41 The severely injured patient

41.1 Approach to trauma care

There is only one thing more troubling than a badly injured patient presenting unannounced at your hospital: a truck full of several badly injured people unannounced! (40.8).

PREPARATION
You will inevitably not get much warning of a seriously injured victim. So, it is very important to have a prepared plan. Hardly any patients are likely to have received effective pre-hospital care at the trauma site.

AN ACCIDENT RECEPTION AREA

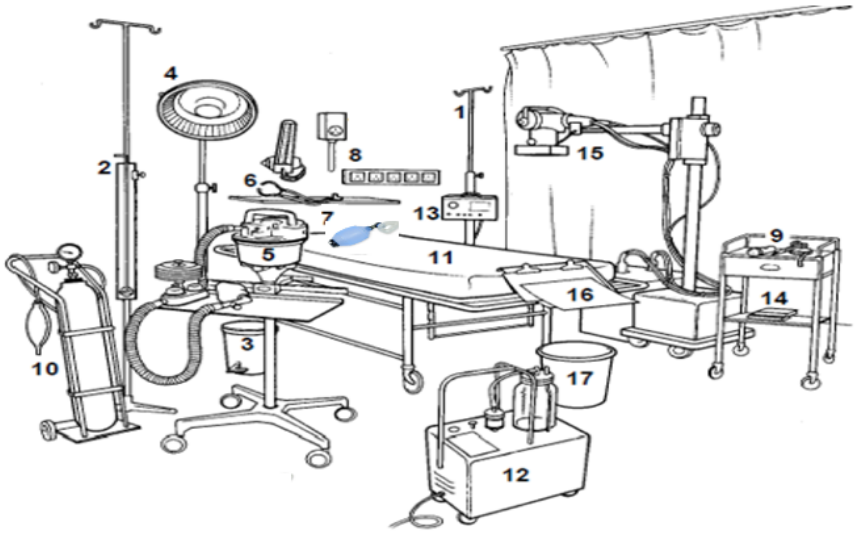

Fig. 41-1 AN ACCIDENT RECEPTION AREA. You may not be able to provide all these things, but try to provide most of them. The best place to take severely injured patient may be your intensive care unit or the operating room itself.
(1) Drip–stand, (2) central venous pressure set, (3) sluice bin, (4) mobile lamp, (5) a completely equipped anaesthetic machine (and a ventilator if you have one), (6) stethoscope & BP machine, (7) Ambu-bag, (8) large plug for portable X-ray machine & several power points, (9) tape measure, torch, and scissors, (10) oxygen cylinder and flow meter with rebreathing bag, (11) special bed or tipping trolley, (12) sucker, (13) blood warming bath, (14) admission books, (15) portable X–ray machine, (16) charts, (17) bin for clothes. You will also need an ophthalmoscope and an auroscope (otoscope), a labelling pen, urine test strips, drip sets, intravenous fluids and cannulae of multiple sizes, and a chest drain set.
N.B. 'Ambu' stands for 'artificial mechanical breathing unit' (not ambulance) and refers to a bag valve mask.

Designate a resuscitation area in your emergency room; otherwise use the operating theatre or the intensive care station. Get tilting resuscitation trolleys, which have a radio-translucent surface, a device to hold X-ray cassettes underneath, holders for an oxygen cylinder and a wire basket for patients' clothes.

Prioritize your tasks roughly this order:
(1) Prepare your team and environment to receive the patient.
(2) Allocate staff.
(3) Perform primary surveys (ABCDE): the goal is to identify life-threatening injuries and intervene appropriately.
(4) Resuscitate and monitor the patient.
(5) Decide whether damage control is needed.
(6) Perform secondary surveys (head-to-toe evaluations and patient history).
(7) Obtain radiographs, ultrasound, laboratory tests.
(8) Re-evaluate the patient & the overall situation.
(9) Provide stabilizing or definitive care.
(10) Prepare for the arrival of another seriously injured patient, or more!

The resuscitation area should contain:
(1) Oxygen, masks, and Guedel airways. You should be able to intubate patients, and so have laryngoscopes and tubes in various sizes (for children and adults) and the necessary drugs available.
N.B. Make sure you designate two persons to be responsible for checking all the instrument batteries routinely.
(2) Warmed intravenous crystalloid solutions at 37-40°C. (A box, or old refrigerator, warmed by multiple lightbulbs is one low-cost option).
N.B. Be sure to have a thermometer to check the temperature within the box. A big enough box can store blankets as well.
A microwave oven is helpful to warm more fluid rapidly or to exceed 40°C in cases of severe hypothermia. *Don't microwave sugar-containing solutions.*
(3) Intravenous giving sets and large-bore intravenous cannulae.
(4) Monitoring devices are very useful (for pulse and oxygen saturation), manual blood pressure cuffs or mechanical devices *must be in good working order*!
You should be ready to attach monitoring leads as soon as the patient arrives, and place an IV line (or two), drawing blood at the same time for necessary laboratory examinations and cross-matching.
(5) Gloves, face mask, eye protection and water proof gowns of various sizes.
(6) Naso-gastric tubes, urinary catheters, chest tubes of various sizes, as well as, tracheostomy or cricothyrotomy equipment.
(7) A portable ultrasound machine.
(8) A dedicated medical waste bin.

