INTRODUCTION

Gunshot wounds impose a continuous burden on community and hospital resources around the world. The availability of handguns and other low or high velocity rifles is rising and as a result there is a rise in gunshot wound victims seen at community hospitals.[1]

Gunshot injuries (GSIs) are a unique form of trauma that are on increase all over the world and contribute significantly to high morbidity and mortality. Gunshot injuries (GSI) are a unique form of trauma that is potentially devastating and associated with substantial emotional, physical and financial burden on community and hospital resources. [2] GSI causes profound morbidity due to prolonged hospitalization, high cost of heath care, loss of productivity and reduced quality of life and above all death. [2, 3]

The commonest cause of gunshot injuries in developed countries is suicidal attempt. However, armed robbery is the commonest cause of gunshot injuries in most developing countries. Civilian gunshot injuries usually are caused by low-velocity bullets and result in low morbidity and mortality, as compared with injuries from high-velocity missiles. However, recently, high-velocity weapons are used increasingly, causing more complicated injuries that task the experience of the attending surgeon. [4]

Gunshot injuries have become a major cause of morbidity and mortality among young males in our society where resources for prehospital and hospital trauma care are limited, and armed robbery attacks and interpersonal violence are the major causes of these injuries. Inefficient firearm control, high rates of unemployment, poverty and substance abuse have been reported to be responsible for increasing incidence of youth restiveness, armed robbery and associated gunshot injuries. [4]

Firearm violence is a major public health problem in the United States. In 1993 there were 40 230 deaths caused by firearm injuries and 40 880 deaths related to motor vehicle accidents. [5] By the year 2000 it is estimated that gunshot wounds will far outnumber traffic fatalities as the leading cause of traumatic death . [6] It is also estimated that there are

7.4 nonfatal shootings for each fatality. [7] The frequency of firearm-related injuries has increased dramatically in many urban centers. Treatment and evaluation of gunshot wounds are not confined to military medicine, but are facts of daily life. Analysis of military trauma indicates mortality from gunshot wounds has declined, but mortality and morbidity associated with civilian gunshot wounds have increased. The increased mortality was attributed to a shift toward use of more sophisticated weapons and corresponding higher-caliber, higher-velocity ammunition. [8]

The history of violence in the world is long and concern has always been present. What has changed is the view of violence as a public health problem. This change began in the 1970s with the recognition by the United States Public Health Service that homicide was among the leading causes of premature deaths. [9]

The type of firearm wounds varies according to the type of firearm weapon used. There are two groups of firearm weapons; the first includes the smooth bore weapons, whereas the second includes the rifled weapons, which are the most important. [10]

There are two types of missiles according to velocity; the first one is the low velocity missile that travels in a speed (below 2,500 feet per second), and the second one is the high velocity missile that travels in a speed (exceeding 2,500 feet per second). [11]

Epidemiology

Weapons have been invented, refined and adapted over the course of human history. Ballistics (Gr. *ballein* to throw) is the scientific study of the motion of projectiles in flight. Most of today's antipersonnel weapons cause ballistic traumas, and their origins can be traced back over thousands of years. The most typical ballistic traumas are those caused by firearms and explosions (blasts). Ballistic trauma is at present an international concern for numerous agencies, both civilian and military. [12]

Battle injuries sustained in conventional warfare are more likely to be lethal than are injuries sustained by civilians. Depending on the tactical situation, mortality may range from 20% to more than 80% of all casualties. The American experience indicates that about 90% of the total mortality occurs on the battlefield. Such casualties, those classified as killed in action, die before reaching medical care. More than 90% of all battle injuries

(morbidity) are caused by penetrating missiles. Exsanguination from wounds of the heart/great vessels and penetrating/perforating wounds of the skull cause the majority of battlefield deaths. [13]

In the United States, suicide and homicide consistently rank in the top 15 causes of death. According to data published by the National Vital Statistics Reports, 11,406 homicide deaths occurred from firearm injuries in 2009 and 18,689 deaths from self-inflicted GSWs. Forty percent of homicides and 14% of suicides by firearm involved injuries to the torso. [14]

between 25,000 and 30,000 Americans die from gunshot wounds each year, and 10% of these deaths are the direct result of penetrating cardiac trauma. [15]

