REVIEW ARTICLE

Urological Emergencies and Diseases in Wilderness Expeditions

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When considering medical emergencies that might affect an expedition, urologic emergencies are typically not included. However, the reality is that manageable and prevalent urologic disease processes can pose significant challenges for the wilderness medicine physician and warrant consideration. The purpose of this review is to identify and discuss the most commonly encountered urologic emergencies and diseases in the wilderness setting and to prepare the expedition medicine physician for management of these urgent conditions. A PubMed and Internet search for urologic emergencies and diseases in wilderness conditions was conducted. We also searched bibliographies for useful supplemental literature and material from leading mountain medicine and wilderness medicine societies as well as population-based studies for common urologic diseases. Urologic emergencies and diseases on expeditions and in wilderness conditions have been reported primarily with retrospective case series and case reports. The most commonly reported urologic emergencies in this setting include urologic trauma, renal calculi, and urinary retention. Parasitic infections in the urinary tract also have been reported to cause urinary symptoms and urinary retention in wilderness conditions. Although urologic diseases in such conditions are uncommon, significant morbidity and even potentially life-threatening sequelae to urologic emergencies were found to occur. Major genitourinary emergencies in expedition medicine are uncommon but involve both potentially manageable urgent conditions and serious life-threatening conditions best treated with urgent stabilization and occasionally medical evacuation. The opportunity exists for increased awareness for management strategies for urologic conditions in the often remote or extreme environments of an expedition.

Keywords: genitourinary, renal calculi, urinary retention, urologic trauma, remote, ultrasonography

Introduction

Explorer Sir Ranulph Fiennes' attempt to become the first person to trek across Antarctica alone in 1996 was abruptly cut short after nearly 48 h of constant pain from renal calculi.¹ Similarly, many other diseases processes such as urinary retention, traumatic injuries, and parasitic organisms can pose significant urologic challenges in remote settings.

Management of emergencies in remote settings is very similar to that in traditional settings with a few exceptions where resource limitations and equipment are factors.

The standard ABCDE algorithm (airway, breathing, circulation, disability, and environment) can be modified in wilderness medicine to MARCH (massive hemorrhage, airway, respirations, circulation, hypo-/hyperthermia, and hike vs helicopter). These steps are imperative for prevention of further deterioration of any wilderness expedition patient's condition. Urologic function also should be considered upon stabilization of these factors because maintaining adequate renal function via the urologic tract is essential for any expedition participant's normal health in the wilderness. A genitourinary (GU) emergency in a remote setting is considered any medical or traumatic event that places an expedition participant at risk of loss of life or at risk for significant impairment of normal urologic or renal function. The challenge for an expedition physician is to prepare for and have adequate provisions for GU emergencies when they arise without

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overburdening the supplies included on the expedition. Our aim is to identify and discuss the most commonly encountered urologic emergencies and diseases in the expedition setting to prepare the expedition medicine physician for management of these conditions in remote settings.

SEARCH STRATEGY

A PubMed search for GU emergencies in wilderness and expedition conditions was conducted. A Medline search using the PubMed database was conducted using the following keyword combinations: (genitourinary and wilderness) OR (renal calculi and wilderness) OR (urinary retention and wilderness) OR (urologic emergency and wilderness) OR (urologic ultrasonography and wilderness) OR (genitourinary and expedition) OR (renal calculi and expedition) OR (urologic emergency and expedition) OR (urologic ultrasonography and expedition) OR (testis torsion and expedition) OR (testis and wilderness) OR (genitourinary trauma and expedition) OR (genitourinary and wilderness) OR (candiru and expedition) OR (candiru and wilderness) OR (leeches and genitourinary and expedition) OR (leeches and genitourinary and wilderness) OR (candiru and genitourinary) OR (leeches and genitourinary).

Further information was gathered from the previously stated Internet word combination searches using the Google search engine. We also searched bibliographies of relevant articles identified for useful supplemental literature as well as population-based studies for common urologic diseases.

REVIEW

A total of 255 records were identified and reviewed to identify articles relevant to the aims of the study. All relevant articles were reviewed and included in this study. Germane references identified in the aforementioned reviews were included in this analysis.