Identify a team leader to supervise care. This is vitally important as otherwise no-one knows what to do when, or everyone does everything at once! Choose the most experienced person (who may be yourself) to do the triage, and to supervise the resuscitation. If you have enough staff, this is best to choose 2 different people for these roles. You will need the help of an experienced nurse to supply what you need, especially one who knows where everything is kept, and what is needed when. *So, it's best to create such a team in advance!*

N.B. Remember: the resuscitation situation is fluid and may change at any time: it is vitally important that your team can accept that things are not going right if all is not well, and knows how to change direction, and accepts the decision to backtrack or do something different.

The key is that everyone knows who is doing what, and what they are supposed to do, and the leader communicates instructions, findings, and plans in a loud clear calm voice. Key aptitudes are: Calmness, Communication, Control & Confidence. *Don't panic!* You need to think logically what to do next: go back to first principles if you are stuck, and start again with ABCD.

When things don't go well, have a debriefing and discuss what could have been done better. *Learn from your failings, and do not see them as failures!*

IDENTIFY HIGH-RISK PATIENTS even before you know the extent of their injury. These are:

(a) Babies:

Babies, especially pre-term babies, have incomplete mechanisms for respiratory drive, haemostasis, warming and cooling. Therefore, they are very vulnerable.

Normal vital values are not as in adults:

Age (yrs)	Heart rate	Respiratory rate	Systolic BP
<1	110-160	30-40	70-90
1-2	100-150	25-35	80-95
2-5	95-140	20-25	80-100
5-12	80-120	15-20	100-120

(b) Children:

Remember these are not little adults: children have different kinds of injuries, react differently physiologically, and have different long-term results. They may not be aware of the danger of certain substances & situations.

Injury is by far the most common medical problem which children face, now more commonly than any disease. It is also the greatest cause of death.

Children have small blood volumes! They mask signs of hypovolaemia, even with severe volume depletion. A systolic BP of <(70 + 2 x yrs of age) mmHg is critical. Then, when this reserve is exhausted, deterioration is sudden and disastrous. *Bradycardia is the serious danger sign*.

PHYSIOLOGICAL CHILD NOMOGRAM

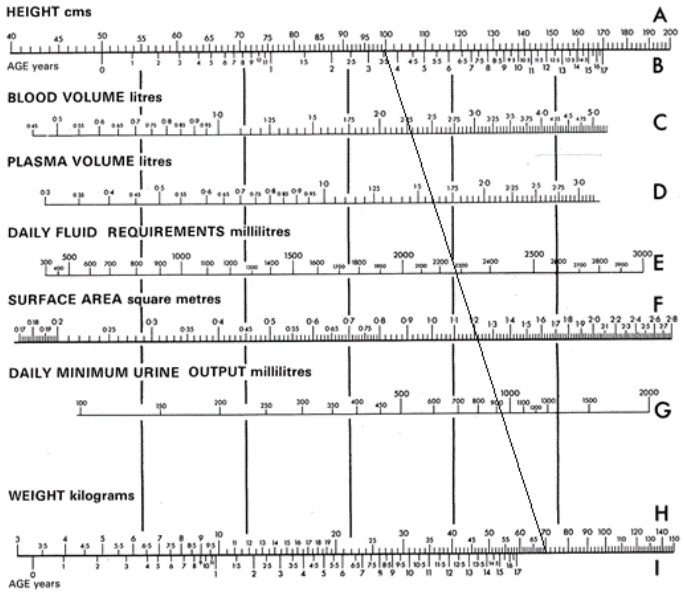

Fig. 41-2 Rule a line connecting your values of height & weight; this is drawn for someone 100cm tall weighing 70kg: where this line crosses C-G, read off the value.

Use a bolus of 20ml/kg IV crystalloids in hypovolaemia, or 10-15ml/kg blood in haemorrhage.
Poor children are often malnourished and anaemic, so replace fluid more slowly and transfuse blood earlier in these.

Children have a larger surface area to volume ratio than adults and so lose heat rapidly; *always keep this in mind*. Keep them warm, protect them from draughts and use warm IV fluids. A burn to a child's head carries much more surface area (50-2) than an adult.

There are specific patterns of injury in children & multiple injuries are common. Any impact has a greater chance of damage in a child: there may be extensive soft tissue injury without external signs.
For example, because of incomplete calcification of bones, rib fractures are uncommon and pulmonary contusion more frequent. The mobile mediastinum makes a pneumothorax more liable to cause mediastinal shift. Place a chest tube in the 2nd intercostal space *not the 5th* in a child, because the diaphragm is higher.

