Abdominal Stab Wounds

General overview

Penetrating wounds of the abdomen have held a peculiar fascination for mankind since the invention of the spear. Sadly increasing knowledge has not brought increasing wisdom, and in all countries these injuries are seen. Less sadly, the effects can be mitigated by early application of surgical principles, and most patients with these injuries can now be saved.

Pathology

The abdomen contains hollow organs such as the colon and bladder, injury to any of which causes spillage of the contents into the general peritoneal cavity with consequent peritonitis. It also contains solid organs which are more or less richly supplied with blood and therefore tend to bleed slowly but often relentlessly when injured. Finally it contains large blood vessels which tend to bleed rapidly and often catastrophically when punctured. Which (if any) of these types of organ has been injured crucially affects management.

Neglect of injury to the first type (hollow organs) causes peritonitis, which is local at first and then if untreated rapidly becomes generalised - affecting the whole peritoneum. The reason for this is that (unlike appendicitis) there has been no time for the omentum to come round and prevent spread of the contamination. If treatment is delayed overmuch, the parietal peritoneum becomes infected, and abscesses form. These may be localised to certain areas (subphrenic, subhepatic, pelvic, or in the paracolic gutters) or may be multiple - typically in between coils of small bowel and causing adhesions and intestinal obstruction.

Neglect of injury to the second type causes slow loss of blood. If this is unrecognised for a long time, the body responds to the blood loss by clamping down the circulation to skin bowel and muscle, then later to kidneys and liver, but always tending to spare the heart and brain. Indeed it would appear to be that the peripheral vasoconstriction has as its purpose the re-routing of blood from the less immediately important structures to the most. Only in the late stages does this form of compensation fail, and then the effects are a falling blood pressure, heart failure and mental confusion. Earlier on, while compensation is effective, the signs are peripheral pallor, a cold peripheral skin (cold nose toes and fingers) and poor urine output. If this period (that of maximal compensation) is prolonged, then those organs which are most sensitive to anoxia get damaged, the kidney and liver being particularly susceptible. The results are renal failure (at first reversible but later irreversible) and total organ failure. So these organs, while being less immediately important than the heart and brain, are necessary for life and worth preserving. (The moral is obvious - treat a cold nose, a thready pulse and a poor urine output with early intravenous restoration of blood volume and early surgery to stop the bleeding).

Neglect of injuries of the third type (to large blood vessels) leads to rapid death from shock. Yet these injuries can be survivable, and the writer has even recently saved someone whose aorta had been stabbed - almost completely severing it from the left common iliac artery - a patient who was swelling up visibly before our very eyes.
One other aspect of pathology needs to be considered. That is the pathology of the track of the wound. People are sometimes stabbed when their muscles are straining (as in a fight, or when they "double up" to protect themselves). Later when they are seen in hospital their muscles are relaxed and they are no longer "doubled up". So as the abdomen has several layers of muscles, there should be no surprise if the "track" in each successive layer is no longer straight, but zig-zag. And consequently, failure to pass a probe straight into the abdomen is no proof that the peritoneum has not been reached by the penetrating knife. Indeed the writer no longer bothers to probe the wound but uses other methods to be sure of the integrity or otherwise of the peritoneum.

Principles of management of abdominal stab wounds.

The principles are surprisingly simple:-

1. The ABC of Trauma Life Support
2. Diagnosis and decision making concerning the likely injury
3. Surgical management of evident bleeding or peritonitis or
4. Expectant management and observation leading on to 3. (above) where observation reveals cause for concern, and that without delay.

1. The ABC of Trauma Life Support

The principles of this are by now well known. The patient is taken into an area reserved for the seriously ill and injured - an area that has more to it than the usual reception stretcher-on-a-trolley - an area with good lighting, access (room) all round the patient - even (perhaps especially) at the head end - and facilities for resuscitation (sucker, laryngoscope, endotracheal tubes, ventilating bag, oropharyngeal airway, intravenous drip sets and fluids, and large-bore resuscitation needles (16 to 17 gauge 36mm short- bevel needles being perhaps the ideal).

A stands for Airway. This comes first. Why? Because the body can stand severe haemorrhagic shock for a quarter of an hour, but it can only stand total blockage of the airway for 3 to 4 minutes before irreversible brain damage occurs. Patients with abdominal stab wounds may vomit, and their airway become blocked. Diagnose it and treat the airway first. Treat it by clearing the oropharynx digitally and perhaps with a sucker, and then ensuring that there is a clear airway-perhaps using an oropharyngeal airway or even an endotracheal tube if necessary.