GU diseases and emergencies on expeditions and in wilderness conditions have been reported with small retrospective case series, case reports, and 1 prospective analysis. GU injuries and diseases are generally not common relative to other problems encountered on wilderness expeditions, and the incidence of true GU emergencies is likely to be even less common than that of minor urologic diseases encountered on an expedition. Two maritime expedition reviews reported that GU disorders occur in 0.9 and 9% of patients treated, respectively.^{2,3} The first review detailed medical logs from 11 voyages to Antarctica over a 2-y period, and the second review investigated medical contacts made by shipboard caregivers to US emergency medicine physicians on 90

US-based vessels over a 4-y period. Although neither reference describes the specific diagnoses or incidence of GU emergencies, the latter outlined common urologic symptoms such as dysuria, hematuria, and scrotal/testicular pain as examples of GU problems encountered.

In general, the GU emergencies most commonly identified in this setting by this review included passage of renal calculi, urinary retention, and urologic trauma. Testis torsion and parasitic invasion of the GU tract also have been observed to cause GU emergencies in wilderness conditions. Although GU emergencies in expedition medicine are very uncommon, significant morbidity and even life-threatening sequelae were found to occur.

RENAL CALCULI

Renal calculi typically present with symptoms of intermittent, severe, debilitating abdominal and flank pain. Often this flank pain is accompanied by hematuria, nausea or vomiting, and malaise. Patients also may experience fever and chills. The protocol for diagnosis, management, and treatment of patients with suspected kidney stones in a traditional medical setting has been well described ([Figure 1](#)).⁴ Management includes hydration, use of nonsteroidal anti-inflammatory drugs or narcotics for pain relief, alpha blockers to allow ureteral smooth muscle dilation (for medical expulsion of ureteral calculi), antiemetics to manage nausea/vomiting, and referral to urology for intractable pain, vomiting, or fever. Unfortunately, many of these traditional resources are not available for expeditioners while in a remote setting. Making a diagnosis of renal calculus passage will likely be limited to patient history and physical examination findings.

Management and treatment of renal calculi is slightly different in the remote setting as well. Inclusion of nonsteroidal anti-inflammatory drugs, narcotics, antiemetics, and perhaps tamsulosin in one's expedition kit in the event of presumed renal calculus would be beneficial to patients in need of care while in a remote setting. Although diagnostic tools are often unavailable for diagnosis of renal calculi, one such tool that may be available is a handheld ultrasonography device. Point-of-care ultrasound has demonstrated 70% sensitivity and 75% specificity in the identification of renal calculi.⁵ There are no surgical options for renal drainage in a remote setting. Consequently, if the patient develops high fever owing to pyelonephritis, intractable vomiting with dehydration, or recalcitrant pain, emergency medical evacuation must be initiated. Body temperature $\geq 38^{\circ}\text{C}$ or $\leq 36^{\circ}\text{C}$, tachycardia ≥ 90 beats $\cdot\text{min}^{-1}$, or tachypnea ≥ 20 breaths $\cdot\text{min}^{-1}$ are typical inflammatory responses for

Figure 1. Diagnosis and management of acute kidney stones. Algorithm for the diagnosis and management of acute kidney stones.⁴ (Adapted with permission from American Family Physicians from Frassetto et al [citation #: 3855].)

urosepsis. These findings in conjunction with renal colic should prompt medical evacuation to ensure adequate urinary tract drainage and intravenous antibiotic therapy for management of such an infection.⁶

The risk of developing renal calculi varies across settings. The annual incidence of stone occurrence in the United States is less than 1% but appears to be increasing.⁷ Little prevalence data for stone occurrence in wilderness conditions have been reported. However, 1 review of Japanese Antarctic expeditions conducted over a 50-y period and involving 1734 total expedition

members reported 13 episodes of renal calculi passage, consistent with incidence of less than 1%.⁸

Another consideration is that the conditions encountered in the expedition setting are widely varied, potentially affecting the incidence of stone occurrence. In many remote settings involving heat and tropical weather, the likelihood of renal calculi formation will presumably be greater owing to water conservation by the kidneys and increased urinary concentration. Dehydration caused by the immediate impact of high altitude expeditions also might increase the risk of calculus

formation.⁹ The paucity of clean water in many expedition settings can further compound the dehydration encountered in such environments and further increases the likelihood of renal calculus formation. Consideration of these climate-related concerns should be given by any physician planning an expedition.

