with the exception of case 7, were shown to have suffered from recent streptococcal infection by virtue of a raised titre of A.S.O. or anti-DNAase B or both, even though effective antibiotic therapy had been given before the sera were collected.

The raised red lesions might have been confused with streptococcal cellulitis, especially in case 10, but cellulitis has a diffuse, spreading edge, is painful to touch, and often suppurates. The lesions described here had a raised and sharply circumscribed edge and were not noticeably tender—apart from complaints of burning and tightness of the skin. Direct isolation of streptococci from the skin lesion was not attempted before antibiotic treatment had been given. This is seldom successful in erysipelas unless fluid withdrawn from blisters or from subcutaneous tissue is cultured.[8] In facial erysipelas swabs taken from the nose, throat, and ear are all more likely to yield positive results.

Though these clinical and laboratory findings supported a diagnosis of idiopathic erysipelas it is curious that so uncommon a disease should have affected several patients simultaneously. The patients affected in this outbreak were of the sex and age group especially liable to develop erysipelas and the segregation of so many susceptible people in an abnormally secluded environment might be expected to encourage widespread and recurrent streptococcal infection once a virulent strain had been introduced. The initial treatment of the patients with ampicillin which failed to elminate the streptococcus may have influenced the spread of infection by delaying the subsequent successful treatment with penicillin G.

The laboratory findings emphasize that even retrospective serological studies may supply useful evidence of streptococcal aetiology.

We thank members of the consultant staff at Warley Hospital—Dr. Brook, Dr. Orelowitz, and Dr. Ratna—for permission to study patients under their care.

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Surgery of Violence

III. Intensive Care of Patients with Bomb Blast and Gunshot Injuries

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Since August 1969 Northern Ireland in general and Belfast in particular has been the site of recurrent episodes of civil disturbances. This article deals with the management of some of the more seriously injured casualties who have been admitted to the intensive care unit of the Royal Victoria Hospital.

The 12-bedded intensive care unit was opened in October 1970 and was originally designed for the care of the critically ill patients of the hospital and to provide a regional service for the management of respiratory insufficiency. The onset of civil disturbances has resulted in a considerable change of emphasis in that the staff of the unit are closely involved in resuscitation in the accident and emergency centre of the hospital and in the care of patients with gunshot wounds and severe injuries resulting from bomb blasts.

The situation of the intensive care unit (I.C.U.) in a hospital complex is of great importance. In a hospital which is concerned with the treatment of major trauma it is best positioned beside the accident and emergency department (fig. 1). This allows the staff of the I.C.U. to take part in resuscitation from the beginning and to establish some continuity in the care of the patients. It also has the advantage that when many seriously injured patients are brought to the resuscitation room simultaneously they can be rapidly transferred to the I.C.U. for further resuscitation and assessment. This provides an acceptable outlet and avoids a bottleneck in the casualty department.

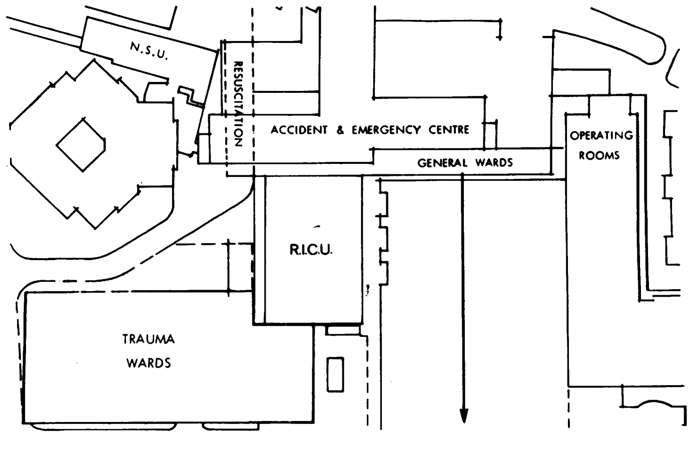

FIG. 1—Position of the intensive care unit in relation to the accident and emergency department.

The unit occupies a space of approximately 7500 ft² (700 m²), with six beds on an open plan and six single rooms. There is an additional room which is occupied by a hyperbaric oxygen chamber but which can be used for other purposes should the

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necessity arise. A bedroom is available for the duty doctors, who provide continuous supervision. In addition a consultant anaesthetist is present in the unit throughout the day and on a rota basis for night work.

Between October 1970 and November 1974, 2040 patients were admitted to the Royal Victoria Hospital as a result of disturbances, and 208 of them were transferred to I.C.U. These included casualties not only from the Royal Victoria Hospital but from other hospitals throughout Northern Ireland. These patients represent approximately a sixth of all admissions to the respiratory intensive care unit during this period. The table shows the site of injury and outcome.