B stands for Breathing. This comes second. An airway is no good if air does not flow along it. If the patient is not breathing, he will have to be helped - perhaps with that resuscitation bag. Or (for the time being) with mouth-to-mouth or mouth-to-nose ventilation. This has saved many lives. Once this has started it should be continued until either the power to breathe has returned, or the patient has been pronounced dead.

C stands for Circulation. This is often (mistakenly) done first. It should be done after the airway and breathing have been dealt with. (After all, it rarely takes more than a minute or two to deal with them, but dealing with this may take tens of minutes). The patient is assessed. Is his nose cold? (Or his toes or fingers). Is his pulse rapid or thready? Is he pale? If the answers to these questions (all of which can be answered in less than a quarter of a minute) are "yes", then he has
hypovolaemic shock. It may be compensated (normal blood pressure) or it may not (low blood pressure) but in either case it needs treatment by rapid intravenous infusion of volume-restoring fluids. A good rule is to start with normal saline, and to have it run in in a continual flow (not just "drop, drop, drop..."). This is where the needle referred to above comes in so handy. It is quicker to introduce than a plastic cannula, and rarely cuts out of the vein. It has the added two advantages of being cheap and re-sterilisable.

Only after the ABC of Trauma Life-Support has been dealt with need we consider the other life-saving procedures - the D of Details - which are still necessary to save life. Details include Diagnosis, Decision making and Decisive Action. (Three D's).

2. (i) Diagnosis of the likely injury

Your initial examination will already have given you valued clues. Oligaemic shock will point to injury of vascular solid organs. A rapidly swelling abdomen in addition to shock will point to aortic injury or injury to a similarly important blood vessel.

The History will also be informative. Little history will have been obtained while attention was diverted to the airway, breathing or the circulation and restoration thereof. Now a slightly more detailed history can be taken. This history can include information about the injury. From which direction did the penetrating missile come? In which direction was it pointing (that may give a clue as to the likely organ[s] injured). Was the abdomen tensed at the time? Is a missile still inside? (My colleague had a patient with a firework inside the abdomen that no-one knew was there!) Has the patient had a blood transfusion before? Did he have a large spleen? (Large target for a spear or arrow!)

Examination should be thorough. Where is the site of entry? Entry over the lower chest may well mean that the abdomen is involved (the diaphragm is at the level of the sixth or seventh rib!) Is there a site of exit? At the site of the stab wound is there evidence of omentum or bowel protruding? Is blood coming out? (If so, is it dark blood from venous bleeding inside the peritoneum or red blood from an artery in the abdominal wall?)

Does the abdomen move with respirations? Is it swelling? (Measure it with a tape measure and mark the skin where the tape went round so you can repeat the examination, and write the girth on the skin and in the notes with the same ball-point). Ask the patient to cough. If this is markedly painful, there may well be peritonitis (pain on coughing is more often positive than rebound tenderness, and is much kinder to elicit as a sign). Palpation follows. Is there marked guarding, or tenderness? If so, light percussion over the various regions of the abdomen may show which quadrant of the abdomen is the most tender. Is there a swollen track in the subcutaneous tissue? Is the spleen enlarged? (Sub-capsular h'morrhage). Percussion in the flanks may reveal the shifting dullness of intraperitoneal blood. Auscultation is rarely helpful. After penetrating injury and indeed after any injury there may be silence in the abdomen for a few hours. Such silence signifies nothing.

By now there should be sufficient clues to help form a plan of action. If there is still doubt, some investigations may clinch the diagnosis. These include:- (a) Repeated h'moglobin or PCV estimations. (The first such examination will not help much - after a severe bleed there is initially
haemoconcentration, but if four or eight hours later there is a steady fall, the likelihood of internal bleeding is increased). (b) Peritoneal lavage. By this is meant washing saline through the peritoneum and when it comes out again seeing if it is soiled with faecal contents or with blood - a positive result meaning laparotomy is necessary. See appendix 1 for Peritoneal lavage. (c) Ultrasound scan. The author has not used this until recently when the investigation became possible at the Birmingham Accident Hospital. If it is available, it can be very helpful in experienced hands. It can detect amounts of intraperitoneal blood that are undetectable by other means - even by lavage. (d) Xrays. These are rarely helpful so I put them last. Even intraperitoneal air is not diagnostic of an injury needing laparotomy - it may have come in through the wound from the outside air (or even with the lavage!)

