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Current Epidemiology of Genitourinary Trauma

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Synopsis

This article reviews recent publications evaluating the current epidemiology of urologic trauma. It begins by providing a brief explanation of databases that have been recently used to study this patient population, then proceeds to discuss each genitourinary organ individually, discussing the most relevant and up to date information published for each one. The conclusion of the article briefly discusses possible future research and development areas pertaining to the topic.

Keywords

urologic; trauma; epidemiology; kidney; ureter; bladder; urethra; genitalia

Introduction

The importance of recognizing and appropriately managing urogenital injuries has been appreciated for centuries. Timely identification and management of these injuries is often organ saving, and at times life saving.

Worldwide, trauma is currently the sixth leading cause of death, accounting for 10% of mortalities.[1] In the United States, over 2.8 million people are hospitalized as a result of trauma yearly, with estimated costs of $406 billion annually in medical expenditures and lost productivity.[2] Trauma has a predilection for young adults, and results in the loss of more productive work years than cancer and heart disease combined.[3] The urogenital system has consistently been shown to be involved in 10% of patients presenting after trauma, and is therefore a significant factor in trauma induced morbidity and mortality.[4]

The majority of trauma data from the 20th century was reported from single institution data sets. With the expansion of electronic medical records and national trauma networks, national data sets have become a more accessible and significant source of information.

The National Electronic Injury Surveillance System (NEISS), originally created in 1970 by the U.S. Consumer Product Safety Commission, is one example of these national data sets. It has been used primarily to evaluate the magnitude of injury associated with consumer products, but since it provides a national probability estimate of all injury-related US emergency department presentations, it has proved to be a useful tool for evaluating many facets of trauma epidemiology.

More recently, the National Trauma Data Bank (NTDB), created in 1989, has continued to grow exponentially and currently contains over 5 million records, making it by far the largest national data set available. It has been increasingly analyzed over the last two decades resulting in significant contributions to the medical literature and increased understanding of trauma incidence, mechanism, and outcomes.[5]

The Crash Research and Engineering (CIREN) database, which is a multicenter research network developed by the National Highway Traffic Safety Administration, provides detailed crash site analysis and specific occupant injury data to help researchers better understand the mechanisms of injury in motor vehicle collisions (MVC).

Although far from comprehensive, these are several important examples of the major data sets relating to trauma. In the future, as the evaluation and sharing of data becomes easier and faster, the continued development of more inclusive and refined data sets will enable researches to probe further into the epidemiology and, hopefully, prevention of trauma.

Organs

Kidney

Prevalence/Incidence—Renal injury has historically been reported in 1.2–3.3% of trauma patients depending on the data set.[6–8] A recent population based study utilizing the NTDB and consisting of 6,231 renal injuries found an incidence of 4.9 per 100,000 population.[9] Like other trauma, renal injuries are also associated with youth and male gender. Renal injuries occurred in patients <44 years of age 70–80% of the time and almost 75% of these were male.[9]

Mechanism—In the USA, 82–95% of renal injuries are secondary to blunt trauma, [9] slightly less than the 93% observed in Canada[8] and 97% in Europe.[10] Penetrating injuries are more prevalent in undeveloped countries and areas with civil unrest. A retrospective, 4-year single institution study from a hospital serving 13 smaller cities throughout southeastern Turkey, a region with elevated sociopolitical tensions and a gun in every residence for self-defense and hunting, reported 59% (42/71) of renal injuries were secondary to GSW.[11] Similarly, 75% (130/174) of renal injuries reported by one hospital in Durban, South Africa were from a penetrating source, with 50% (87/174) due to GSW. [12] Although penetrating renal injury, which is responsible for 16% of renal injuries per

review of the NTDB, is much less common than blunt renal trauma, the incidence of civilian gunshot wounds (GSW) is reportedly increasing in the United States, Africa, and some European countries.[9, 13] Of traumatized patients in the United States, the proportion with renal injury was highest in those sustaining injuries from firearms (3.5%), MVC (2.2%), bicycle accidents (1.9%), pedestrian accidents (1.5%), stab wounds (0.8%), and falls (0.5%).[9]

The Epidemiology of Renal Trauma – Summary of Multiple Series[9]