Over the last 30 years, the incidence of penetrating cardiac trauma has increased eight-fold. Classically, the majority of penetrating cardiac trauma cases have resulted from stab wounds in civilian settings and from missile injuries in war time. Missile injuries to the heart now occur with greater frequency than stab wounds in civilian settings and are more lethal, with 11% of victims arriving at the trauma center alive compared to 40% of cardiac stab wound victims arriving alive. [16]

Prior to 1984, over 80% of missile injuries were caused by small caliber handguns (ranging from .22 to .32) and 75% of victims sustained only single bullet injuries. Surgeons at major trauma centers today see increasingly larger caliber bullets in gunshot victims and a greater number of bullet injuries per patient. Shotgun injuries currently account for 4% of penetrating cardiac trauma cases and have a mortality rate of nearly 100%. [17]

Firearms in different societies [12]

No one really knows how many weapons are in circulation among the general population of most countries. International Physicians for the Prevention of Nuclear War Organization has estimated that more than 500 million military-style small arms circulate in global markets, along with an equivalent number of civilian-type fireams, and the demand is increasing. The first international effort to gain some insight into the problem was the study by the U.N. Commission on Crime Prevention and Criminal Justice. This

study conducted a survey of the member states with the aim to collect and compare data on the manufacture, trade, and private possession of firearms, on national regulations for firearms, and on homicides, suicides, and accidents involving firearms. The combined official figure of WHO's study produced a figure of 34 million firearms in private possession for the 35 countries that provided data, which probably represents little more than the tip of the arsenal iceberg).

Russia, for example, reported a figure of 3,6 million, but they are generally thought to have a huge number of illegal guns in circulation, with the black market being fed through profuse leaks from the national military arsenal. In Canada, as another example, the number of legitimate owners is unknown; instead of the 7 million figure submitted to the U.N., estimates of as many as 21–25 million firearms in private possession have been made.

The United States is, without a doubt, a country with one of the largest private firearm arsenals, and very likely the world leader in this aspect. There are a quarter of a million federally licensed firearm dealers in the country. Estimates of private firearm ownerships in the United States run from 192 million to 230 million according to the U.S. National Rifle Association.

Missile Injuries Burden

The personal and socio-economic costs of injuries are profound. As well as the possibility of death, individuals may face a lifetime of disability and endure lengthy expensive rehabilitation. They may require support and intervention from a range of agencies – health, social protection, housing, education, rehabilitation etc. Missile Injuries are a major cause of long-term disability and absence from work. They also have a profound impact of the lives of family members. [(18)]

Firearm injuries are associated with an excessive mortality burden but the burden of non-fatal firearm-related injuries is estimated to be far worse and unfortunately, it is hard to quantify all aspects of this burden such as the social and emotional aspects. For instance, it is difficult to measure the income loss by patients while on admission, the fiscal/emotional trauma to the patient, the costs of patients coping with permanent disabilities, the effect of

patients' disabilities on their employers/relatives and the burden of care borne by the health staff caring for patients. Consequently, many estimates are only limited to calculating patients' financial expenditures in the hospital. Despite the limited appraisal, the estimated economic burden of rising firearm-related trauma is staggering and constitutes a threat to both national fiscal and human resources when the trend is not curtailed. This cost is bound to further escalate where patients need multiple admissions that will increase the costs of hospital stay, costs of therapies including pharmaceuticals and blood products, laboratory services and diagnostic imaging studies which are components of costs estimations. [19]

Mechanism of Injury

Principally, there are three mechanisms of tissue damage due to missiles; laceration and crushing, shock waves, and cavitation. The first mechanism is generated by the missile displacing the tissues in its track and are recognized as the primary wounding mechanism, The degree and amount of laceration and crushing are dependent upon missile velocity, its shape, and angle of impact; however, the shape and construction of a missile are not significant factors at such low-velocities as observed in handguns. Shock waves; the second mechanism often cited as significant in wounding, they occur by the compression of tissues that lay ahead of the missile, and are generated by high velocity missiles generally exceeding 2,500 feet per second. The missile has ability to produce a temporary cavity, Which is considered an important component in wound production and the degree of destruction. When a missile enters the body; the kinetic energy imparted on the surrounding tissues forces them forward and radially producing a temporary cavity or temporary displacement of tissues. The temporary cavity may be considerably larger than the diameter of the missile, and rarely lasts longer than a few milliseconds before collapsing into the permanent cavity or wound (missile track). The nature of internal tissue injuries from rifled firearm weapons depend greatly on the velocity of the missile. [20]