URINARY RETENTION

Acute urinary retention due to benign prostatic hyperplasia (BPH) has previously resulted in discontinuation of a Mount Everest ascent. The dehydrating effects of altitude stimulates increased fluid intake to keep up with the body's demands.⁹ Increased hydration also may exacerbate urinary retention, although no data are available on the incidence of urinary retention in high altitude settings. This complete or partial inability to urinate over a prolonged period of time can even be associated with acute renal failure. Acute urinary retention includes difficulty initiating urination with a weak stream accompanied by severe suprapubic and genital pain. The causes of acute urinary retention vary, but some medical conditions increase the likelihood of acute urinary retention. In a population-based study of 1192 men 50 y and older with BPH, the acute urinary retention rates were 8.5 per 1000 man-years with a 95% CI of 6.4 to 11.2.¹⁰ One example for an expedition setting in which this issue relevant is Mount Everest, where approximately 1000 people ascend each year, with 54% of Everest climbers from 2006 to 2019 being ≥ 40 y old and 85% being male.¹¹ Considering these demographics, there is a reasonable likelihood that a few climbers per year experience acute urinary retention related to BPH as they attempt to summit the peak.

Other potential causes of acute urinary retention include neurologic abnormalities. Spinal cord injuries are known to occur in wilderness expeditions, with 1 study of mountaineering in Scotland describing 21 patients sustaining spinal injuries between 1992 and 2001.¹² The frequency of these types of injuries has even prompted guidelines for protection of the spine from such injuries in wilderness medicine.¹³ Similarly, the urinary tract is also acutely affected, with spinal cord injuries manifesting with urinary retention owing to spinal shock.¹⁴ Placement of an indwelling urethral catheter after acute spinal cord injury and before medical evacuation also is recommended. Furthermore, wilderness physicians may encounter the need to oversee intermittent catheterization of the bladder for management of patients with chronic neurologic disease because such patients do participate in wilderness expeditions.¹⁵ Although chronic management of urinary retention from neurologic disease has not been well documented, one such patient with Friedrich's ataxia

summitted Mount Kilimanjaro while maintaining intermittent catheterization during the expedition.¹⁶ Failure to adequately maintain bladder management for these conditions also would increase the risk of renal failure. Consequently, understanding the timing, technique, and supplies required for intermittent catheterization is important for a wilderness physician when overseeing an expedition with patients who have neurologic disease.

Acute urinary retention can be related to the usage of alpha agonists as well.¹⁷ The use of alpha agonists for nasal congestion is common in individuals at altitude, with 29% of individuals having reported nasal congestion after ascent to a mountain clinic at 3450 m in one study.¹⁸ When taken systemically, alpha agonists can cause contraction of the internal urethral sphincter, leading to increased resistance to urinary flow.¹⁹ Although no data have been published on the incidence of acute urinary retention related to alpha agonist usage in wilderness settings, the potential for common usage of nasal decongestants in settings such as high altitude may further increase the likelihood of this problem for men older than 40 y owing to potential underlying BPH. Consideration of these factors for an expedition physician is recommended as well.

Although the prevalence of acute urinary retention in the wilderness setting is not known, reports have demonstrated this to be a potential problem for expedition medicine. During a Japanese Antarctic expedition, one such patient in acute renal failure owing to urinary retention underwent formation of a vesicostomy, a surgically reconstructed incontinent urinary diversion in which an opening to the bladder is created in the suprapubic region. The surgery was performed with use of local anesthesia.⁸ With examples like this being reported and with known high prevalence rates for urinary retention from diseases such as BPH, inclusion of supplies for intervention in urinary retention in an expedition medicine kit is warranted. An 18F coude catheter is large and rigid enough to push through an enlarged and edematous prostatic urethra for a man with BPH (Figure 2).²⁰ Alternatively, if a urethral catheter is unavailable in an expedition medical kit, a needle and syringe and local anesthetic would be adequate for temporary management of acute urinary retention via suprapubic aspiration (Figure 3).

The same Japanese expedition group also prospectively analyzed the presence of urinary symptoms in the polar Antarctic environment.²¹ In this analysis, 12 members of an Antarctic polar expedition completed various urinary and sleep surveys and kept daily voiding dairies for 3 d consecutively every 2 mo during their voyage. No worsening of urinary symptoms was reported in this cohort exposed to high altitude in Antarctica.

Figure 2. Coudé catheter (46 cm). Coudé “elbow” catheter is preferred for catheterization of patients with benign prostatic hypertrophy to allow easier traversal of the proximal urethral opening.

However, it is worth noting that the median age was 38 y (range 26–52) with only a small number of patients evaluated (12), one of whom was a woman. Because of the low median age range of the population studied, the likelihood of lower urinary tract symptoms caused by BPH in this population was very low.