(ii) Decision making concerning the likely injury etc.

You now have enough information to make an informed decision about the patient and write out or effect a plan of action. If there are signs of peritonitis - operate. If there are signs of internal bleeding - operate. If there are signs of massive internal bleeding and still continuing bleeding - get the patient to theatre at once (but not before the ABC!) and continue resuscitation there, prepared to "go in" within minutes once anaesthesia has been started (probably with ketamine and relaxant because ketamine does not of itself drop the blood pressure). If there are no such worrying signs, then "expectant management" is started. See section 4 below.

It is a wise idea to write down the "plan of action" in the patient's notes, in case another doctor takes over during the acute stage.

(iii) Decisive action

If operation has been decided upon, then no time is lost. Blood is crossmatched (with very special attention to the rhesus factor especially if the patient is a woman or has had transfusion before), theatre forewarned, anaesthetist notified, consent obtained, relatives warned, instruments inspected. And of course the patient is got into optimal condition for surgery by transfusion, emptying (with the Ryle's tube) of the stomach and administration of atropine (as a premedication and to counteract the effect of ketamine). A book of operative surgery (or this paper!) is propped up on a "lectern" in the theatre in readiness.

3. Surgical Management of evident bleeding or peritonitis

If the penetrating instrument is still in place when the decision is made, then it should be left in situ and painted up with the patient's skin, rather than pull it out before operating.

Laparotomy is performed. The incision is decided upon when the abdomen is palpated after full painting up and draping - the painting extending from the nipples to below the symphysis pubis and well out into both flanks, and the abdomen, lower chest and flanks, down to symphysis being exposed in case of necessity of extension of the wound. I usually do a long paramedian muscle-splitting incision on the side stabbed or on the side of most tenderness. Splitting the rectus abdominis is quick, and repair is more effective than repair of the old-fashioned rectus retracting paramedian incision. This incision can be rapidly enlarged up or down, or even into one or other flank by a T-cut if access is not enough. If there was still doubt about whether the peritoneum had
been penetrated, then the initial incision can be quite small until that has been decided. If penetration had not occurred, it is easier to close! Otherwise it can be enlarged for exploration.

Figure 1. A Paramedian Muscle splitting incision

Exploration:- If the arrow or other penetrating instrument is still in situ, then it will guide to the area of likely injury. This can be very helpful - for example if it is penetrating the pancreas! Otherwise the whole abdomen must be systematically explored. Follow a rigid rule for this. My rule is start at the top and work down. I examine the diaphragm, upper stomach and oesophagus, liver (and gallbladder), the lesser sac (behind the stomach - accessible by opening the omentum between stomach and transverse colon through a relatively bloodless area), the pancreas lying behind peritoneum in the lesser sac), the duodenum, the kidneys (and ureters), the mesenteric and omental blood vessels, the duodeno-jejunal flexure, the small bowel from end to end looking at both sides and the mesentery, the appendix and large bowel (including the retroperitoneal side of the large bowel in the case of flank wounds), the bladder, uterus, tubes and ovaries. Dictate to
assistants what you have seen and identified as you go - it is an educational exercise for them. They can write it down for later transcription into the notes. If you find nothing, close the abdomen with a large needle and stout monofilament nylon suture, taking large bites with the needle, and going through all the layers (except the skin) of the abdomen with each bite of the needle so as to get maximum grip for the sutures and a sound closure. I usually use continuous doubled nylon size 0 or 1 rather than catgut or small sizes like 00 or 000. The skin can be closed separately (though this step is left for a few days if there was massive bacterial peritonitis).

Management of the injured organs depends on exactly which organ(s) you found:-

Damaged spleen:- Splenectomy is the time-honoured way of dealing with damage to this organ. The reason for this is obvious - it was once thought to have no function, it is easily removable, having a nice pedicle, and its operative repair is quite difficult (even if the anatomy of its blood supply is known and understood) because it is so friable, and likely to bleed again if haemostasis has not been properly obtained.