For damage to occur some or all of the kinetic energy of the missile has to be absorbed by target tissues So the mode of injury depends on the velocity of the missile, [21] relatively the missile that travels in a speed (exceeding 2,500 feet per second) when it passes through the tissues sends a shock wave of compression ahead from the laceration track. [22] That wave lasts only for a brief period but it raises the tissue pressure up to

thousands of kilopascals that can cause severe damage into fluid-containing tissues like vessels lying away from the missile track. Direct effect of missile is the permanent tissue loss along the local track; the tissues are compressed ahead of the track by a compression in the form of shock waves of spherical form so that tissue damage can be produced in a considerable distance away from the original missile track. High energy is absorbed by local tissues from a high velocity missile; thus the tissues are accelerated violently in both forward and outward direction. The momentum gained by the tissues causes them to continue this movement even after the passage of the missile; this phenomenon creates a temporary cavity in the tissue that can be up to 40 times bigger than the diameter of the missile. [(23)] Penetrating missile transfers destructive energy to surrounding tissues, the impact imparts a temporary pressure wave perpendicular to the path of the missile which accelerates the tissues forwards and sideways. Due to the inertia, the tissue particles continue in their forward movement after the missiles have passed and a cavity up to 30 times the original cross-sectional area of the missile is formed followed by a quick collapse. [(24)] The stress waves which are directly related to the velocity of the missiles destroy or push a side structures on the bullet track. Cavity collapse is influenced by tissue elasticity, hemorrhage and edema leaving behind a smaller permanent pathway filled with vapor bubbles, and missiles fragments. The velocity of the missile as it strikes the target is the main determinant of the wounding capacity which is directly proportional to the amount of energy transferred and to the actual energy expended. [(25)] The greater the energy of the missile at the moment of impact the greater is the tissue destruction. [(26)] The striking energy of a missile is the product of its mass or weight multiplied by the square of its velocity, and because it is squared, velocity is the most important factor not the size or caliber of the missile. High impact has a greater destructive power to cause shock leading to death. [(20)]

Craniocerebral Missile Injuries

Craniocerebral missile injuries are common in military personnel in war zones but for the past few decades civilian population around the world has become vulnerable to such injuries due to civil wars, regional conflicts, militancy, terrorism and military-related operations. [(28)]

Projectiles are pellets fired from a shotgun, bullets from rifles, machine-guns, carbines, automatic guns and shrapnels and splinters by exploding bombs, mines and grenades. A high velocity primary missile deposits its kinetic energy on the skull, it fragments or mushrooms (deforms) with the fracture of the bone, thereby driving a number of small bone pieces (secondary missiles) into the brain tissue and furthering the damage. Also a high pressure sonic wave, lasting for microseconds (insignificant), radiates outwards from the point of primary missile impact. But more damaging to the brain tissue, adjacent and distant to track, is a low pressure, long (milliseconds) lasting wave which displaces and crushes the brain tissue radially due to moving missile in the brain. [29]This effect of tangential compression of brain tissue from primary track leads to temporary cavitation and suction of air, skin, hairs and debris into brain parenchyma. A missile (bullet or splinter) may tumble (yaw) within the brain tissue at its greatest slowing, presenting its long axis to the flight path thereby increasing primary track dimensions and secondary cavitation only to damage more brain. Such a phenomenon leads to a large exit wound with a perforating injury. [28, 30]