The head in a child is bigger compared to the rest of the body, and so is more likely to suffer trauma. Moreover, *cerebral injury in children presents with hypoventilation and apnoea* rather than tachypnoea. *Don't use rigid cervical collars in children!*

In a young child, the trachea is only 5–7cm long and the cricoid the narrowest point of the airway. *Don't do a cricothyroidotomy in a child <12yrs,* but a tracheostomy. *Always pass a nasogastric tube* to avoid injury to the oesophagus.

Don't ignore psychological stress in children: many may believe trauma is their fault even when it is not! Calm children's fears and be generous with the use of local anaesthetic creams, and ketamine in smaller appropriate doses.

Examine a child in the close company of a parent, if possible, to avoid psychological "withdrawal" when suffering pain or stress. *Don't restrain a struggling child*, but put him in the arms of a parent. *Don't discuss medical procedures in front of a small child*.

There are tragic situations where an injured child is a new orphan or combat involving civilian populations touches an entire family. Psychosocial and rehabilitation problems are great. *Don't forget the important social and economic role played by children in many traditional societies in low-income countries*.

The sight of injured children can also exact an emotional price and psychological burden on members of your team.

Make sure you have equipment of appropriate size! The intra-osseous route is very suitable; tranexamic acid is very good to arrest bleeding.

Median sternotomy and clamshell thoracic incisions are preferred since a left anterolateral approach does not give adequate access. Likewise, a transverse laparotomy incision is best in children.

The liver and spleen are relatively large in children and thus more susceptible to projectile and blast trauma. Avoid splenectomy if possible, owing to the problem of overwhelming post-splenectomy infection, and loss of immunological protection.

Fractures of long bones with growth plates can result in divergence of limb length and require corrective shoes afterwards. Contractures of joints are an immediate problem and can delay or prevent the fitting and use of protheses in amputees.

The collateral circulation is less developed in children with the consequent risk of distal ischaemia. The small size of vessels makes repair more of a surgical challenge. Autologous grafts grow with the child but late aneurysm formation is a possibility to keep in mind.

(c) Pregnant women:

Remember to check for pregnancy in any woman <45yrs: examine early for a gravid uterus and use pregnancy testing early.

Remember you are caring for 2 patients, but the mother takes priority, as she functions as the transport for the foetus, and her health is critical to the foetus.

Because of an increased blood volume in pregnancy, a woman may lose >2L before signs of hypovolaemia become evident.

If the mother suffers hypovolaemic shock, the chances are the foetus will die. A loss of 1L may be unnoticed and will give rise to foetal distress. Therefore, *assess the foetal heart rate early.*

In late pregnancy, the foetus presses on the IVC, and so in the supine position a pregnant woman may become hypotensive; *put a pillow under the right hip.*

Women in later stages of pregnancy have a physiologic anaemia but an expanded blood volume; they are also normally tachycardic and may lose 1.5L of blood without dropping their BP. They are also hypocapnic owing to hyperventilation, and so p_{CO2} at 35-40mm Hg may be a sign of respiratory failure. Also, gastric emptying is prolonged, *so insert a nasogastric tube early.*

A dilated pyelocalyceal system seen on US, glucose in the urine, a widened *symphysis pubis* (up to 8mm), are normal in pregnancy.
Proteinuria is not: beware that eclampsia may look like a head injury!

(d) The elderly:

With age, there is less physiological reserve, greater fragility, slower healing, intolerance of heat & cold, malnutrition or obesity, and diminished immunity.

Cardiac insufficiency is frequent; so administer IV fluids in smaller amounts more frequently, and watch for symptoms & signs of circulatory overload. Elderly patients are less able to compensate for blood loss.

Those taking ß-blockers and those with a pacemaker will not show an expected tachycardia with fluid or blood loss. In an 80-year old, the maximal tachycardia is c. 140/min. A hypertensive patient may be profoundly shocked with a systolic BP of 120mm Hg. Fluid overload is also a big risk in anaemia & chronic renal insufficiency, but poorly functioning kidneys do not tolerate hypovolaemia at all well.

Elderly patients tolerate chest injury badly, especially if there is underlying chronic obstructive airways disease or asthma.

Neurological deficits accumulate with age, and so neurological assessment after injury may be difficult or impossible. You may confuse the effects of hypoxia with simple confusion.

If there is liver disease, watch out for repeated episodes of hypoglycaemia.

Many elderly patients are taking a mixture of medication, not always regularly or logically. Their blood clotting may well be abnormal.

Fractures are common, and particularly of osteoporotic bones, which heal poorly. Old people do not manage bed rest well, and if you keep them in bed for >1 month, *they may never recover!*

Some elderly folk are abused by carers or even their family: *don't miss evidence of neglect or abuse.* Some elderly have previously expressed the wish not to be resuscitated (especially if they have a malignancy); *don't override such a decision if you think it justified.* Consider the possibility of suicide.