	Rate of Renal Injury (%)	Number	Blunt (%)	Penetrating (%)	Minor Injuries (%)	* Major Injuries (%)	Renal Exploration (%)	Nephrectomy (%)
Seattle[7]	2.8	154	93.5	6.5	92	8	N/A	3.8
Toronto[14]	3.25	132	95.4	4.6	72	28	7.4	3.2
San Francisco[6]	N/A	2,254	89.8	10.2	91.1	8.9	7.4	0.8
British Columbia[8]	1.4	227	93.4	6.6	81.7	18.3	7.1	N/A
NTDB[9]	1.2	6,231	81.6	16.0	82.5	17.5	13	7

* Major injury defined as AAST grades 2–5 or ICD-9 code for laceration, parenchymal disruption, or vascular injury

Motor Vehicle Collisions—Motor vehicle collisions account for approximately 70% of blunt renal injuries, with 50.9% involving 2 vehicles, 21.1% a solitary vehicle, and 11.1% vehicle vs. pedestrian.[15, 16] According to the World Health Organization, approximately 1.3 million people die yearly from road traffic accidents, and another 20–50 million suffer non-fatal injuries.[17] Ongoing research into preventative measures to lessen solid organ injury has provided insight into the mechanism of renal injury in various MVC scenarios, as well as the effects of multiple automobile safety features. One of these studies, a recent review of the CIREN database, demonstrated a 45.3% and 52.8% reduction in renal injury during collisions with frontal and side airbags respectively.[18] In a separate analysis of the same data set, seat belts, which unquestionably decrease overall morbidity and mortality in accidents, have been shown to account for 90% of renal injuries in frontal collisions.[19] Side-door panel/armrest direct impact is the source of renal injury in the majority of side impact collisions, as is the steering wheel and instrument panel for unrestrained drivers in head on collisions. Interestingly, although not statistically significant, renal injury was more likely on the right side for restrained drivers and left for restrained passengers, possibly due to the lower/mid abdominal location of the shoulder restraint on the medial side.[19]

Bicycles—With 57 million, or 27% of the US population over the age of 16 riding bicycles on a daily basis, injuries sustained from bicycle related accidents contribute significantly to the trauma population. According to a review of mode-by-mode fatality and travel statistics report from the US Department of Transportation by Pucher and Dijkstra, bicycling is considered 12 times more likely to result in mortality than riding in a car per kilometer traveled, and results in over 600 deaths annually.[20, 21] A review of the 16,585 bicycle related trauma cases in the NTDB noted that genitourinary trauma occurred in 2% of bicycle

accidents (358 patients).[20] Renal trauma was the most common type of genitourinary injury in this subset (75–80% of GU injuries), with bladder and urethral injuries a distant second.[16, 20, 22]. A review of the NEISS database estimated that 43,542 (95% CI 36,447–50,363), or 9% of all GU injuries presenting to US emergency departments from 2002–2010 had a bicycle related injury.[23] Of these injuries, 31% (12,707 (95% CI 9585–15,830)) involved the testicles or scrotum, with renal injury representing only 5% (2158 (95% CI 1360–2956)) of GU injuries presenting to the ER.[23] This discrepancy is likely due to the different patient populations represented by the NTDB and NEISS. Patients in the NTDB have injuries significant enough to require hospital admission, and therefore are more likely to have a renal injury. The NEISS database, on the other hand, includes all emergency department presentations, most of which are treated in an ambulatory setting, and not surprisingly consist of a significantly higher number of scrotal injuries.[23]

Pediatrics—Due to children's weaker abdominal muscles, less ossified and protective rib cage, paucity of perirenal fat, intra-abdominal renal location, and relatively larger kidney-to-body size ratio they have an increased risk of blunt renal injury.[24] Approximately 10% of children presenting with blunt abdominal trauma have a renal injury.[25] According to a recent review of the NEISS database there were approximately 8,249 pediatric renal injuries that presented to emergency rooms in the United States between 2002 and 2010. Although renal injuries accounted for only 3.5% of all pediatric GU injuries, it was responsible for 25.7% of hospital admissions in this cohort.[26]