However, recent studies have suggested that the long-term prognosis for splenectomised patients is not without danger. The mortality from infections -especially in children (and also from vascular disease like coronary thrombosis in England and America!) is higher in them than in the normal population, so a new interest in preserving the spleen where possible is understandable. As with the kidney, the vascular tree of the spleen is fairly constant, and this knowledge can be used to retain portions of the organ with a viable blood supply. Selected cases may achieve haemostasis with suturing (splenorrhaphy) as with the liver. So minor injuries can often be well controlled as in similar injuries to the liver - with haemostatic agents like gelatin sponge, thrombin etc. However, such surgery is necessarily time-consuming, and the occasional practitioner is well advised to remove the damaged organ if he has not the necessary experience in its preservation. Conservative treatment with "expectant" management is being talked about in paediatric surgical circles, but even they don't recommend it in open injuries.

Figure 3. Relation of pancreas tail to splenic pedicle
Splenectomy is urgent when the bleeding seems to be outstripping efforts at blood replacement. Where there is other intra-abdominal damage needing surgical treatment, the spleen should be removed rather than persist with efforts at splenorrhaphy etc. Even if the incision has not been ideal, it is usually possible (sometimes after the addition of a transverse cut to the left flank) to pass a hand upwards and to the left between spleen and diaphragm, and draw the spleen into the wound. Where shock is present, it may prove necessary to be content at first with compressing the splenic pedicle between finger and thumb while the an’sthetist continues to resuscitate the patient, and only to perform the splenectomy itself when the anaesthetic team has pronounced itself happy that they have “caught up with” the bleeding. The vessels in the pedicle are ligated and divided individually with non-absorbable ligatures, and injury to the tail of the pancreas is avoided.

**Fig. 16-8 AUTOTRANSFUSION using a funnel and a blood-taking set.**
This is also useful if the patient has a ruptured spleen (66.6). Use large pieces of gauze, and collect the blood in a taking set. Kindly contributed by Stephen Whitehead of Mwa Hospital, Kenya.

**Damaged Liver:-**

Managing massive destruction of this organ can be very frightening to experienced and inexperienced surgeons alike. Haemorrhage can be fast and difficult to control, and partial removal of the organ requires anatomical knowledge and operative expertise that is not easily achievable. Happily massive damage rarely follows stab wounds. And that is good because the
early promise of hepatic lobectomy has not been realised except in some very specialised centres, and even in many of these now the emphasis is on simple procedures in the early hours after injury, leaving the more heroic procedures for those cases that survive.

Small lacerations that do not bleed are best drained. Those that bleed will usually respond to suturing, when a blunt and long curved needle is the ideal one to pass the catgut. Where bleeding is considerable, Pringle's manoeuvre may help stanch the flow of blood temporarily. In this manoeuvre the hepatic artery and portal vein are compressed between finger and thumb as they pass in the free border of the lesser omentum to the liver hilum. Unfortunately the normothermic liver can only survive a quarter of an hour of such compression, but this may suffice for the placing of sutures. For longer periods a moist pack is safer.

In cases where bleeding has been severe, bleeding may result from loss of platelets and other blood fractions, and the transfusion of fresh blood (in the absence of blood fractions) should be considered.

Ligating the hepatic artery in desperate cases with uncontrollable bleeding can on occasion prove life-saving. The liver can survive on such blood supply as comes to it by the portal vein. However, this is not a procedure that should be embarked upon lightly. Often what seemed to be severe bleeding at first settles down after resectional debridement, a period of "hot packing" and one or two well placed sutures. The author has only once had to use hepatic artery ligation, but in that case it proved useless, as the liver continued to bleed because of the blood coming through the portal circulation. In this case hemi-hepatectomy was the only way in which to stop the bleeding, but the patient died of his other serious injuries.

Biliary leaks are best anticipated by draining the affected area of damaged liver. Where they do develop as complications, it is probably best to replace fluid and electrolytes lost, and to wait. Many of them cease spontaneously in the absence of distal biliary obstruction. One procedure which is not recommended is the cannulation of the bile ducts with a "T" tube unless it has been injured. It seems that the normal undilated duct is peculiarly liable after cannulation to develop strictures.