(e) The obese (BMI >30):

Apart from difficulties with venous access and diagnosis, cardiopulmonary reserve in the obese is reduced, so administer IV fluids more slowly.

(f) Athletes:

Although, it may seem odd to worry about the most fit of your patients, but they will have a physiologic response more like children and so you may not see the expected early signs of shock. *A pulse of 60/min may actually be a significant tachycardia.*

N.B. Note that if a person survives a severe injury, he develops a huge demand catabolism and loses up to 20g nitrogen/day in the urine.
This equates to 125g protein lost or 625g muscle mass every day! Therefore these patients *must* get a high protein diet to recover! *If they lose 40% of their body protein, they may not survive.*

41.2 Primary trauma care

PRIMARY SURVEY
The principle of a Primary Survey of a trauma patient is to detect (and treat) any life-threatening injuries before they kill him. *You must do this in a logical order.* Thus the most important element, the Airway, comes first, as, obviously, nobody can survive if oxygen is not getting to the lungs. The order follows the letters ABCDE, so is easy to memorize:

Airway (with control of the cervical spine (42.1-4),
Breathing and ventilation (43.1-7),
Circulation with haemorrhage control (44.1-8),
Disability (neurologic status) (45.1-2) &
Exposure/environment/extremities.

Start with a **10sec evaluation** as you introduce yourself and begin your evaluation. Ask the patient his name and what happened. An appropriate response suggests that the airway is intact (speech is clear), the breathing is satisfactory (there is enough air movement to speak), the circulation and neurologic status are probably also satisfactory (the perfusion of the brain is good enough to function).

If you can palpate a peripheral pulse, this gives a rough estimate of systolic blood pressure (radial >90, femoral >80, carotid >60mmHg). Check a good capillary return (<2sec) in the skin.

If this is not the case, deal with problems of **A** before you move on to **B**, and **B** before **C** & so on.
N.B. If at any time, the patient deteriorates during the resuscitation, you should return to the beginning of the ABCD and start again.

The idea is to assess a patient's injuries and resuscitate at the same time. Obviously, this may conflict with making a complete examination or doing various diagnostic tests. *You must strive to keep the patient alive!* This may well mean going to theatre to stop bleeding or to evacuate a haematoma pressing on the brain. *You should try to do this within 15mins, or at least in 30mins.*

In the primary survey, *don't try to calculate the Glasgow Coma Score*; '**AVPU**' (**A**lert, **V**erbal response, **P**ain response, **U**nresponsive) is more relevant. The patient may need mannitol to reduce cerebral oedema (45.1).
Always remember to stabilize the cervical spine (41.3) *until spinal injury has been ruled out!*

SECONDARY SURVEY
Once you have stabilized the patient, proceed with a complete history and physical examination.

N.B. If at any point, the patient deteriorates, return to the Primary Survey!
Look for other injuries, especially of the limbs, and back: log-roll the patient, keeping the neck stabilized.

N.B. Deal with back wounds before anterior chest or abdominal wounds, as turning a patient prone post-laparotomy may result in haemodynamic shock.

Deal with hypothermia by maintaining a warm environment, using warmed IV fluids, and keeping the patient covered with warm blankets (except when you are examining him).

Where haemostasis is not secure or not definitive, control fluid volumes to maintain a systolic BP at 80-90 mm Hg.

If your patient has a BP of 120/70 and good oxygen saturation, but 1h before had lost 4l of blood, he is hardly in a stable condition! He needs very close monitoring, probably more blood transfusion and maybe cardiac inotropic support. *He is not fit for definitive surgical repair,* and you need to think 'damage control' (41.4)

41.3 Cervical spine protection

The neck is easily injured, especially when the head is. A serious neck injury may be catastrophic resulting in tetraplegia, with or without respiratory paralysis, especially while extricating a victim from a vehicle or building.

You must assign someone to hold a trauma victim's head in line with his body till you are sure there is no danger to the cervical spine.

In the history, assure yourself there is:
(1) no dangerous mechanism of trauma,
(2) no numbness or tingling in the arms or hands,
(3) full capability to walk, or no neck tenderness on midline cervical palpation, or pain present before at the site of injury,
(4) voluntary ability to rotate the neck 45º to left or right.

A conscious patient who fulfils these criteria *does not need a rigid neck collar.* Put an unconscious patient in a modified lateral recovery position with neutral neck alignment.

Obtain AP & lateral radiographs which *must* show all 7 cervical vertebrae: for this you may need an assistant to pull on the arms to hold the shoulders down.

Don't apply a neck collar routinely because:
(1) you cannot assess neck vein filling (& the collar may increase intracranial pressure by venous congestion),
(2) you cannot examine the alignment of the trachea,
(3) mouth opening may be difficult, and so airway management impossible in case of vomiting,
(4) you cannot test for meningeal irritation,
(5) respiration may be restricted, especially in a penetrating wound of the neck,
(6) long wearing of the collar may cause pressure ulcers.