All Terrain Vehicles (ATVs)—The use of ATVs in both the general and pediatric populations has continued to increase over the last 20 yrs. Despite government legislation, multiple public awareness campaigns, improved safety labeling and age appropriate recommendations from numerous organizations, ATVs are responsible for an increasing number of pediatric injuries and deaths each year. An estimated 28,300 children under the age of 16 years of age presented to the emergency department in 2010 with ATV related injuries and there have been 2,775 reported deaths since 1982.[27] Several recent single institutional retrospective studies evaluated the risk of GU injury in this subset of patients. Approximately 3–3.7% of ATV related pediatric admissions sustained GU trauma, which was overwhelmingly renal in nature (22/23 patients, 96%).[28, 29] In contrast to a previous publication where a rollover injury or a blow to the abdomen from the handlebars was the source of renal injury, ejection was identified as the predominant mechanism of ATV-related pediatric injury in these more recent cohorts.[29, 30]

Sports and Solitary Kidneys—There has been a significant amount of ambiguity regarding the appropriate recommendations for children with solitary kidneys who wish to participate in contact sports. According to 182 responses to a survey sent to 231 active members of the American Academy of Pediatrics in 2002, 68% of these practitioners reported that they recommend patients with a solitary kidney avoid contact sports. [31] Since 1994 the American Academy of Pediatrics has recommended a "qualified yes" pending assessment for children with solitary kidneys wishing to participate in contact sports.[32] In 2012 Grinsell et. al utilized the data collected for the National Athletic Trainers' Association Injury Surveillance Study, an observational cohort study collected

during the 1995–1997 academic years, to evaluate the risk of renal injury in contact/collision sports. From 1995–1997 over 4.4 million athlete-exposures, defined as 1 athlete participating in 1 game or practice, were evaluated and 23,666 physical injuries were reported. A total of 18 minor kidney injuries, 3 lacerations and 15 contusions, were observed. None of these injuries required surgical management or resulted in known loss of renal function.[33] For boys, football had the highest rate of renal injury (rate 9.2 injuries/million athlete-exposures). Girls had the highest risk of sustaining a renal injury while playing soccer (5.9 injuries/million athlete-exposures). Overall, the risk of renal injury was significantly less than rates of traumatic brain/head/neck/spine injuries and it was concluded that patients with solitary kidneys should be allowed to participate in contact sports.[33]

Ureter

Prevalence/Incidence—Ureteral trauma is rare. Almost 25 years ago a large single-institution retrospective study reported ureteral injury in 1% of all urologic trauma.[34] More recently, a retrospective analysis of the 22,706 GU injuries in the NTDB from 2002–2006 found ureteral trauma responsible for 2.5% of GU trauma (582 patients total).[35] This significantly increased incidence is attributed to improved evacuation, stabilization, and evaluation methods of trauma patients resulting in increased survival of severely injured patients with improved initial detection of ureteral injuries.[35]

A recent literature review on ureteral trauma published by Pereira et. al. identified 77 articles with level 3–4 evidence. Consistent with the observation that the majority of trauma occurs in young males, the reviewers noted that an average of 83.4% of patients with ureteral trauma were males averaging 23.2 years of age. This male predominance, which is even higher than for overall trauma, may be representative of the strong association of ureteral injuries with penetrating trauma (61–62%).[35, 36]

Mechanism/Location—A review of the NTDB from 2002 – 2006 noted that penetrating ureteral injuries occur in a significantly younger population than blunt injuries, 27 vs. 37 years of age respectively ($p < .001$), and are more likely to occur in men than blunt injuries (91% vs. 73%).[35] Interestingly, this review also demonstrated a much higher overall percentage of ureteral injuries from blunt mechanisms than previously published (38% vs. 3%).[37] The vast majority of penetrating ureteral injuries (88%) were secondary to gunshot wounds while most blunt injuries were associated with MVC (50%). A recent 25-year review of ureteral trauma at the San Francisco General Hospital described the location of 38 ureteral injuries as 70% upper, 8% mid, and 22% distal.[36, 38] Most of the upper ureteral injuries were described as short segment losses amenable to repair with a tension-free anastomosis after initial debridement.[38]

Mechanisms of Ureteral Injury per NTDB Review[35]		
	N=528	**Total cases (%)**
BLUNT TRAUMA	24	38
MVC	110	19

Mechanisms of Ureteral Injury per NTDB Review[35]		
	N=528	Total cases (%)
Pedestrian	25	4
Motorcyclist	18	3
High Fall	15	3
Low Fall	8	1
Cyclist	3	<1
Other	45	8
PENETRATING TRAUMA	358	62
Gunshot Wound	316	54
Stab	29	5
Other	13	2