Injury to the gallbladder and bile ducts alone is rare. Where it has occurred, (and this is usually in penetrating injuries), surgery is indicated - cholecystostomy (see below) if the gallbladder is injured or cholecystectomy if the injury is extensive or involves the cystic duct. Repair of bile ducts (either in the form of direct repair over a plastic stent, or in the form of direct anastomosis between ducts and bowel) can be done where the ducts are involved. Where there has been complete transection of the common duct, then the upper transected end must be looked for and either it or the gallbladder implanted into small bowel somehow (choledocho-jejunostomy, or even choledochoduodenostomy)

Injury to the Kidney:-

Open injuries to the kidneys do not often require much in the way of an operation. There are several reasons for this. One is that minor wounds of the kidney often are very easy to stitch up. If you suspect a kidney stabbing, then doing an IVP urgently may help find out if the kidney has been significantly injured, for the Xray will then show spillage of dye, and also show how the
kidney is functioning. Also, if operation is decided upon, it is vital to know if there is a functioning kidney on the other side (hence the value of the IVP - a kidney shaped lump palpated at operation proves nothing). If only a part of the kidney is damaged, and is found to be isch'mic (bluish grey instead of pinkish red) then if the operator is experienced, it may prove possible to resect the avascular pole of the kidney leaving the healthy renal tissue with a good blood supply. Only if the kidney is hopelessly pulped will it prove necessary to resect it. If you have repaired the kidney, or resected part, put a corrugated drain down to it before coming out.

If surgery is performed, or even if it is not, a good follow-up is important where renal damage is known to have occurred. Late complications like extrarenal pseudohydronephrosis or hypertension may still occur and require surgical treatment.

**Injury to the Pancreas:-**

Pancreatic injuries, fortunately, are fairly rare, perhaps because the pancreas is in a well protected site. However, they are rarely extensive in stab wounds, but even so are difficult to deal with. Where there is bruising only, with no disruption of the capsule, drainage only will be enough. If only the tail is injured, it can be resected with drainage. Probably the spleen would have to come out too. If the injury is more proximal, and in the main part of the body of the organ, especially if a major duct is exposed, it may sometimes prove necessary to anastomose the exposed pancreatic duct with a loop of jejunun brought up as a "Roux loop”. In severe injuries of the head of the organ the pancreas and duodenum may have to be explored by "Kocher's Manoeuvre" (cutting peritoneum on the lateral side of duodenum so that the duodenum can be lifted off structures beneath it) to fully assess the damage, and where the trauma has been extensive, it may prove necessary to remove both (pancreatoduodenectomy), but this is a formidable surgical procedure and patients often do not survive. It cannot be done in small district hospitals. The complications may be formidable, with the development of postoperative fistula, abscess formation, and (rarely) of the development of a pseudocyst between stomach and pancreas. The fluid that leaks from a fistula of the pancreas contains digestive juices that can digest away the skin, necessitating the use of a protective layer of greasy paint, or even an apparatus like an ileostomy bag to protect the skin. While the fistula is producing copious quantities of electrolyte rich fluid the amounts lost need to be measured accurately so that the water and electrolytes can be replaced. The temptation to operate again urgently is best resisted, as a proportion of these fistulae settle down if the correct operation has been chosen. I doubt if you will ever see a pancreatic injury. I have seen two.

If a pseudocyst of the pancreas develops, it will probably present as a mass in the epigastrium, and barium meal will show that it deforms the posterior wall of the stomach, bulging it forwards. It is best treated by opening the stomach from in front, and then opening into the pseudocyst by incising the posterior wall of the stomach from the inside and over-running the edge with a continuous chromic catgut suture as though anastomosing the stomach with the cyst, then closing the front of the stomach again. (Transgastric cystogastrostomy).

**Injury of the Stomach:-**

If the stomach is stabbed, it is readily repaired in two layers with catgut, but it should always be decompressed postoperatively by a nasogastric tube.
Injury to the Small Bowel:-

Small perforations may be readily closed with a two layer closure of absorbable or non-absorbable suture. If possible they should be closed transversely rather than longitudinally, so as not to narrow the lumen of the bowel. In the duodenum this may not always be practicable. Where a length of the bowel has been affected by multiple perforations, or has been torn away from its mesentery and is no longer viable, it should be resected back to where there is a good blood supply and the ends brought together as an end-to-end anastomosis. The same should be done if there is extensive bruising of the bowel wall sufficient to imperil its viability.

A high jejunal laceration may require a Kocher manoeuvre (see above under "pancreas" to be performed, in order to visualise the injury and mobilise enough bowel to effect repair.

