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ORIGINAL ARTICLE

# Terrorist attack in Nice — The experience of general surgeons☆

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Abdominal trauma;
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**Summary**
*Introduction:* After the attacks in Paris, France was again struck by terrorism in the city of Nice during the night of July 14, 2016. At 22:33 in the evening, a 19-ton truck drove into the crowd of holiday celebrators. The attack resulted in 458 wounded and 86 deaths. The purpose of this study was to describe the management of patients with abdominal trauma admitted alive in our institution, in the context of a massive influx of victims.
*Material and methods:* We performed a retrospective analysis of the management of adults with abdominal trauma arising from the terrorist attack in Nice.
*Results:* Among the 182 victims admitted to our trauma center, eleven patients presented with abdominal trauma. The median age was 44 years [14—63] and the median Injury Severity Score (ISS) was 34 [9—59]. Eight patients underwent urgent surgical treatment in the operating room including six for abdominal trauma. These patients were treated according to the principles of surgical damage control, albeit without the need for temporary abdominal closure or packing. Three patients could have had their lesions managed non-operatively had they been admitted outside this surge episode, which saturated the technical means of the receiving hospital.
*Conclusion:* The terrorist attack that victimized the citizens of Nice resulted in the second largest number of dead of any attack on French soil. A large number of patients were admitted to the city's only center for adult trauma care. The management of these patients posed diagnostic, therapeutic and logistical problems. Increased use of pre-hospital pelvic restraint belts may help to reduce vehicular trauma. We do not feel that non-operative management of abdominal lesions can be envisaged in the context of a mass influx of victims. We recommend surgical hemostasis for patients with secondary hemorrhagic risk from visceral trauma in the context of a massive influx of victims.


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## Introduction

For many years, terrorist attacks have been carried out around the world, perpetrated by various political and religious groups. These have included bomb attacks in Paris in 1986 [1], Madrid in 2004 [2], Boston in 2013 [3,4], Brussels in 2016, as well as attacks by heavily armed groups on November 13, 2015 in Paris [5,6].

By definition, local medical resources may be insufficient for these attacks, which result in a massive number of victims with serious injuries. In order to best prepare for the management of a massive influx of victims, surgeons and institutions must understand the resulting injury mechanisms and logistical problems [2].

On Bastille Day, July 14, 2016 at 22:33, the city of Nice was the victim of the second largest terrorist attack in France, in number of victims. In total, 86 people died including ten children [7,8]. The number of wounded in this attack was 458 victims.

The Nice attack was the first in Europe to involve the use of a vehicle as a weapon to attack a crowd. A 19-ton truck was driven at full speed during this 45-second attack and severely injured the crowds of people present.

The injuries caused by this type of attack are different from those caused by firearms or explosions. The aim of this study is to present how eleven patients with abdominal lesions were simultaneously managed in a situation of mass influx of victims.

## Material and methods

This is a single-center retrospective study. All adult patients were admitted to the Pasteur-2 Hospital, a Level 1 trauma center of Nice University Hospital.

We reviewed the records of all patients who arrived at the triage unit at the facility and selected those with open or closed abdominal trauma.

We did not discuss the deceased patients because the ongoing judicial investigation does not allow us to present the injuries of these victims.

Patients underwent triage at the site of the attack and/or when they arrived at the trauma center. The triage process consisted of a rapid clinical examination including hemodynamic parameters, findings of hemodynamic, ventilatory or neurological distress, and an abbreviated ultrasound scan (FAST). A complete clinical examination and complementary studies were carried out as indicated after admission of the patient to a sector that provided care adapted to the patient's clinical state.

Triage classified the victims on a scale of four severity levels:

- absolute emergency;
- relative emergency;
- minor urgency;
- deceased or dying patients.

Patients classified as ''deceased or dying'' included patients dead at the scene, or those with extreme respiratory, hemodynamic or neurological instability. Patients classified as ''absolute emergency'' had hemodynamic instability or a respiratory or neurological abnormality. Those classified as ''relative emergency'' had no criteria of instability but had cervicofacial, thoracic, abdominopelvic or long bone trauma. Finally, the remaining patients, classified as ''minor urgency'', had peripheral injuries or psychological trauma.