Concurrent Injuries—Associated injuries are present in 90.4% of trauma patients with ureteral injury.[36] This association represents the ureter's approximation to many abdominal and retroperitoneal organs as well as the severity, and often penetrating nature, of the insult needed to cause a ureteral injury.[39] Siram et. al found the colon/appendix (51%) and small intestine (49%) to be most common associated injuries, which is consistent with findings of previous single institution studies.[35, 36] Surprisingly though, their data showed a much greater incidence of vessel injury with penetrating trauma than previously described by Perez-Brayfield (38% vs. 13%).[35, 40] Congruent with previous single institution series, Siram et. al also found a higher incidence of arterial injuries with blunt rather than penetrating trauma (9% vs. 5% respectively).[35] The converse is true for penetrating trauma where venous injuries occurred 27% of the time and arterial injuries were seen in 16%. The iliac vessels lie just posterior to the ureters as they enter the bony pelvis and are especially susceptible to injury at this location, which explains how together they are injured in 28% of penetrating trauma. Not surprisingly, patients with blunt trauma and ureteral injuries are much more likely to have associated orthopedic injuries than penetrating cases (20% vs. 1%).[35]

Iatrogenic Ureteral Injury—According to the Consensus on GU Trauma statement on diagnosis and management of ureteric injury by Brandes and McAninch gyenocological surgery accounts for over half of all iatrogenic ureteric injuries.[41] A systematic review of benign gynecologic surgery estimated that ureteral injury ranged from 0.2–7.3 per 1000 surgeries.[42] Although ureteral injury typically occurs during gynecological, urological, urogynecological, and other pelvic surgeries, it has been reported with something as simple as a foley catheter placement.[41, 43, 44]

The pelvic ureter is involved in 80% or iatrogenic ureteral injuries, making it by far the most commonly involved segment.[45] The most common types of ureteral injury, in decreasing order of frequency, are ligation, kinking by suture, transection/avulsion, partial transection, crush, and devascularization with delayed necrosis/stricture.[41] Prior studies have identified resection of large pelvic masses, malignant neoplasms, inflammatory disease,

laparoscopy, and prior operation or radiation therapy as risk factors for iatrogenic ureteral injury.[46, 47] These injuries generally occur in the distal one-third of the ureter and are not prevented by placement of preoperative stents, although they do assist with intraoperative recognition when they occur.

Incidence of Specific Organ Injury in Patients with GU Trauma						
	NEISS[48]	**Scotland[49]§**	**GSW[13]§**	**MVC[16]**	**Bicycles[20,23]**	**Motorcycles[16]**
Kidney	7.7%	67%	54%	65%	5–75%	28%
Ureter	N/A	3%	3.8%	0	N/A	0
Bladder	N/A	18%	18.7%	16%	13%	5%
Urethra	N/A	16%	2.9%	2%	9%	3§%
External Genitalia	74.3%	20%	29.4%	17%	13–31%	64%

§multiple GU organs may be injured in a individual trauma patient

Bladder

Prevalence/Incidence—Due to its protected location within the bony pelvis, bladder injuries are not as common as their renal counterpart, but still occur with both blunt and penetrating trauma. Deibert et al reviewed the NTDB from 2002–2006 and identified 8,565 patients with documented bladder injury. Of the subjects 75% were male and 57% were under 40 yrs. (mean 38.9 yrs.).[50] A retrospective single institution study previously found 1.6% of blunt trauma patients had a bladder injury.[51] In 2009 Bjurlin et al reviewed the 1,466,887 patient records in the NTDB between 2001 –2005 and found that 3.6% of patients presenting with a pelvic fracture had a concomitant bladder injury.[52] Although men are more likely to engage in risky activities that result in a pelvic fracture, they noted that men and women presenting with pelvic fracture had a similar incidence of isolated bladder ruptures (3.41% vs. 3.37%, p=0.848).[52] Several large literature reviews have found that extraperitoneal bladder ruptures make up the majority of injuries (55–78%), with the rest consisting of intraperitoneal (17–39%) and combined intra- and extraperitoneal (5–8%) ruptures.[53, 54]