Injury to the Large Bowel:-

Badly managed, these injuries carry a high incidence of postoperative complications and death. Most routine surgery on the large bowel is preceded by a regime that will empty the bowel and sterilise it. Furthermore the circulation in the bowel will in routine cases not have been imperilled by the presence in the circulation of large amounts of vasoconstricting noradrenaline such as after injury. For these reasons, the surgeon dealing with injury of the large bowel is bound to "play safe" when in doubt, as, for instance, in the matter as to whether a temporary colostomy should be done. The writer as a junior rang up a senior surgeon in the 1960’s for advice in a case with a small hole in the transverse colon. "Make the hole larger and bring it out" was the helpful answer. It is often still the answer. So - a small perforation of the caecum can be converted into a caecostomy, with the caecum sutured to the abdominal wall, and with a rubber catheter brought out through the abdominal wall to allow drainage. The tube can be removed when the patient is well two weeks or so later, and the resulting fistula usually heals up without need for further surgery.

Gashes in the transverse colon, splenic flexure and descending or sigmoid colon are best brought out (through a separate incision in the abdominal wall) over a glass rod and then immediately (when the main incision has been closed) enlarged to make a proper definitive transverse colostomy, with the edges of the colostomy sutured accurately to skin with catgut. When the patient is quite fit later and the bowel has been prepared, the colostomy can be closed. Gashes in the rectum (which occur with spearing up the anus and "astride” injuries) cannot of course be brought to the surface in this way, and so in these cases a loop of proximal bowel is brought to the surface as a defunctioning colostomy (again over a glass rod) and the rent repaired and drained. Only where the rectal split is extensive is it necessary to divide the rectum across at the site of the split, close the distal end and drop it back into the pelvis with drainage, and bring out the sigmoid colon as an end (terminal) colostomy (Hartmann’s procedure). When this is done, the eventual operation to re-anastomose the bowel is quite a formidable procedure, and may require specialised equipment and an experienced surgeon. It should not in such cases be booked as a "closure of colostomy".

The eventual closure of colostomies can be done either extraperitoneally or intraperitoneally, but usually intraperitoneally because the hurry in which the colostomy was made usually makes extraperitoneal closure difficult if not impossible.
From time to time publication suggest that many of these injuries can be managed by closure of
the perforation as a primary procedure. In the writer’s experience, when surgeons have followed
this kind of advice, tragedy has followed in the form of breakdown of the repair, often with
complications such as multiple intra-abdominal abscesses, or subphrenic collections of pus - often
with fatal consequences.

Figure 4. Making a colostomy

Figure 5. Making a Caecostomy with a De
Pezzer catheter.
Diaphragmatic Injury:-

All these injuries need repair as diaphragmatic injuries tend not to heal spontaneously, and when herniation occurs, the hernia tends to grow in size and cause respiratory embarrassment etc. Indeed, strangulation of the herniated viscera is not unknown.

There is some controversy as to whether these injuries are best repaired from above or from below the diaphragm. The answer is that an experienced surgeon can nearly always repair the diaphragmatic defect through the incision with which he/she is most familiar, or the incision which has already been made (to diagnose the injury). This is however only part of the story. In virtually all cases an approach is needed which allows a full exploration of the whole contents of the abdomen, and this approach can be extended where such exploration shows the presence of a lesion which needs good exposure for its repair. So do an upper vertical laparotomy incision which can be converted to a thoracoabdominal approach if necessary (and it is rarely absolutely necessary - many diaphragmatic tears can be adequately repaired "from below"). This gives the potentially lethal abdominal associated injuries the best chance for repair, and still leaves the possibility of a chest incision as an available option. An inexperienced surgeon may well take up the option which will make the diaphragmatic repair easier.

A good method of repair is to use interrupted figure-of-eight nonabsorbable sutures through the whole thickness of the diaphragm. Following repair the chest needs a basal drain connected to an underwater seal bottle, and of course this drain is best inserted before the diaphragm is repaired if repair is to be done from below!

Bladder Injuries:-

Bladder injury can escape diagnosis for some hours - perhaps because sterile urine is not particularly irritating to the peritoneum. Perhaps also for this reason such delay in diagnosis of this particular injury is not likely to be lethal. Many cases are diagnosed incidentally at laparotomy purely because the surgeon makes it an invariable practice to inspect the bladder before "closing up". One case in the writer's memory was diagnosed because when the catheter was passed for assessment of urinary output it yielded 2 litres of straw-coloured "urine" and it was supposed (correctly) that the catheter must have been not in the bladder but in the peritoneum, having passed through the site of rupture. A more usual finding is scanty amounts of blood-stained urine when the catheter is passed. It is then easy to inject contrast medium up the catheter and obtain a "cystogram". This shows opaque medium outside the bladder and in the pelvis.