Missile wounds are tangential, penetrating and perforating. Tangential wounds occur when a missile grazes the skull at an oblique angle, only lacerating the scalp or stays under scalp causing depressed or elevated fractures and indriving bone fragments into brain parenchyma causing dural tears, cortical contusions, extradural or subdural hematomas. Prognosis is good after debridement. Penetrating missile injuries occur when a projectile strikes the skull nearly perpendicular, so that less energy is needed to break the bone and flight path is primarily taken into brain tissue after a tumble. The injuries produced are contusions, lacerations, haematomas, ventricular and dural sinus injuries, arterio-venous fistulas, pseudoaneurysms and remote infarcts. The fragmentation of the bone produces secondary missiles which take different paths in the brain tissue causing more damage. [28]

Perforating wounds are produced by high velocity missiles, fired at close range, causing secondary explosive cavitation due to yaw of missile, larger wounds of exit, skull base fractures, enormous rise in intracranial pressure temporarily, suction of debris, air, hair and skin into brain parenchyma, tonsillar hematomas and medullary compression as remote effects. [31]

Skull X-rays and plain CT-scan are the investigative tools, latter being the only primary and practical diagnostic tool. However, MRI is contraindicated. Metallic scatter can compromise the quality of a CT-scan. Angiography is procedure of choice in patients with sylvian fissure hematomas and when missile trajectory is detected close to either middle cerebral artery complex or sylvian fissure, basal cisterns, supraclinoidal area and cavernous and other sinuses. [28] Surgical management varies in technique, according to extent and depth of brain injury, from minimal, conservative and standard to radical. [28, 32, 33, 34, 35]

Facial Missile Injuries

The hallmark of high-velocity ballistic injuries to the face is highly comminuted fractures of the facial skeleton and avulsion injuries of facial as well as intraoral soft tissue along the main trajectory of the offending missile. Concomitant injuries often include secondary distant fractures, caused by the propagation of the shock wave. Other secondary injuries may include avascular necrosis caused by damage to the intimal lining of blood vessels resulting in intimal flaps and tears, often distant from the main trajectory. [36] Other factors that influence the clinical presentation are the bullet caliber or projectile size and shape, the traveling distance, the initial muzzle velocity, and the ballistic properties of the missile, and of course the anatomic nature of the injury site. Injury sites may vary anatomically and may consist of strong bony structures (such as the mandible), weak bony structures (the midface, for example), and soft tissue structures such as the neck. [37, 38]

Firearm wounds to the maxillofacial complex are uncommon and can result in devastating functional and aesthetic consequences for patients. It can result from suicide, homicide or accident. The majority of patients die due to such injuries but some can survive with excessive serious injuries on the face. Depending on the type of firearm, the velocity of the projectile, the distance from which the patient is shot and tissue resistance are the factors that determine the severity of injury to the affected person. [39]

Eye Missile Injuries

Although the eye makes up much less than 1% of the frontal body surface area, it is very susceptible to injury. Small fragments that may not penetrate clothing or that barely

penetrate the skin are able to cause blinding damage to the eye. Ocular injuries that occur in a terrorist blast can be as minor as a superficial foreign body from debris, a subconjunctival hemorrhage, or a corneal abrasion, and as severe as an open globe injury, orbital fracture, or damage to the optic nerve. [40]

Gunshot injuries to the eye are usually severe, whether the missile is an air pellet, a bullet ball, a paintball, a rubber bullet, or a bullet from a high-powered rifle. [41, 42]

Types of ocular injuries include eyelid and/or eyebrow laceration, orbital fracture, orbital foreign body, lacrimal system injury, corneal abrasion, corneal laceration, corneoscleral laceration, conjunctivitis and/or conjunctival irritation, hyphema, corneal burn, and traumatic cataract. [40]

When an eye injury occurs, seek medical help from an ophthalmologist or another doctor as soon as possible — even if the injury seems minor. Delaying care could lead to permanent vision loss or blindness. In addition, take simple steps to prevent further damage. For example: [43]

- Don't touch, rub or apply pressure to the eye
- Don't try to remove an object that appears stuck on the surface of the eye or an object that appears to have penetrated the eye
- Don't apply ointment or medication to the eye
- Flush out any chemicals the eye has been exposed to with plenty of clean water
- Gently place a shield or gauze patch over the eye until you can get medical attention