Injuries to abdominal solid organs were presented according to the American Association for the Surgery of Trauma (AAST) classification [9].

We calculated the Injury Severity Score (ISS) for each patient admitted that night. The ISS is an anatomical scoring system that provides an overall score for patients with multiple injuries. The patient is assigned an Abbreviated Injury Scale (AIS) for each of six body regions (head, face, chest, abdomen, extremities (including pelvis), external [no injury]). Only the best AIS score for each body region is used. The three most seriously injured areas of the body have their score squared and the sum of these constitutes the ISS score.

Pancreatic fistula was defined as a lipase level in drainage greater than 250 IU/mL post-operatively.

## Results

A total of 458 people were injured. Eight-six of them, including ten children, died.

The first victims spontaneously presented themselves at the nearest hospital, the pediatric hospital of Lenval: 10 cases of absolute urgency, four of which were adults and 32 relative urgency cases. In this pediatric hospital, there were six deaths including two children, mainly due to hemorrhagic fractures of the pelvic ring.

The on-site command post then took over the coordination of the 559 available health personnel, including 33 doctors, 58 nurses and 468 firefighters. Many critical victims were immediately referred to adult or pediatric trauma centers. This on-site triage process was performed correctly with only 3% of the first 234 patients requiring secondary transfer.

The first patient arrived at our hospital approximately 30 minutes after the attack, at 23:13. A trio consisting of an emergency physician, a general surgeon and an anesthesiologist led the hospital triage process; the mean triage time per patient was $2'27'' \pm 1'45''$. At 23:30, the ''Plan White'' was activated, leading to an important reinforcement of staff and a change in the organization of patient circulation: 38 emergency department rooms were freed up as well as 13 operating rooms and 16 Intensive care unit beds.

Pasteur-2 Hospital took care of a total of 182 victims. During the first two hours, 25 absolute emergencies and 44 relative emergencies were admitted. Of the 25 absolute emergencies:

- two patients died immediately after admission:
  - one from complex pelvic lesions,
  - the other from severe head trauma;
- four patients experienced severe hemorrhagic shock;
- a single case of acute respiratory distress was treated with chest tube decompression.

The median patient age was 44 [14—63] years and the median ISS score was 34 [9—59]. The saturation of imaging capabilities did not allow routine performance of chest X-rays. FAST scans were performed for all ''absolute emergency'' patients to help determine their therapeutic orientation.

Eleven surviving adult patients with abdominal trauma were admitted as absolute emergencies. Nine patients had closed abdominal trauma. One patient had gunshot wounds and one patient was admitted for penetrating perineal

**Table 1** Initial data on adults admitted to the hospital alive.

| Patient number | Age | Gender | Mechanism of trauma | Closed vs. penetrating | Hemodynamic instability | GCS | Hgb (g/dL) |
|---|---|---|---|---|---|---|---|
| 1 | 14 | F | Pedestrian crushed by the truck | P | 0 | 15 | 11.7 |
| 2 | 52 | F | Pedestrian crushed by the truck | F | 0 | 12 ≥ 9 | 10.2 |
| 3 | 54 | M | Pedestrian crushed by the truck | F | 1 ≥ 0[a] | 15 | 9.8 |
| 4 | 21 | M | Pedestrian crushed by the truck | F | 0 | 15 | 12.1 |
| 5 | 37 | M | Pedestrian crushed by the truck | F | 0 | 8 | 13.1 |
| 6 | 58 | M | Pedestrian crushed by the truck | F | 1 | 6 | 12.7 |
| 7 | 63 | F | Pedestrian crushed by the truck | F | 1 | 7 | 9.9 |
| 8 | 14 | M | Pedestrian crushed by the truck | F | 1 | 15 | 7.5 |
| 9 | 45 | M | Gunshot wound | P | 0 | 15 | 12.3 |
| 10 | 44 | F | Pedestrian crushed by the truck | F | 1 | 12 ≥ 5 | 10.6 |
| 11 | 28 | F | Pedestrian crushed by the truck | F | 0 | 14 ≥ 9 | 10.5 |

Gender: F: female; M: male; hemodynamic instability: 0: no hemodynamic instability; 1 hemodynamic instability; GCS: Glasgow Coma Scale; Hgb: hemoglobin.
[a] Respiratory distress due to tension pneumothorax.

trauma. The demographic and biological characteristics of patients on admission are summarized in Table 1.