Blunt Bladder Trauma—Blunt trauma accounts for the majority of bladder ruptures (51–86%).[51, 55, 56] The 2004 “Consensus Statement on Bladder injuries” noted that a pelvic fracture increased the likelihood of bladder rupture from 1.6% to 5.7%, which is slightly more than the 3.6% described in the NTDB review.[53] A 20 year prospectively maintained database recently reported that MVCs are the most common cause of blunt bladder rupture (50.5%) followed by pedestrians vs. automobile (29.1%) and falling from a great height (14.5%).[55] Pelvic fractures are present 70% (35–90%) of the time there is a bladder rupture, which demonstrates the strong association between these conditions.[50, 57] Specific pelvic injuries, notably diastasis of the symphysis pubis or sacroiliac joints and displaced fractures of the obturator ring or pubic rami, have been shown to be associated with bladder rupture.[58] The majority of bladder ruptures without an associated pelvic fracture occur after a hard blow to the abdomen in a person with a distended bladder, often resulting in an intraperitoneal blowout injury of the bladder dome. The associated mortality

rate of 10–22% for patients with a bladder rupture demonstrates the high-energy and multisystem trauma that is usually involved.[56]

Penetrating Bladder Trauma—The percentage of bladder injuries caused by a penetrating mechanism range from 14–49% in several large single series and NTDB reviews, with gunshot wounds comprising the vast majority (88%, 316/358 patients with penetrating injury).[50, 55] Per a large literature review penetrating bladder injury is reported in 3.6% of abdominal gunshot wounds, 13% of penetrating injuries to the rectum, and 20% of penetrating injuries to the buttock.[53]

Iatrogenic Bladder Injury—Iatrogenic bladder injury is not uncommon. It is the most frequently injured organ during obstetric and gynecological procedures, with a rising incidence paralleling the rise in complexity of the surgery (1.8–13.8 per 1000 surgeries).[44, 59] Other reported miscellaneous causes for bladder injury reported in literature include trocar placement in the emergency setting for diagnostic laparoscopy, [60] during orthopedic treatment of pelvic fractures with external fixators, [61] and placement of an intrauterine device.[62]

***Operative Risk of Iatrogenic Bladder Injury*[53]**	
Injury Type	**Frequency per 1000 procedures**
Open Radical Hysterectomy	14
Lap. Assisted Vaginal Hysterectomy	13.8
Laparoscopic Hysterectomy	10
Vaginal Hysterectomy	9
Cesarean Section	1.8
Laparoscopic Herniorraphy	1.6
Mid Urethral Sling	0.4
Vaginal Delivery	0.1

Bladder Neck Injury—Bladder neck injuries secondary to blunt trauma in prepubescent males are well described in the urologic literature. The increased prevalence in this age group over adults is thought to be secondary to their undeveloped prostate. Consequently, there is minimal literature beyond case reports describing pelvic fracture-related injuries of the bladder neck and prostate until Mundy and Andrich recently reported on 15 patients where they described the mechanism of bladder neck involvement as an extension of a primary injury to the prostate and prostatic urethra.[63]

Urethra

Prevalence/Incidence—Urethral injuries are rare in the trauma population, accounting for approximately 4% of GU trauma per several series, but have the propensity to incur substantial long-term morbidity including intractable stricture disease, incontinence, impotence, and infertility.[49, 64] When the urethra is injured, 65% are complete disruptions with the remaining 35% resulting in partial tears.[65] Men are approximately five times

more likely to have a urethral injury than women, which is attributed to the longer length and reduced mobility of the male urethra.[66, 67]

Posterior Urethral Injuries—Posterior urethral injuries associated with pelvic fractures are the most common non-iatrogenic urethral injury in industrialized societies and are approximately 4 times more common than anterior urethral injuries.[68] Depending on the magnitude of trauma, the posterior urethra is initially stretched, and then partially or completely disrupted at the bulbomembranous junction.[69] Continued research into the mechanisms of posterior urethral injury with pelvic fractures as well as the inherent risks/associations of specific fracture types has further advanced the understanding of these injuries. A prospective study including over 200 males with pelvic fractures demonstrated that combined straddle fracture and diastasis of the sacroiliac joint confer a 24 times higher risk of urethral injury. Straddle fracture alone has 3.85 times the risk and Malgaigne's fracture increases the risk by a factor of 3.4.[70] In a retrospective, nested case-control study of 119 male patients with pelvic fracture and urethral injury Basta and Wessels found that 92% of the subjects had specific inferomedial pubic bone fractures or pubic symphysis diastasis, with 88% of these being displaced more than 1cm.[71] Recently, computer generated models of the pelvis and urethra have allowed a greater understanding of the mechanisms of urethral stretching followed by disruption at the bulbomembranous junction.[72–74]