Neck Missile Injuries

All penetrating neck wounds are potentially very dangerous and require emergency treatment. The choice of treatment for the stable patient remains controversial, a number of studies encouraging mandatory surgical exploration and a similar number encourage selective surgical exploration. [44]

The leading cause of death in penetrating neck trauma is vascular injury. [45] However, predicting vascular injury in gunshot wounds of the neck is difficult because (*a*) erratic trajectories and missiles of different velocities and conformations create injuries with different characteristics, and (*b*) cavitation and secondary missile formation can produce tissue destruction outside the immediate path of the primary projectile. [8, 46]

Fragmentation, yaw (tumbling), and secondary missile formation increase the profile of the missile, and thus increase the magnitude of the injury. Fragmentation of the missile increases the area of the wound as the multiple fragments of irregular shape penetrate and destroy tissue (5). Bullets may fragment even if there is no contact with bone. Yaw is deviation of the bullet along its longitudinal axis. Secondary missile formation occurs when the bullet strikes such objects as bone, teeth, and buttons and drives these objects (missiles) into the wound. Each secondary missile creates its temporary cavity and permanent tract that may be even more destructive than the primary missile. [46]

Bleeding, shock from injury to the major vessels in the neck, and compromise of the airway are the major factors causing death after penetrating neck injury. Patients with active bleeding, who are in shock, or who have an expanding hematoma or airway compromise require immediate surgical exploration. [45, 47]

The clinical signs of arterial injury include pulse deficit, bruit, expanding hematoma, and arterial bleeding.

A combination of arteriography and surgical exploration may be the best method to avoid missed vascular injuries. In the future, spiral CT angiography may prove valuable in excluding major vascular injury. The clinical findings of neurologic deficit, expanding hematoma, bruit, and absent pulse associated with major vascular injury are often absent. Prevertebral soft-tissue swelling and bullet fragments adjacent to major vessels are useful radiographic signs for predicting vascular injury. [8]

The emergency care of firearm injuries to the head and neck must be focused on the basics of resuscitation. Primary attention should be given to the condition of airway as bleeding and subsequent swelling can endanger breathing. [48] After these protocols hemodynamic resuscitation should be performed. [49] The second step for head and neck

injury, detailed examination on vascular and laryngotracheal area must be performed in case of shock, expanding hematoma, active hemorrhage, bruit or thrill, pulse deficit, neurological deficit, subcutaneous emphysema, a "sucking" wound, stridor, dyspnoea, hoarseness, dysphonia or hemoptysis. [39]

Spinal Cord Missile Injuries

In the civilian setting in the United States (USA) GSW SCI is the second or the third most common cause of SCI. This constitutes between 12-15% of all SCI although one source suggested 25% of all SCI were due to GSW. By comparison during a similar period 28% of SCI were due to road traffic accidents and 16% due to falls. [50]

With modern high velocity weapons a direct hit on the spinal cord is not required to cause devastating injury. [50] Indeed, experimentally, subdural haematoma along the whole length of the spinal cord can be achieved by hitting a spinous process with a high velocity projectile. Microscopic damage to the spinal cord is not confined to the level at which it is hit, with injury to cells being seen up to 15 cm from the level of primary injury. [50, 51]

Plain X-ray will demonstrate bone anatomy and presence and position of retained foreign bodies. For more detailed bone anatomy computerised tomography (CT) can provide good detail which may require a mobile CT scanner with CT myelography, spiral and 3D reconstruction capability in the field. [50]

Magnetic resonance imaging (MRI) is very useful for soft tissue appearances, especially of the cord itself. Early realisation that the cord is completely transected, for example, has enormous prognostic implications. However, MRI can cause FB movement and the FB may cause significant artifact although such patients have been imaged safely. [52] Prior to the exploration of neck injuries affecting the cervical spine angiography is recommended, especially for the vertebral artery anatomy. [50]

Missile injuries of the Extremities

Missile injuries of the extremities might involve complex soft tissue, bone, vascular, musculotendinous and nerve injuries. [1]

Vascular structures are frequently injured because of their proximity to bone. [27] A delay in the diagnosis or treatment can result in a chronic debilitating handicap due to ischemia and limb loss. Prompt restoration of blood flow is mandatory in traumatic peripheral arterial injuries. Damage to vessels can result also in death due to exsanguination. [1]