All patients whose hemodynamic status permitted underwent full-body computerized tomography (CT) to enable complete assessment of lesions. Of the eleven patients with abdominal trauma, nine had a full body scan. Two patients required emergency surgical treatment in the face of major hemodynamic failure: patient number 8 suffered from major thoracic trauma requiring resuscitation by bi-thoracotomy and patient number 9, with an abdominal gunshot wound, was immediately taken to the operating room for laparotomy. The lesions of these 11 patients are detailed in Table 2.

Patient number 8 underwent CT after the resuscitative thoracotomy, but his hemodynamic state suddenly worsened during CT, which revealed a grade IV (AAST classification) splenic injury with active extravasation of contrast media (''blush''). The patient was immediately returned to the operating room for laparotomy and hemostatic splenectomy.

Eight of the eleven patients underwent urgent surgery but only six for their abdominal trauma. Their management is summarized in Table 3.

These six patients undergoing laparotomy were treated according to damage control surgery principles, but no temporary abdominal closure or laparostomy was performed. In addition, two intestinal resections with anastomosis were performed. The choice was made to carry out immediate definitive repair of abdominal lesions except for patient number 1. Given his young age (14 years), a colostomy was not performed urgently the night of the attack but was delayed to the fourth day after the initial operation.

No case of abdominal compartment syndrome was seen. No arteriography was performed. No severe complications (Clavien-Dindo grade > 3) were observed [10]. The only complications that we noted were pancreatic fistula in the two patients who underwent splenectomy; medical treatment with somatostatin led to spontaneous cessation of fistulous drainage on post-operative days 3 and 5, respectively.

## Discussion

All adult patients were admitted to Pasteur-2 Hospital, the only trauma center in the city, with 182 victims being treated in our Level 1 trauma center. There were 25 absolute emergencies and 44 relative emergencies admitted within two hours. The shock resuscitation room is typically included in the emergency department, but ours had been relocated to the 19-bed post-surgical recovery room (SSPI). Two operating rooms are usually reserved for emergencies. After the activation of ''Plan White'', we were able to open 13 operating rooms, allowing us to treat all absolute emergency patients (most with closed trauma), followed by those in relative emergency (all admitted to the emergency ward).

The facilities of a municipal hospital center are insufficient for such an influx of emergencies. Difficulties were encountered from the outset as the patients were being registered with saturation of the computer system and the staff. In order to locate patients in real time, the triage surgeon had to fill out a Velleda© chart by hand. The technical capacities of the radiology department could not keep up with the rhythm of the examinations being carried out and the imagery server was immediately saturated. The identification of patients after imaging was therefore a major difficulty.

This required a very different approach than all other attacks in Europe, where the victims were distributed to several hospitals around the city or country. Our strategy of focusing all the patients at one site is more practical in allowing us to focus human and logistical resources, as well as for families to find their loved ones. Nevertheless, this strategy can result in saturation of the technical platforms. Luckily, the emergency department, intensive care and operating rooms proved to be sufficient.

Eleven patients had abdominal trauma, representing a relatively small fraction compared to traumatic bone injuries, but these patients constituted absolute emergencies. The diagnostic and therapeutic strategy for these closed crush lesions is different from that for stab or gunshot wounds and requires defining the priorities between CT scanner, embolization and operating room. In our case, these crush-injured patients presented with multiple lesions. We chose to focus on immediate surgical hemostasis in order to treat ongoing bleeding that might involve several organs or several anatomical regions, rather than to resort to arterial embolization whose capacity was very quickly overwhelmed.

