 g/dl. Arterial blood gases were not performed to any extent. Other physiological data were incomplete and therefore not included.

Six patients received 2 units of SAGMAN (a concentrate of red blood cells in a solution of saline with adenosine, glucose and mannitol). Three of these were given O-negative blood on clinical suspicion of a major bleed. One of these received 2 units despite not needing them according to clinical practice guidelines[16]. The remaining three patients received typed and cross-matched blood.

Table 2 Suggested changes to the hospital major incident plan

Sending out personnel to the scene of an emergency is no longer part of the plan
Back-up communication (for example walkie-talkies) is to be acquired for use in MCIs
The logistics of radiological services to the ED should be revised
Establish a 'dual-command' in-hospital triage system[4]
Reduce the number of triage categories from four to two*
All shifts in the ED should include an experienced nurse, to optimize patient flow
Patient reports should be given by all participating doctors before downgrading the hospital alert status
The major incident plan should include a comprehensive audit after an MCI

*Two categories: (1) moderately to severely injured and needs treatment, and (2) minor injuries and can wait. MCI, mass casualty incident; ED, emergency department.

Radiological procedures

Four trauma-protocol CT scans were performed (head, neck, thorax, abdomen and pelvis) and three trauma CT scans without a head scan (neck, thorax, abdomen and pelvis) (*Table 1*). In addition, two head CT scans and one chest CT scan were performed. Thirteen patients had a total of 25 ordinary X-ray examinations, most of which were performed in the radiology department and not in the emergency department. Two focused assessment with sonography for trauma (FAST) scans (*Fig. 3*) and one ultrasound scan of the abdomen were performed. During the next 24 h, one CT scan of the head and cervical spine, one of the head and one of cervical spine were performed, and seven additional ordinary X-ray examinations were carried out.

Discussion

During a mass casualty incident, a large casualty caseload adversely affects the quality of trauma care given to individual patients[2]. The goal of the hospital's emergency plan is to provide severely injured patients with the same level of care as under normal conditions. On 22 July 2011, the number of patients that the hospital had announced it could take care of was quickly exceeded by two- to threefold. This meant that the surge capacity was exceeded and it was impossible to provide the same level of care as under normal circumstances. The hospital probably benefited from having a major incident plan based on principles rather than on fixed protocols with regard to number of triage groups, reduced staffed trauma teams and

radiological usage, as experienced by others[17]. Experienced staff who knew the major incident plan were on duty in the emergency department. This, together with a time gap between setting the red alert and the arrival of patients, made implementation of the plan possible. As stated by Hirshberg and colleagues[2], the absolute limiting factor in a setting such as this is the availability of competent trauma surgeons, able to lead trauma teams. The decision to triage the patients into two categories, rather than four, proved to be efficient. Only two of the four operating rooms available at any given time were used, which freed personnel to be used in the emergency department. Utilizing key personnel in this way was also found to be of advantage after the Omagh bombing in Northern Ireland, UK[18].

Internal communication between key personnel in the emergency department, operating rooms, radiology department and intensive care unit was difficult, owing to congestion of the telephone system and the need to be mobile. This has also been experienced by others[4,12,17,19]. The communication problems were not foreseen in the hospital's major incident plan. A functioning back up emergency communication system (such as walkie-talkies) could have improved communication (*Table 2*).

The hospital sent out personnel to give aid at the scene. This included one consultant surgeon and one consultant anaesthetist who assisted at a secondary prehospital triage point. Their expertise would have been better employed in the hospital, as reported by others[4].

Although penetrating injuries are relatively rare in Norway[20,21], the straightforward identification of these injuries made triage easier than would be the case with a mass casualty incident with a majority of blunt injuries. This was reflected in the low overtriage and undertriage rates, with only one undertriaged patient. The accuracy of this initial triage was important, as overtriage is regarded by many as associated with increased mortality[12,22]. Ideally there should have been a form of 'dual command' concept where, in addition to the consultant doing initial triage, a second consultant supervised the in-hospital patient flow[2,9].

The downgrading of the hospital's state of alert was not sufficiently well organized. A meeting with a quick presentation of all the patients received, with all participating doctors present, should have been performed.

Many of the emergency department rooms were too small to allow access with the portable X-ray machine or ultrasound equipment, and communication was improved by performing radiological diagnostics in the radiology department. According to ATLS™ principles, X-rays and FAST are adjuncts to the primary survey. As human resources were limited, the use of CT scans over FAST was prioritized. Furthermore, the CT scans enabled the disposal of key personnel to patients in greatest need to be optimized, and personnel to be re-employed after eliminating potentially critical injuries. In retrospect, more extensive X-ray or FAST usage would not have increased the level of patient care or reduced taxation of hospital resources. There are no clear guidelines regarding the use of CT in a mass casualty incident[2], but many trauma centres appear to reserve immediate CT for patients with severe head injuries[1,2,9]. FAST imaging reduces the number of CT scans required in blunt abdominal trauma and penetrating torso trauma; however, a negative FAST scan in penetrating trauma should prompt further diagnostic studies in a stable patient[23]. To make better use of FAST imaging and conventional X-rays in the future, a logistics plan for restructuring of the radiology department is required in order that more FAST and X-rays can be performed during a mass casualty incident.

This was a retrospective study with relatively few patients, thus limiting conclusions on how the overall management was beneficial to patient outcome. Owing to the hectic circumstances, patient and logistical data registration were suboptimal, making a more comprehensive and detailed analysis impossible. Strained resources, exceeded surge capacity, and improvisation by staff led to deviations from both the hospital's mass casualty incident plan and ATLS™ principles in patient treatment.

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Supporting information

Additional supporting information may be found in the online version of this article:

Fig S1 Patient flow to hospitals from the Utøya Island mass casualty scene, indicating the number of patients triaged (Word document)

Appendix S1 Ballistics (Word document)

Table S1 Injuries and procedures during the first 24 h after triage (Word document)