For example, a patient with a heart stab wound is hardly likely to need a cervical collar!

However, remember that *minor movements of an unstable cervical spine injury may result in damage to the spinal cord!* Even if a patient has survived a bumpy road journey unscathed, *do not assume his neck must be intact* as a result! So, protect the neck on a spine board from sudden movements with soft pillows and head straps.

41.4 Monitoring

You have now done all you can for an injured patient for the moment, but there may be more to do at any time, so make a thorough assessment thoroughly at definite intervals to observe any changes in his condition, because changes will then be more obvious. Repeat this survey more frequently if the condition deteriorates or there was previously severe hypotension, acidosis, hypothermia or coagulopathy.

Change is gradual, and you are more likely to observe it if you retain a mental picture at one moment and then return 15-30mins later. The change may be subtle: you may observe a change of 10 points in the pulse, increasing pallor, or the onset of sweating. These last cannot easily be measured and charted, yet they often precede a catastrophic fall in blood pressure. If you have even a simple intensive care unit, this is the place for a patient who is seriously ill, before and after surgery.

Record the following:
(1) pulse
(2) oxygen saturation
(3) acidosis
(4) blood pressure
(5) central venous pressure (CVP)
(6) conscious level (GCS)
(7) fluid input & output
(8) temperature: (you may need a special low temperature thermometer)

A quick summary of each patient should include:
(1) Age
(2) Time of injury
(3) Mechanism of injury
(4) Nature of injuries
(5) Signs
(6) Treatment

Nurses who diligently chart these observations are the patient's life-line.

N.B. Check the lungs twice daily at least: this way you will not miss a haemothorax or accumulation of pleural fluid.

It is really worth investing in a bedside monitor for this purpose.

41.5 Critical Care

Every hospital admits critically ill patients, whatever the pathology: medical, obstetric, or surgical, trauma or non-trauma.

In a hospital with limited resources in a low-income country, an intensive care unit (ICU), or intensive surgical care unit, usually with a nurse to patient ratio of 1:1, mechanical ventilation, sophisticated monitoring and therapeutic technology, all supported by sophisticated laboratory facilities, are not available.

Yet, that does not mean that you cannot, or do not, care for critically ill patients every day, the best you can, with the means available.

You therefore should concentrate equipment and staff in a designated critical care unit (CCU). The fundamental elements that are necessary are: a specialised area within the hospital, trained personnel, a higher nurse-to-patient ratio than in a general ward, 24h monitoring, and a steady supply of oxygen.

The care of the critically ill follows the same logic as the triage of mass casualties (40.8): it is always a balance between needs and the resources available.

The setting up of a CCU requires re-organisation of personnel and facilities so that it is possible to segregate, monitor and give the best care possible under the conditions pertaining, to the most seriously ill patients, without too much disruption to the rest of the hospital caring for the less severely ill.

Don't ask if critical care is appropriate; ask rather how it is possible. A lack of resources is not an excuse for not providing the most appropriate treatment available.

ALL HOSPITALS HAVE CRITICALLY ILL PATIENTS

ORGANISATION OF A CRITICAL CARE WARD

(a) Infrastructure
Depending on the infrastructure of your hospital, the ICU should be a room apart, best situated close to the emergency reception, theatres, and X-ray departments.

A post-operative recovery room could function as a high-dependency unit (HDU) and be placed between the theatres and the CCU. This arrangement allows for the same nursing personnel to staff both HDU & CCU and be in close liaison with anaesthetists and surgeons.

Depending on the total number of beds in the hospital and the workload, you should aim for at least 6 – 8 CCU beds. If the hospital infrastructure does not allow for this, then designate part of a large general ward with a localised higher nurse-to-patient ratio as an "acute" bed area.

You may need to make special arrangements for patients requiring isolation or for those with tetanus, who need a quiet and dark room: a small room will suffice.

(b) Arranging the space
Place the nursing station centrally, so that direct visualisation of all patients is possible. Place the beds in an 'L' or 'U' shape. You can separate the beds by a moveable curtain for patient privacy, if required. *Allow enough space around each bed for equipment and clinical manoeuvres.*

An easily accessible area for storing equipment, supplies and medicines, clean linen should be available, as well as for the removal of waste. A sink with running water, soap dispenser, and hand towels are essential. Alcohol-based hand gels are also useful.

(c) Equipment and supplies
Concentrate essential monitoring and therapeutic equipment in the CCU: pulse oximeter, suction, oxygen (either a cylinder or an oxygen concentrator), humidifier system, stethoscope and sphygmomanometer, laryngoscope and self-inflating Ambu-bag, simple ECG and defibrillator.

Organise a separate emergency life-support trolley, to include an Ambu-bag, equipment for intubation, ECG and defibrillator, and emergency medications.