There is little factual evidence regarding the effectiveness of damage control surgery in patients with major

**Table 2** Description of the different injuries of patients presenting with abdominal trauma.

| Patient # | ISS | Liver | Spleen | Pelvic Ring | Thorax | Kidney | Vertebral fractures | Orthopedic extremity injuries | Neuro | Other |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | Lateral malleolus | 0 | Complex perineal trauma |
| 2 | 41 | 2 | 2 | 0 | Bilateral pulmonary contusion and hemopneumothorax | 0 | T8 and L1 | Scapula, malleolus and quadriceps muscle rupture | Subdural hematoma | Fractures of the skull base |
| 3 | 14 | 0 | 3 | 0 | Bilateral pulmonary contusion and hemopneumothorax | 0 | 0 | Fibula | 0 | 0 |
| 4 | 13 | 0 | 3 | 0 | Pulmonary contusion | 0 | T5 and L1-L2 | 0 | 0 | 0 |
| 5 | 29 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | Epidural hematoma | 0 |
| 6 | 59 | 0 | 4 | 0 | Pulmonary contusion and tension pneumothorax | Renal ischemia | C7, T2, L1 to L5 | 0 | Contusion of the brain stem | Adrenal and pancreati-chematoma |
| 7 | 50 | 0 | 4 | 0 | 0 | 1 | 0 | Ulna and tibia | Bilateral subdural hematoma | Adrenal hematoma |
| 8 | 41 | 4 | 4 | 0 | Major thoracic trauma | Dissection of the renal artery | 0 | 0 | 0 | Splenic leak (CT done afterthoracic surgery) |
| 9 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Gunshot wound with peritonitis-no CT |
| 10 | 34 | 0 | 3 | 0 | Bilateral pulmonary contusion | 0 | C3 to C6 and L3 to L5 | Scapula | Carotid dissection | 0 |
| 11 | 38 | 3 | 0 | 0 | Small pneumothorax | 0 | T8 and L1 | Lateral malleolus | Epidural hematoma | 0 |
| Median | 34 | | | | | | | | | |

0: signifies absence of lesion. The other numbers represent the severity score of the injury to each organ according to the American Association for the Surgery of Trauma (AAST) classification.

**Table 3** Description of the treatment performed for each abdominal trauma patient.

| Patient # | To OR | Day of surgery | Lesion requiring surgical treatment | # of intestinal injuries | Associated lesions | Surgical treatment |
|---|---|---|---|---|---|---|
| 1 | 1 | Day 0 and 4 | Penetrating perineal trauma | 1 | 0 | Perineal and sphincteric repair on day 0/colostomy on day 4 |
| 2 | 1 | 2 | Orthopedic lesions | 0 | 0 | Repair of quadriceps muscle |
| 3 | 0 | 0 | 0 | 0 | 0 | NOT |
| 4 | 0 | 0 | 0 | 0 | 0 | NOT |
| 5 | 1 | 0 | Extradural hematoma | 0 | | NOT |
| 6 | 1 | 0 | Hemodynamic instability | 0 | 0 | Splenectomy |
| 7 | 1 | 0 et 1 | Multiple associated lesions | 0 | 0 | Spleno-pancreatectomy, left nephrectomy on day 0/ORIF on day 1 |
| 8 | 1 | 0 | Hemodynamic instability | 0 | Mutilating laceration of left arm | Bi-thoracotomy followed by suture repair of hepatic laceration and splenectomy |
| 9 | 1 | 0 | Abdominal gunshot wound | 3 | 0 | Ileal and gastric repairs |
| 10 | 1 | 0 et 1 | Hemodynamic instability | 0 | | Splenectomy/cranial traction pins on day 1 |
| 11 | 1 | 0 | Extradural hematoma | 0 | Achilles tendon rupture | Evacuation of extradural hematoma |

NOT: non-operative treatment; ORIF: operative reduction and internal fixation.

abdominal trauma [11]. Nevertheless, the techniques of damage control surgery are used in a wide range of abdominal emergencies and represent an increasingly recognized rescue tactic in surgery, particularly for the most severely affected patients [12]. The goal of this strategy is to treat any life-threatening lesion as quickly as possible and to defer definitive treatment of non-life-threatening lesions [13]. When resources become saturated, damage control surgery offers an additional advantage by allowing logistical resources to be quickly redistributed to other patients. That is, when a large number of patients will be admitted, it is preferable to rapidly stabilize patients in absolute urgency and postpone time-consuming definitive treatment in order to avoid saturation of resources [14].