Outcome related to Site of Injury from Civil Disturbances October 1970 to November 1974

Site	Discharged	Died	Total
Head	34	40	74
Neck and jaw	14	5	19
Chest	23	4	27
Abdomen	4	8	12
Chest and abdomen	13	6	19
Multiple	40	17	57
Total	128	80	208

Resuscitation and Early Treatment

The close proximity of the intensive care unit to the accident and emergency centre enables the consultant anaesthetist in charge to deal with difficult airway problems and to advise on the care of unconscious patients, especially those with head injuries. Often intravenous infusions can be established by routes more familiar to the anaesthetist than to his surgical colleagues when conventional sites are not available.

Airway Problems

Injuries to the face, jaw, or neck due to either bullets or shrapnel from bombs may rapidly produce upper airway obstruction. This usually arises from oedema of the soft tissues or from direct damage to the larynx or trachea. The insertion of a cuffed tracheal tube at the earliest opportunity is of paramount importance both to ensure a clear airway and to prevent regurgitation of stomach contents and aspiration into the lungs, with subsequent pneumonitis. The latter is a very real danger, as many of the patients have been injured in bars and clubs.

Deeply unconscious patients may usually be intubated without any great difficulty. On the other hand many are restless, irritable, uncooperative, and hypoxic. Intubation in these circumstances cannot be performed without some form of sedation. The administration of diazepam (5-10 mg) intravenously will enable rapid intubation to be performed without a struggle and without compromising the patient's already hazardous condition. In our experience emergency tracheostomy has fortunately been very seldom required. It has been our practice in many instances to perform an elective tracheostomy after exploration of the wounds and surgical repair. This facilitates management in the postoperative period, and many respiratory problems can be prevented. An additional advantage of tracheostomy in these circumstances is that that the difficulties of giving further anaesthetics are overcome. Frequently these patients require many visits to the operating theatre for further surgery and wound dressings.

Fluid Replacement

Much has been written on the type of fluid which should be given initially to the injured patient in haemorrhagic shock. The emphasis varies from centre to centre and from one country to another, but certain principles are common to all. Hartmann's solution (Ringer's lactate) is readily available, and since it is stable at room temperature it can be given without the problems associated with blood stored at 4°C. 1-2 l can be given rapidly while cross-matched blood is being prepared. Group O Rh-negative blood is kept in a refrigerator in the resuscitation room, but is used only if the patient's condition fails to respond or deteriorates on the above regimen. Dextran solutions (MW 70 000) are used in addition to Hartmann's solution, but the volume is restricted to 10 ml/kg body weight in order to avoid acute tubular necrosis of the kidney.

The volumes of intravenous fluids given must be closely monitored to avoid over- or under-correction of fluid loss. Measurement of urinary output and central venous pressure is started at the earliest possible moment and will usually provide a helpful guide to fluid replacement.

Blood Transfusion

Blood provided by blood banks is seldom fresh; the older the blood the greater the amount of clot and debris present. If massive transfusion is required a considerable amount will enter the circulation and may give rise to microemboli. The filters on standard blood transfusion sets will prevent the passage only of particles greater than 170 μm. The recent introduction of microfilters which remove all particles greater than 10 μm has helped to prevent pulmonary emboli and post-traumatic pulmonary insufficiency. These filters do not significantly restrict the rate of transfusion but should not be used when fresh blood and platelets are being given.

Head Injuries

The initial management of head injuries resulting from bomb blasts and gunshot wounds is of considerable importance. It is well known that hypoxia, hypercarbia, acidosis, and electrolyte disturbances will increase cerebral oedema. Pioneer work by Lundberg, Lassen, Gordon, and Rossanda has shown the value of hyperventilation therapy in head injuries. This form of treatment has been used in this hospital since 1971.[1] Within a few minutes of admission a tracheal tube is introduced and hyperventilation therapy started with the aim of reducing the partial pressure of carbon dioxide in the arterial blood to approximately 25 torr (3 kPa). This allows the undamaged blood vessels of the brain to contract and reduces intracranial blood volume, with a fall of intracranial pressure.

Minor variations in intracranial volume such as those caused by coughing, vomiting, restlessness, shivering, and convulsions can increase intracranial pressure with dramatic and sometimes irreversible cerebral damage. This complication can be prevented or alleviated by this form of therapy. During the period of hyperventilation it is desirable to monitor intracranial pressure, cerebrospinal fluid lactate content, and cerebral blood flow to detect the presence of an expanding intracranial haematoma and as a guide to prognosis and the effectiveness of treatment. Close observation of the pupils still remains an important feature of management.