If you have more sophisticated equipment available, and the staff is used to using them, so much the better: *viz.* mechanical ventilation, cardiac monitor, central venous lines.

N.B. Don't forget that the more sophisticated the technology, the greater the need for specialised personnel for maintenance and repair.

Oxygen supply by means of compressed cylinders has many logistical difficulties. Get an oxygen concentrator that can run off the mains current and, if electricity shortages are frequent but short-lived, an uninterruptible power supply (UPS). Battery backup power systems are now available, as well as solar power delivery. Cylinders can always be used as a backup source. Get what best serves your hospital.

(d) Laboratory support

At a minimum, in addition to blood grouping, screening and cross-matching, your laboratory should be able to perform basic blood analysis, biochemistry and serology. Serum electrolytes are good to have, if possible. Arterial blood gases are usually beyond the scope of a district hospital.

(e) Personnel

First and foremost, *increase the nurse-to-patient ratio*. If you have 1 nurse to 10-20 patients in the general ward, try to achieve 1 nurse to 3-4 in the CCU, over the full 24h period.

Optimally, a full-time physician, or at least one who can offer 75% responsibility to the CCU, should be available; a full-time matron is essential.

All too often, the level of training of nursing personnel is far lower than that of doctors. This means that fully trained surgeons, anaesthetists, and other specialist doctors must help in training staff in frequent monitoring of patients and in the early diagnosis of a clinical problem. Many countries, however, have non-physician clinicians who, with proper training and supervision, are highly reliable and efficient.

Families are often involved in patient feeding and care. You should probably restrict this in the CCU, but the particular circumstances of your hospital will decide the best measures to adopt. If family members are present, teach them hand hygiene and other essential procedures, including when & how they can feed their relatives!

(f) Internal CCU functioning

The most important factors are organizational. *A proper functioning CCU doesn't depend on equipment*; rather how you do things:

(1) good nurse–patient ratio;
(2) regular ward rounds;
(3) frequent evaluation and documentation of patients;
(4) structured handover between shifts;
(5) adherence to agreed protocols;
(6) admission and discharge policies.

Close co-operation among all staff involved is essential: you must ensure a daily multi-disciplinary ward round to monitor patients' progress and establish an integrated plan for care. Insist on systematic recording of patient observations and interventions.

A well-structured observation chart, adapted to the context, is extremely helpful. This allows for the establishment of an "early warning system".

Make regular observations of:
(1) airway sounds;
(2) respiratory rate;
(3) pulse and blood pressure;
(4) temperature;
(5) conscious level (AVPU system);
(6) oxygen saturation (by oximeter);
(7) urine output.

Then categorize these observations as normal (green), abnormal (yellow), and critical (red). Such documentation greatly facilitates both training and handover between nursing shifts.

Create clinical protocols and checklists suitable for your context to allow for safe and uniform practice. They also facilitate early recognition of any deterioration in a patient's condition and ensure prompt and appropriate management.

Documentation, protocols and checklists permit the early diagnosis of a problem. Deterioration of a patient's condition is usually preceded by a derangement of physiological signs and symptoms and the efficiency of critical care depends on continuous monitoring, timely recognition of patient deterioration, and prompt intervention.

There is little use in a nurse faithfully and carefully recording a rising pulse and decreasing blood pressure unless it is recognized & reacted upon! *A patient's condition rarely deteriorates suddenly; it is staff who should react suddenly!*

Use protocols to instruct nursing staff what response to make to acute conditions and which resuscitative measures to undertake until medical assistance arrives.

Good hygiene practice, in particular hand hygiene, is essential: simple hand washing *between* patient contact is essential. There are WHO guidelines on hand hygiene and recommendations for sustainable local preparation of hand rub formulations. You can print, laminate and display these prominently for ready reference.
Remember that excessive stress on staff will contribute to rushed care and increase in nosocomial infection

(g) Admission and discharge criteria

The success of a CCU depends mainly on the type of patients admitted. Consultation amongst staff is important to avoid any unnecessary tension and friction within the hospital team.

Again, the logic of triage is a help: *avoid fruitless efforts and recognise probable survivors*. The CCU is neither a casualty department, nor a terminal care unit. The patient who will most benefit will be an otherwise relatively healthy person suffering from an acute condition, so often the case after trauma.

An acute exacerbation of a chronic condition, or several chronic conditions, is a much more difficult clinical problem, with less chance of a positive outcome, especially when working with limited resources.

Examples of conditions that would benefit from admission include patients with:
(1) tracheostomy or chest drainage;
(2) tetanus,
(3) eclampsia,
(4) venomous snake or scorpion bite,
(5) coma & head injury,
(6) post laparotomy or Caesarean section,
(7) need of frequent monitoring, IV fluids, *e.g.* polytrauma cases

Just as criteria for admission need to be decided upon by the team, so likewise the criteria for discharge to the general ward. *Scarce resources and overworked personnel do not make a good mix.*

(h) Assisted ventilation

A condition requiring assisted ventilation is often given as criterion for admission to an intensive care unit in a high-income country.