Injuries can present acutely or up to several months in cases of an arteriovenous fistula. The presence of "hard signs" of arterial injury such as absent pulses, unequivocal signs of ischemia, profuse hemorrhage, pulsating or expanding hematoma warrants urgent surgical intervention. [1]

Historically, angiography was the imaging modality of choice, but recent studies show that non-invasive studies such as duplex Doppler ultrasonography are as sensitive as arteriography in most cases. [1]

Surgical options include temporary polytetrafluoroethylene (PTFE) shunting, end-to-end reanastomosis, or interposition reverse saphenous vein graft. [1]

Nerve injury presents clinically with hypoesthesia, parasthesias, or paralysis. Since spontaneous recovery is usually expected in neuropraxia and axonotmesis. [1]

We usually explore wounds presenting with obvious nerve injury. If possible we tend to suture the nerves using the epineural technique, and if the nerve ends are damaged or the wound is contaminated we mark the nerve ends and return to the operating room, at a later date for a definite nerve-grafting procedure. It is important that the nerve be repaired without tension. [1]

A gunshot fracture is a high energy open fracture by definition. the most common treatment modality was external fixation (36%), followed by intramedullary nailing (28%), and debridement only without fixation (20%). Primary open reduction and internal fixation were performed in 8% of the fractures. [1]

Chest Missile Injuries

Wounds of the thorax constitute 15-20% of all combat injuries. Many patients die from cardiac or major vascular injuries before reaching medical assistance. Establishment of adequate ventilation takes absolute precedence over all other therapeutic measures. Bleeding may also be critical. The treatment aims at re-establishing normal physiological functions. More than 90% of all penetrating chest injuries can be managed initially by chest drain. (27)

Penetrating chest injuries sustained in war were mostly caused by powerful missiles with great kinetic energy bringing to extensive injuries of tissue and organs. This type of injury can be found in 28% of the total chest injuries. Asignificant percentage of penetrating chest injuries refers to combined injuries of thoracic and abdominal organs accompanied with injuries of anatomic compartment /diaphragm. (53)

Iris important to secure an airtight seal of open wounds of the chest to prevent a potentially fatal open pneumothorax. This is immediately followed by tube thoracostomy. This should been done during the primary survey. Failure to do so will result in collapse of the lung on the affected side with alteration of the ventilation/perfusion ratio and, in addition, will progressively decrease the quantity and quality of air entering the affected lung. As dyspnoea increases due to anoxia, the mediastinum shifts on respiration and decreases venous return to the heart — the clinical picture in the later stages is identical to a tension pneumothorax. All penetrating wounds of the chest require adequate venting of the pleura by formal tube thoracostomy. This simple procedure will prevent the accumulation of blood or air under tension. (54)

Abdominal Missile Injuries

Between 25% and 40% of the abdominal wounds have associated thoracic wounds, and 5% have penetrated the perineum, buttocks or thighs.

In any penetrating injury to the abdomen due to a gun shot, surgical exploration is always indicated . The first step in the procedure is to check all potential sources of bleeding because uncontrolled bleeding is the most frequent cause of intra-operative death.

In a seriously injured patient, the technique of damage control surgery must be employed. [55] The most common injuries from gunshot wounds include: [56]

- Small intestines: 50%.
- Colon: 40%.
- Liver: 30%.
- Vascular structures: 25

Resuscitation includes:

(a) A good wide-bore intravenous line. If the patient is in a poor condition, several lines may be necessary and, if possible, they should be inserted in the upper extremities.

(b) A urinary catheter. This should be inserted in order to assess urinary output. It might also reveal unnoticed uro-genital lesions.

(c) A nasogastric tube. The tube will prevent gastric dilatation and avoid gastric contents being aspirated into the lungs.

(d) Routine antibiotic treatment is penicillin supplemented by metronidazole and chloramphenicol. If surgery does not reveal a lesion of the colon, metronidazole may be suspended. It is rarely necessary – even with seriously wounded patients – to continue the treatment for more than five days.

(e) Most abdominal cases can be treated without previous X-ray. An X-ray should not delay the treatment of a patient who needs urgent surgery.