A most satisfying response is sometimes found in patients who suddenly develop a high intracranial pressure associated with dilated unreactive pupils, for the introduction of hyperventilation produces a dramatic fall in intracranial pressure, with a return of normal pupillary reflexes. We have found hyperventilation of value both before and during surgery, and it can also be continued for several days into the postoperative period with beneficial results.

Artificial Ventilation

Indications for artificial ventilation in patients injured in bomb blasts and from bullets can be considered in three main groups.[2]

PROPHYLACTIC

This group includes not only patients who are electively ventilated, such as those with severe head injuries, but also those who have undergone prolonged and extensive surgery. Artificial ventilation enables adequate analgesia to be provided without fear of respiratory depression and nursing procedures to be carried out without discomfort to the patient, and it allows the distress to the patient of realizing the extent of his injuries to be postponed until a more favourable time.

DIRECT LUNG DAMAGE

It is easy to understand how a crushing injury of the chest can result in respiratory insufficiency, but the mechanism is less obvious after high velocity bullets and bomb blasts. The bullets travel faster than the speed of sound, and the great energy dissipated in the tissues results in shock waves. In the case of the lung this produces tissue damage some distance away from the bullet tract. As the lung is elastic, permanent damage seldom results, but initially fulminant pulmonary oedema often threatens life. Though the bullet may have penetrated only one lung, the other lung may be as severely damaged and its function impaired.

Blast injuries of the lungs occur when people are close to an explosion, especially when it occurs in a confined space such as a bar or restaurant. The clinical picture is remarkably consistent in that for a period of 24-48 hours the patient remains free from respiratory distress and the arterial blood gases are essentially normal; then gradually increasing dyspnoea associated with a dry cough becomes apparent. Moist sounds are then audible throughout both lungs, and the chest *x*-ray film shows a diffuse interstitial pulmonary oedema (fig. 2). The blood gas analysis now shows increasing hypoxaemia and carbon dioxide retention.

Treatment of this condition consists in artificial ventilation with a positive end-expiratory pressure (P.E.E.P.), giving high inspiratory concentrations of oxygen, and administering diuretics and steroids. Though the management of these cases is often complicated by the development of pneumothorax and artificial ventilation may be required for several weeks (in one of our patients for 60 days) the prognosis is surprisingly good.

Lung damage is due to the shock waves of the explosion travelling at high velocity and being transmitted through the chest wall to the liquid phase of the lung before an equalizing pressure can be transmitted through the tracheobronchial tree. These pressure differentials give rise to alveolar damage and haemorrhage. The lungs also become compressed between the inward moving chest wall and the rising diaphragm, because the pressure wave also compresses the abdominal wall.[3]

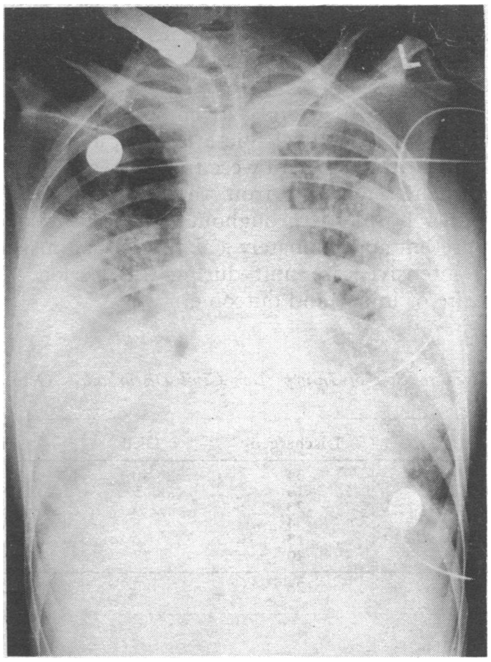

FIG. 2—Chest *x*-ray film showing interstitial pulmonary oedema following bomb blast.

POST-TRAUMATIC INSUFFICIENCY

There are many possible explanations for this syndrome, especially in patients with multiple injuries who have received massive blood transfusion and have undergone extensive surgery. It is clear that, whatever the mechanism of its production, the end result is an increase in both pulmonary vascular resistance and in pulmonary capillary permeability. This produces pulmonary oedema, which may either resolve completely or progress into fatal consolidation of both lungs. The clinical course is unpredictable, and once consolidation occurs it is almost totally refractory to treatment.

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