In the absence of mechanical ventilation, this would appear to be a non-starter! However, relatively few patients actually need assisted ventilation.

If you do have the possibility to acquire a mechanical ventilator, find one with appropriate technology such as a ventilator that runs off an oxygen concentrator, rather than pressurised cylinders. This still requires a constant electricity supply and maintenance staff.

You can always ‘bag’ an intubated patient with an Ambu-bag. Mobilize volunteers from amongst family and friends and train them to squeeze the bag in synchrony with their own breathing. How long such improvisation can, or should, continue will depend on your circumstances.
However, your discharge criteria must define this situation very carefully.

Assisted ventilation, of whatever type, creates stress in the rest of the hospital. When to take a patient off ventilation (either because it is no longer needed, or no longer useful), can easily disturb the functioning of the other wards because of its consequences. Consider the repercussions on relations with the family. This is especially the case if the possibilities for assisted ventilation are limited and another critically ill patient requiring ventilation presents.

41.6 Damage control

DAMAGE CONTROL RESUSCITATION
The concept originated in the US Navy, referring to the ability of a ship to absorb damage and maintain mission integrity:

DAMAGE CONTROL

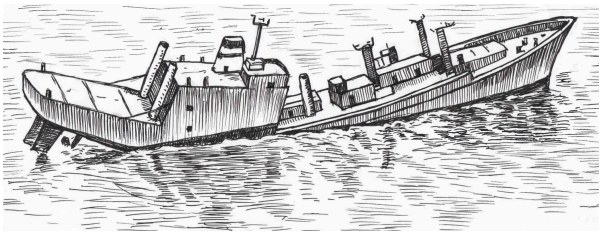

Fig. 41-3 DAMAGE CONTROL. The idea is to fix just as much as you need to get ‘home’ where you can make the proper repairs.

The idea behind ‘damage control’ is to try to limit the serious effects of injury, and not to add to them by unnecessary or futile procedures. Damage control resuscitation focuses on correcting initial hypotension by the early use of blood, and keeping the patient warm.

The combination of coagulopathy, hypothermia, & acidosis, which occurs in severe trauma, often results in death. Left untreated, the result is a vicious cycle in which each one of these increase the severity of other and the patient enters a downward spiral.

(a) Coagulopathy
Bleeding uses up clotting factors in the blood to try to stop the bleeding naturally. The more the blood loss, the greater the loss of clotting factors.
In pre-existing liver & renal failure, there are usually clotting disorders already present.

Transfusing fresh whole blood is much better at correcting coagulation than re-combining blood derivatives such as red cell concentrates, plasma, and platelets.

Fortunately, the procedures and availability of relatives and friends in low resource environments are often much simpler than in more sophisticated centres.

N.B. Use fresh frozen plasma (FFP), in other cases of coagulopathy. *Beware if your testing of HIV and other transmissible diseases is poor, the risk of using FFP is much higher than blood*, because it is pooled from several donors.

N.B. Clotting becomes worse with hypothermia & acidosis.

(b) Hypothermia (45.2)
Patients can become cold in any place, at any time of year and at any altitude. Patients may become cold in temperatures you might consider warm.
Always assume your patient's temperature is dropping right before your eyes, because it is, and much faster than you would expect (2°C/h). Keep the examination room warm and minimize drafts.

Uncover the patient completely for examination, but cover up again as soon as you can. Remove all wet clothing and replace these with dry, warm blankets. Help the patient avoid shivering.

Administer only warmed fluids (37-40°C): room-temperature (15-25°C) fluid and chilled blood products given in any amount will exacerbate hypothermia.

Clotting is dependent on the temperature and pH. Also, hypothermia leads to impaired tissue oxygen delivery and so to decreased cardiac output, myocardial ischaemia, decreased cardiovascular response to catecholamines (adrenaline), and dysrhythmias such as atrial and ventricular fibrillation.
Hypothermia also impairs the function of white blood cells and leads to increased sepsis.

(c) Acidosis
Poor perfusion of the tissues, anaemia from acute blood loss, peripheral vasoconstriction in response to hypothermia and blood loss, and overall decreased cardiac output all severely impair oxygen delivery to the tissues.
Anaerobic metabolism results and the serum lactate level rises. *This may occur in the presence of normal or slightly abnormal vital signs.*

Moreover, normal (physiological, 0.9%) saline, which has a pH c. 5.5, far more acidic than the desired normal blood pH. So, in large volumes this produces a hyperchloraemic acidosis which compounds any existing lactic acidosis.

The high chloride levels increase systemic tissue inflammation and contribute to the coagulopathy. Ringer's lactate (Hartmann's) solution has a pH of 6.5, *but does not increase lactic acidosis* because its lactate is metabolized faster than it is infused.