Management of patients with abdominal trauma followed the principles of emergency surgery. However, these surgeries did not include temporary abdominal closure, laparostomy, or scheduled surgical re-operation. This can be explained because none of the mandatory indications for damage control surgery were present: no clinical coagulopathy, no case of major hypothermia (the outside temperature was 28 °C), no need for transfusions of more than eight units. In addition, surgical hemostasis procedures were performed within less than two hours. No patient died in hospital due to abdominal injury, despite the presence of major associated injuries and high ISS.

Another peculiarity related to the massive influx of victims was surgical treatment for lesions that, in a different context, could have been managed non-operatively. This is the case for patients 6, 7 and 10:

- patients 6 and 10: CT did not demonstrate their abdominal lesions to be major and their hemodynamic instability was relative. Nevertheless, there was neither enough time nor available personnel to perform vascular repletion and transfusion;
- patient 7: the patient did not have hemodynamic instability. There was a grade IV AAST splenic lesion without ongoing contrast blush as well as left renal ischemia due to renal artery dissection and contusion of the pancreatic tail. Under ''normal conditions'', the treatment could have been arteriographic with renal revascularization by stent, possible splenic embolization and monitoring of pancreatic trauma. However, intensive care monitoring of non-operative abdominal lesions is not technically feasible in the event of a massive influx of casualties. Surgical treatment should be the privileged approach.

We do not have access to the records of patients who died because of ongoing legal investigative and judicial proceedings, but it was our impression that many of the patients who died at the scene of the attack or immediately after their arrival at the hospital (pediatric or adult)

had hemorrhagic pelvic lesions due to complex fractures of the pelvic ring. It is possible that systematic use of pelvic compression belts might have increased the survival of victims of vehicular trauma.

## Therapeutic proposals in case of mass influx of victims

Pre-hospital organizational aspects have not been developed. Nevertheless, the routine use of pelvic restraint belts seems to us indispensable, as well as admission to a trauma center as rapidly as possible, without a long on-site triage process.

The medico-surgical triage at admission must include a rapid clinical examination, measurement of hemodynamic parameters, and performance of an abbreviated abdominal and pleural ultrasound examination (e-FAST). Then, patients should be directed either to the operating room, the shock resuscitation unit, or the emergency room according to the severity of their clinical status.

Surgical hemostasis should be given priority over emergency interventional radiology techniques. Non-operative management of visceral lesions can only be offered to patients who are hemodynamically stable with imaging evidence of minimal damage. Imaging evidence of any severe or suspicious lesion must lead to an emergency surgical exploration.

The performance of an abbreviated damage-control type surgical strategy must be evaluated by the triage surgeon and the operating surgeon, according to the availability of an operating room and of necessary materiel.

## Conclusion

The organizational particularity of the terrorist attack in Nice is that all adult patients were concentrated in a single hospital. This can lead to a saturation of the technical platform but is the only solution for cities that have only one trauma center.

Greater pre-hospital use of pelvic compression belts could reduce road trauma mortality from vehicular injury. In the context of mass influx of victims, non-operative management of abdominal trauma patients does not seem to us to be possible, especially in case of associated injuries. We recommend surgical hemostasis treatment of lesions presenting a secondary hemorrhagic risk in the context of a massive influx of victims.

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## Contribution of author

Massalou, Ichai and Baqué coordinated the manuscript.

All the authors wrote together and approved the manuscript.

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## Disclosure of interest

The authors declare that they have no competing interest.

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