Stomach

The stomach is injured in 10-15% of abdominal wounds. Single lesions are not common but easily dealt with because of the rich vascularization of the organ. Injury of the stomach is often associated with lesions of adjacent organs: the liver, spleen, colon, pancreas, duodenum, great vessels and kidney, resulting in a high mortality rate. If a lesion is found at the anterior surface, a posterior lesion must be suspected and the posterior wall of the stomach inspected. [27]

Small bowel

As bowel perforations are found, temporary control measures are rapidly initiated in an effort to prevent excessive or ongoing soilage. Once all bowel injuries are accounted for, the decision must be made whether to perform primary repair, resection of the injured segment, or some combination of the two. Primary repair of multiple injuries preserves bowel length and is generally preferred. At the discretion of the operating surgeon, resection of a segment containing multiple injuries may be performed to expedite the operation, provided that the amount of bowel to be resected is small enough that its loss would have only a negligible effect on digestive function. [57]

Colon

Experience with primary repair of penetrating colonic injuries in civilian settings suggested that primary repair could be performed safely and perhaps, in select cases, with less morbidity than colostomy. Nondestructive colonic injuries are defined as wounds that involve less than 50% of the bowel wall without devascularization. Such wounds account for approximately 80% of colon wounds and are amenable to primary suture repair with limited amounts of debridement. Destructive colonic injuries are defined as wounds that completely transect the colon or involve tissue loss and devascularized segments . Optimal management is resection and primary anastomosis. [58] patients with destructive colonic injuries who had comorbid medical conditions or transfusion requirements greater than 6 units of blood were at significantly higher risk for suture line breakdown when managed with resection and primary anastomosis. It is recommended to manage these patients as high-risk patients and perform fecal diversion. [59]

Rectum

Recognition of rectal injuries requires diagnostic vigilance. All patients with a penetrating wound to the pelvis, perineum, buttock, or upper thigh should be evaluated for rectal injury. Digital examination for the presence of rectal blood is mandatory, but the absence of blood does not definitively rule out injury. Rigid proctoscopy should be performed whenever there is any suspicion of rectal injury. [57]

Liver

High velocity missile injury of the liver is often life threatening and exerts considerable clemands upon surgeons and upon the available resources, especially the blood bank and reserves of intravenous fluids. Injury to the liver may be suspected by the presence of hemodynamic instability and anemia, as well as by the anatomical site of entry and exit wounds with some consideration to the trajectory followed by the missile.(60)

Advances in medicine and surgery have led up to 80% of traumatic hepatic injuries being managed nonoperatively, with no associated rise in mortality. In general this is applicable to lower grades of hepatic injuries, but with proper patient selection, Patients who are haemodynamically unstable require operative intervention and the use of damage control techniques to achieve haemostasis, thereby allowing full resuscitation of the patient. (61)

Spleeen

Injuries to the body of the spleen that do not disrupt major vessels cause an initial blood loss of about 500 ml that ceases spontaneously without signs of abdominal distention or shock. Splenic injury resulting in blood in the abdomen produces characteristic signs and symptoms. Generalized left upper abdominal pain occurs in approximately one-third of those with splenic injury. Palpation to the left upper abdomen may cause referred pain to the tip of the left shoulder (Kehr's sign) that suggests splenic injury.
In recent years, treatment of spleen injuries has evolved toward splenic repair and preservation because of the spleen's important role in immunity and a better understanding of complications that can arise from splenectomy later in life. Partial splenectomy or splenic repairs are being done with greater frequency and success. (57)

Pancreas

Major injuries of the pancreas are uncommon, but may result in considerable morbidity and mortality because of the magnitude of associated vascular and duodenal injuries or underestimation of the extent of the pancreatic injury. Seventy percent of pancreatic injuries are minor and include contusions, haematomas and superficial capsular lacerations without an underlying major ductal injury. Controls of bleeding and simple

external drainage without repair of capsular lacerations are sufficient treatment. Injury to the neck, body or tail of the pancreas with major lacerations or transections and associated pancreatic duct injury is best treated by distal pancreatectomy. (63)