Anterior Urethral Injuries—Blunt injury to the anterior urethra occurs approximately 1/4 as often as posterior injury and is generally a "straddle type" injury of the bulbar urethra. This type of injury results from direct trauma to the urethra itself and often results in a partial disruption or, quite frequently, is not initially identified and presents later as a stricture.[54] Slightly less commonly, the anterior urethra is injured during a fracture of the penis. The incidence of concomitant urethral injury varies geographically, but ranges from 0%–3% in Asia and the Middle East to 20%–38% in the United States and Europe.[75, 76] Urethral injuries also occur more commonly with bilateral cavernosal tears.[77]

Penetrating injuries to the anterior urethra are usually secondary to GSW and involve the bulbar and pendulous segments equally.[78] The urethra was injured in 2.9% of civilian GSW involving the GU system in a retrospective review of 309 patients sustaining GSW in the Henry Ford Medical Center Trauma Registry. Frequently there are concomitant lower extremity and pelvic injuries in these patients (44% and 33% respectively).[13]

Iatrogenic Urethral Injury—Perhaps the most common cause of anterior urethral injury is iatrogenic from foley catheter placement. Although it is difficult to identify the exact number of foley catheters placed, 24 million are sold to hospitals within the United States annually.[79] A year long, prospective single institution study at UCSD found catheter related injuries to occur in approximately 3.2 per 1,000 patients, but after implementing nursing education programs on foley catheter placement they showed a decrease in incidence to less than 1 per 1,000 patients, illustrating the value of these preventative measures.[80]

External Genitalia—Due to the external location of the male genitalia, they are relatively exposed and vulnerable to trauma. Although not generally life threatening, genital injury is relatively common. Prompt attention is warranted to limit long-term sexual, reproductive, physiologic, and psychological damage.

Scrotal and Testicular Trauma—Although exposed and dependent in nature, the mobility of the scrotum often prevents it and its contents from severe injury. Still, traumatic injury to the external genitalia, including the penis, is seen in 27.8 to 68.1% of all trauma patients with injury to the GU tract according to multiple published series.[81, 82] Blunt trauma accounts for up to 85% of scrotal and testicular injuries, the majority of which are sustained during athletic activity.[83] Scrotal trauma can result in a spectrum of findings ranging from local hematoma to ruptured or dislocated testicles.[84]

Penetrating scrotal trauma, albeit less common, is generally more severe and usually requires surgical exploration. Up to 40%–60% of penetrating genitourinary injuries involve the external genitalia. In a 30 year single institution retrospective review of 110 patients with penetrating external genital injuries, Phonsombt and McAninch found that gun shots account for 55% of penetrating scrotal trauma, with stab wounds/lacerations (42%), and bites (3%) accounting for the rest.[85] Orchiectomy rates range from 25% – 65% depending on the study, with a higher prevalence in lacerations than GSW, likely due to the high propensity of self inflicted orchiectomies which are less often salvageable.[81]

Review of Published Series on GSW Trauma to Scrotum

Institution	No. Patients	No. Injured Testicles (%)	No non-op mgmt. (%)	No Orchiectomies (%)
Temple Univ.[81]	97	50(54.9)	6(6.2)	24(48)
UMDNJ[86]	62	33(61.1)	8(12.9)	20(60.6)
UCSF[85]	40	24(60)	0(0)	6(25)
LSU[87]	27	23(85.2)	0(0)	15(65.2)
UCLA-Harbor[88]	19	4(66.7)	13(68.4)	2(50.0)
Wash. Univ.[89]	17	17(100)	0(0)	6(35.3)

Penile Trauma—Penile trauma is less common than scrotal/testicular trauma, but still comprises 10–16% of genitourinary injuries per several single institution series.[90] In one large civilian study, penetrating penile trauma accounted for 33% of all penetrating genital trauma (scrotum=48%).[85] Associated urethral injury ranges from 4–24% depending on the study and mechanism. Stab wounds/lacerations appear to have a higher likelihood of involving the urethra than GSW.[13, 85]