Furthermore, breathing difficulties, whether central or local may also produce a respiratory acidosis owing to the accumulation of CO_2 levels, especially if there is pre-existing chronic obstructive pulmonary disease.
When the pH reaches <7.2, coagulation and oxygen delivery are both impaired and muscles, including respiratory muscles, become fatigued. Also, the mental state deteriorates, up to and including coma.

ABCDE
Clear the airway as a first priority: if you don't succeed, move rapidly to cricoidotomy or tracheostomy (42.3).

Establish good ventilation: this may mean a needle thoracostomy (43.1), chest drain (43.2), or endotracheal intubation (42.2). Administer oxygen.
Replace fluid loss: make sure you have large-bore IV access, and preferably a second IV cannula in place (in case the first falls out, blocks, or you need to pour in large volumes of blood). Start blood transfusion as quickly as possible if there is >2l blood loss in an adult (less in children and much less in babies).

Keep the patient warm: use warm blankets, warmed IV fluids (37-40°C), and warmed blood.

Stop the bleeding!! This may mean applying a tourniquet, quickly suturing a scalp wound (44.2), inserting a balloon tamponade, splinting broken bones, performing a laparotomy or (less commonly) a thoracotomy. *Don't delay!* Administer tranexamic acid.

Preserve brain function. The most frequent cause of brain damage is hypoxia, so make sure the airway & ventilation, and circulation are satisfactory first. If the signs suggest you need to perform a craniotomy, *don't delay!*

SURGICAL INTERVENTION

It's all a question of time.

TIME IS BRAIN; TIME IS LIFE

Get the patient to theatre without delay! Don't compromise on safety for the neck: keep it immobilized.

You don't need radiographs in the extreme situation. Unless you have an X-ray facility in the resuscitation bay, don't bother with radiographs even in acute cases. Use your clinical examination, and if possible, ultrasound (FAST, 43.2, 44.3).

N.B. A chest radiograph will often miss a significant haemothorax.

N.B. A cervical spine radiograph often misses some vertebrae, or is very difficult to interpret. A pelvic radiograph doesn't show if a fracture is bleeding.

Make sure the theatre is prepared for any time of day or night. If you have to call in staff, do so early on! Make sure you have packs, and blood available, and auto-transfusion equipment (5.3).

If your intervention will take >90mins, it will probably result in serious complications. So, if you are not experienced, or if you are naturally a slow surgeon, *don't perform complicated procedures!* The risk is the patient will die on the table or shortly afterwards.

Remember that the place to correct the stress of injury is not the theatre where there is more stress from surgical intervention!

Monitoring where you are every 10mins is an important way of keeping track of progress: use 'STACK':
(1) Systolic blood pressure
(2) Temperature
(3) Acidosis
(4) Coagulation diathesis
(5) Kit (make sure enough equipment is available)

In unsophisticated centres, it is best to do what is simple, quick and easy to perform. These will give the best results. *Don't try to fix everything the first time round!* Come back after the patient has had a respite, when the condition has improved, and there is more reserve to withstand more stress.

THE 4 PARTS TO DAMAGE CONTROL:
(1) DC0 is Disaster Control Resuscitation: the emphasis here is rapid assessment & initial treatment in your resuscitation room.
(2) DC1 is rapid control of bleeding and contamination, packing, and temporary wound closure in the operating theatre.
(3) DC2 is continuing intensive resuscitation to correct physiological & biochemical disorder and checking for other less important injuries.
(4) DC3 is definitive repair; this may require several separate visits to theatre if there are multiple injuries or problems.
Details of each of these stages are described in the following chapters, but these are important comments regarding each step:

(a) *Optimize cardiac output.*
If you can, insert a CVP catheter and measure pressures. with a manometer to guide fluid administration and normalize the hemodynamic status.
Try to check serum lactate levels, as this will give you an excellent guide whether your patient is improving; a return to normal levels by 24h are a good indication of recovery.

(b) *Optimize oxygen-carrying capacity.*
Correct underlying anaemia (use a Hb of 100g/L as your goal; remember that levels above this do not improve a patient's oxygenation).

(c) *Recognize need for re-operation in 24-36h.*
These causes will probably need an early or unplanned return to theatre:
(1) Failure to make regular progress towards normal Hb, lactic acid, pH, temperature, clotting times and oxygen saturation.
(2) Ongoing bleeding despite normalized clotting and core temperature.
(3) Visceral injury that you missed before.
(4) Development of abdominal compartment syndrome.
(5) Limb compartment syndrome.
(6) Sepsis: *the earliest symptom of this is loss of appetite & unexplained fall in urine output.*
(7) A smelly or obviously septic or contaminated wound.

Before you reach DC3, ask yourself if the patient is ready. If you ask another, more experienced, surgeon to do the second-look operation, you must discuss the case thoroughly and make a detailed hand-over.