Kidney

Kidney damage must always be suspected after blunt trauma to the lumbar region. This will be confirmed if haematuria develops. Surgery is only indicated if severe macroscopic haematuria persists over 48 hours and/or the patient becomes shocked as a result of blood loss.Delayed haemorrhage up to 2 weeks after blunt trauma is possible. (27)

Urinary Bladder

Bladder injury is suspected, but not proven, if the passage of a catheter does not produce urine. Other possibilities are that the patient is anuric or that there is a rupture of the posterior urethra and the catheter has not entered the bladder. But up to 300 ml of urine may be retrieved by a catheter in a bladder with small perforations, and even intraperitoneal bladder perforations may drain 100-200 ml of urine. (27)

Urethra

If a urethral injury is suspected, a catheter must not be passed before surgery as there is a risk that a partial laceration of the urethra may be worsened. Suspicious signs of a urethral injury are an inability to pass urine, bleeding via the urethral orifice and wounds indicating that a missile has damaged the urethra. Difficulty in passing a urethral catheter always raises the possibility of a urethral injury. If an injury of the urethra is suspected, a rectal examination should be performed. Nephrectomy is sometimes necessary to achieve haemostasis Partial nephrectomy is indicated only when the injured kidney is the patient's only kidney. (27)

Postoperative Complications

The highest incidence of postoperative complications is between one and three days after the operation.

❖ ***Postoperative fever*** [64]

➢ Days 0-2:

- Mild fever (temperature <38°C) (common):
  - Tissue damage and necrosis at the operation site and/or Haematoma.
- Persistent fever (temperature >38C):
  - Atelectasis: the collapsed lung may become secondarily infected.
  - Specific infections related to the surgery.
  - Blood transfusion or drug reaction.

➢ Days 3-5:

- Bronchopneumonia.
- Sepsis.
- Wound infection.
- Drip site infection or phlebitis.
- Abscess formation - eg, subphrenic or pelvic, depending on the surgery involved.
- DVT.

➢ After 5 days:

Specific complications related to surgery - eg, bowel anastomosis breakdown, fistula formation.

➢ After the first week:

- Wound infection.
- Distant sites of infection - e.g., UTI.
- DVT, pulmonary embolus.

❖ ***Haemorrhage*** [65]

If large volumes of blood have been transfused then haemorrhage may be exacerbated by consumption coagulopathy. It may also be due to preoperative anticoagulants or unrecognised bleeding diathesis.

Late postoperative haemorrhage occurs several days after surgery and is usually due to infection damaging vessels at the operation site.

❖ ***Infection***

Infectious complications are the main causes of postoperative morbidity in abdominal surgery. The most common form is superficial wound infection occurring within the first week. [66]

❖ ***Disordered wound healing***

Most wounds heal without complications and healing is not impaired in the elderly unless there are specific adverse factors or complications. Factors which may affect healing rate are: poor blood supply, excess suture tension, long-term steroids, immunosuppressive therapy, radiotherapy, severe rheumatoid disease. [67]

❖ ***Respiratory complications.***

Respiratory complications occur after major surgery, particularly after general anaesthesia and can include:

- Atelectasis (alveolar collapse):
- Pneumonia: requires antibiotics, and physiotherapy.
- Aspiration pneumonitis:
- Acute respiratory distress syndrome:

❖ ***Thromboembolism***

DVT and pulmonary embolism are major causes of complications and death after surgery. [68]

❖ ***Common urinary problems***

- Urinary retention: this is a common immediate postoperative complication. [69]
- UTI: this is very common, especially in women.
- Acute kidney injury: [70]

❖ ***Complications of bowel surgery*** [71]

- Delayed return of function:
  - Temporary disruption of peristalsis: the patient may complain of nausea, anorexia and vomiting and it usually appears with the re-introduction of fluids. It is often described as ileus.
  - The more prolonged extensive form with vomiting and intolerance to oral intake is called adynamic obstruction
- Early mechanical obstruction: this may be caused by a twisted or trapped loop of bowel or adhesions
- Late mechanical obstruction: adhesions can organise and persist, commonly causing isolated episodes of small bowel obstruction months or years after surgery.