Penile fracture is an uncommon and likely underreported injury, accounting for one in every 175,000 emergency room visits.[91] Still, according to the National Inpatient Sample, a nationally representative weighted sample of hospital admission data, there were 1,043 men admitted to US hospitals for penile fracture in 2006–2007.[92] Of the 1331 cases of penile fracture reported in the literature between 1935 and 2001, over half were from the

Mediterranean region.[93] Mechanism of injury varies geographically. The practice of "taghaandan," where the erect penis is forcibly pushed down to achieve detumescence, is the most common cause in the Mediterranean region.[94] In the United States and Europe, the majority of fractures occur after the penis slips out of the vagina during intercourse and thrusts against the perineum or pubic symphysis.[95] A retrospective chart review of 16 patients presenting to the University of Maryland with penile fracture found that intercourse in stressful situations, specifically out-of-the-ordinary locations (68.7%) and extramarital affairs (43.8%), appears to be a common theme in these patients.[96]

Military Trauma—The ever-changing landscape of warfare and the institution of Kevlar body armor have likely affected the mechanism and distribution of GU injury seen in modern combat. Historically, genitourinary injury constituted a small portion of battlefield injuries, ranging from 0.7%–8%, with renal injury noted in up to 40%.[97–99] The vast majority of these wounds resulted from bullet injury. Now, projectile fragments from mortar shells, aerial bombs, rockets, and improvised explosive devices account for most modern battlefield urologic injuries.[97]

Recent reports from overseas contingency operations the US Military is currently engaged in have reported similar findings with GU involvement in 2.8%–5% of injuries.[98, 100] The largest cohort, consisting of 16,323 trauma admissions, reported 887 GU injuries with involvement of the scrotum in 257 (29%), kidney in 203 (22.9%), bladder in 189 (21.3%), penis in 126 (14.2%), testicle in 81 (9.1%), ureter in 24 (2.7%), and urethra in 7 (0.8%).[100] Explosive devices were responsible for 50%–65% of the injuries, individual firearms caused 15%–37%, and the remaining 11%–13% were due to blunt injury, primarily motor vehicle accidents.[98, 100]

The shift in primary mechanism of injury, from penetrating missile to explosive fragments, and the increased use of body armor have changed the spectrum of injuries seen on the battlefield. The higher rate of genital injury (68%) seen in soldiers in recent conflicts is likely because of explosions.[100, 101] The decreased renal and ureteral injuries are likely a result of protective body armor.[97, 98, 102]

Research future directions

At the time of establishment of the CDC injury center in 1987, only five centers, including Harvard University, Johns Hopkins University, University of North Carolina, University of Washington, and Wayne State University were funded. Today the injury center funds eleven programs, and vast improvements continue to be noted in multiple injury areas. For example, in 2010, 32,885 people died in motor vehicle traffic crashes in the United States – the lowest number of fatalities since 1949 and a 2.9% decline from 2009 (33,883 fatalities).[103]

Continued research and development of safer vehicles along with public efforts and policy to create safer roadways and regulate hazardous driving activities will likely further promote this trend.

The application of computer generated models based off of human imaging to traffic accident modeling has given us insight into the understanding of the mechanics of posterior urethral injury.[73, 104]

On a different note, the recognition of violence as a public health problem has resulted in multiple evidence-based strategies and programs to reduce violence, especially in youths, and highlighted the cost-effectiveness of monetary allocations aimed at prevention instead of incarceration.[105]

As we continue into the 21st century armed with more efficient diagnostic machinery, communication and data storage technology, and tools that enable us to provide more efficient and higher quality patient care, we must continue to advance our understanding of the epidemiology of trauma to better prevent it, and more effectively treat it when it does occur.

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Key Points

- With 10% of the 2.8 million trauma patients hospitalized yearly in the US sustaining genitourinary injuries, an understanding of the epidemiology of genitourinary organ injury facilitates prompt diagnosis and appropriate treatment of these injuries
- The use of national data sets to conduct large population based studies has increased our understanding of the epidemiology of genitourinary trauma
- The majority of renal, bladder, and posterior urethral trauma is from blunt mechanisms, most commonly motor vehicle collisions.
- Most ureteral and anterior urethral injuries are iatrogenic
- Research and development of safer vehicles along with public efforts and policy to create safer roadways and regulate hazardous driving activities continues to decrease morbidity and mortality from motor vehicle collisions