Treatment is straightforward. Laparotomy is performed and the rent sutured, leaving in an indwelling urethral catheter for 2 weeks for drainage. The rent may be intraperitoneal or extraperitoneal, and there may indeed be not one but multiple tears. Hence it is important that the bladder be opened sufficiently widely to allow inspection of the whole interior.

Injury of Major Vessels:-

In such cases haemorrhage may be so profuse as to necessitate immediate laparotomy. Such cases can be frightening to deal with, and in cases of impending death it may be necessary to open the
abdomen without prolonged "scrubbing up" (just putting on gown and sterile gloves). Immediately after scooping the blood out of the peritoneum it is wise to resist the temptation to plunge wildly about deep in the abdomen with artery forceps and to be content with massive packs and perhaps a firm pressure over the aorta while blood replacement proceeds. When the pack is removed - perhaps fifteen minutes later, it may be possible to find the bleeding vessel and deal with it appropriately. Where the vessel is a vein, cold fluid may be felt to be coming from it if a lower limb vein has been chosen for resuscitative intravenous infusion, and while this may occasionally help in locating the site of rupture, it means that lower limb veins should not usually be used for resuscitation in such cases. Where a major artery such as the iliac has been severed definitive repair may prove necessary, and this may call for the help of a vascular surgeon.

4. Expectant management and observation

Where expectant management has been decided upon, the patient is admitted, given an intravenous drip and "nil by mouth" to begin with, and is observed. The following are done:

(a) The pulse rate, blood pressure, and temperature are charted hourly (to begin with), and the fingers and nose are often felt to make sure they are not getting cold.

(b) The Haematocrit (or Hb) is measured at least twice daily to detect early signs of slow bleeding.

(c) The urine output is charted.

(d) The doctor is notified if any of the following happen: The pulse rate rises, signs of shock such as cold nose or thready pulse develop, the temperature rises, the urine output lessens or the patient begins to shiver or be in a lot of pain.

If signs develop which make the doctor think that there is intra-abdominal bleeding, or peritonitis, then operation is done after all. (See above).

Postoperative recovery and mortality

Close supervision postoperatively is essential. This includes careful control of fluid and electrolyte balance, the further transfusion of blood, and chest physiotherapy to prevent pulmonary collapse. A 4-hourly temperature chart is essential, and an hourly pulse. Where anaerobic bacteria are likely to have contaminated the wound or peritoneum, Metronidazole is prescribed in addition to other antibiotics. A "second look" operation may have to be performed if it is suspected that further complications such as intra-abdominal abscesses, or intestinal obstruction, are occurring. Once this is decided upon, it should not be long delayed, as delay increases the difficulty of further operative procedures, and also the mortality.

Summary

Early diagnosis, and effective management before the pathology has become advanced, can do much to lower the mortality. The surgeon in charge should not be ashamed if he has a few "negative laparotomies" in his management of such cases, provided that these do not result in mortality. The outlook for cases that have had the correct surgery is good. The following
preventable factors may however spoil what might otherwise have been a good result, and the dangers seem to be hard to learn:-

1) Operation performed too late because repeated examination of the patient was not carried out.

2) Missing intra-abdominal bleeding because of "masking" by associated injuries like fractures, and not doing twice daily haemoglobins.

3) The wrong operation performed (e.g. Repairing the damaged colon instead of performing a proper colostomy) because of ignorance or inexperience. (The "triumph" of hope over experience).

4) The surgeon being over-confident about his own ability, and so performing an operation outside his/her capability (e.g. hemi-hepatectomy instead of packing the liver).

5) Over-reliance on technologically exciting methods instead of well-proven clinical expertise (e.g. reliance on ultrasound scans over against repeated clinical examination).

6) Poor tissue handling - especially in closure of the abdominal wound. (e.g. closing the abdominal wound in layers with catgut instead of using a non-absorbable suture material and a mass closure method).

7) Death on induction of anaesthesia because of poor resuscitation and/or use of thiopentone instead of Ketamine in shocked cases.