TRAUMA

One retrospective study evaluated the epidemiologic findings for multiple India to Antarctic expeditions between 1993 to 2011 comprising a total of 1989 medical evaluations for 235 men and 2 women.²² The group identified trauma as the most common medical condition for expeditions on Antarctica, although they did not subcategorize the incidence of specific body systems involved with these injuries, nor were urologic injuries specified in this study. In the Japanese Antarctic expeditions between 1956 and 2016, there were 6837 cases

Figure 3. Suprapubic aspiration technique. Technique for performing a suprapubic aspiration of bladder fluid: Full bladder should be palpated, 2 cm above the pubic symphysis, with the needle perpendicular to abdomen; insert needle and allow urine to drain until urine stops flowing. (Artwork courtesy of Lauren Kinder.)

involving medical evaluations, with urologic cases accounting for 30 of the total (0.4%).⁸ One specific urologic trauma case involved a pelvic fracture and urethral injury caused by a snow vehicle that required hospitalization for 3 mo at the Antarctic base, Syowa Station.

From the upper to the lower urinary tract, both blunt and penetrating trauma can cause injury to varying degrees. Signs of renal injury from blunt or penetrating trauma include hematuria, flank ecchymoses, and hypotension.²³ The challenges for treatment of significant renal trauma will likely exceed equipment that is available remotely, underscoring the importance of stabilization, fluid resuscitation, and medical evacuation in the initial management of these types of injuries. With suspected renal injuries, the ability to use a point-of-care ultrasound study for renal trauma has been reported in the literature, although its sensitivity and specificity have not been described (Figure 4).^{24,25} The ability to use a portable ultrasonography device for a focused assessment with sonography in trauma examination for identification of intra-abdominal fluid has allowed for efficient triage of conditions even in a remote setting.^{23,24} Identification of a renal injury on point-of-care ultrasound may theoretically influence medical evacuation, although clinical suspicion based on history, physical examination findings, and mechanism of injury is fundamental in a wilderness physician's management and decision-making in determining the need for medical evacuation.

Figure 4. Point-of-care ultrasound of subcapsular hematoma. Hypoechoic fluid deep to renal capsule, consistent with subcapsular hematoma.²⁶ (Open Access CC-BY 3.0 unrestricted reuse and reproduction, courtesy of Cureus.)

Isolated ureteral injuries are rare and would likely occur in the situation of multiple system injuries. Ureteral injury would therefore be managed via medivac owing to

the likely critical status of a patient with such injuries.²⁶ Bladder injuries can occur through significant blunt abdominal trauma. Most bladder injuries are associated with pelvic fractures and gross hematuria.²⁷ Diagnosis of bladder injuries in a remote setting would include a clinical history and physical examination, with management consisting of urinary diversion with a Foley catheter and subsequent medical evacuation.

External genitalia injuries can be significant as well. Expedition medicine management of genital trauma requires irrigation of the wound site and an antibiotic regimen. Additionally, assessment of the urethral injury would be achieved based on the injury mechanism and blood at the urethral meatus, which is consistent with initial traditional assessment. Management, however, would differ from traditional practice by initially attempting urinary diversion with a Foley catheter if the patient presents with urinary retention. Unsuccessful initial Foley catheter placement would prompt medical evacuation and possibly suprapubic bladder aspiration if medical evacuation is prolonged. Acute testicular injury will be evident based on the mechanism and physical

Figure 5. Manual testicular detorsion. Algorithm for management of acute testis torsion in a nonsurgical urgent setting by manual detorsion. (A) Presentation and anatomy of testicular torsion. (B) Perform a spermatic cord block to provide anesthesia to the testicle and epididymis with the use of a local anesthetic. (C) Torsion directionality: General directionality of torsion and detorsion procedure. (D) Detorsion maneuver: simultaneous rotation in the medial to lateral and caudal to cranial direction.³⁴ (This figure was published in Roberts and Hedges' Clinical Procedures in Emergency Medicine and Acute Care, 7th edition, James Roberts, Urologic Procedures, Page 1143, Copyright Elsevier [2018]). (Adapted with permission courtesy of Elsevier.) (Artwork courtesy of Lauren Kinder.)

Figure 6. Bladder leech ultrasonography. Ultrasonography showing an intravesical mobile foreign body.³⁷ (Reprint permission courtesy of Elsevier, license number 4794950384097.)

examination, with acute testicular tenderness and scrotal laceration or dramatic echymoses present.²⁸ As is the case with all traumatic injuries, medical evacuation is vital if the patient is unstable or septic.

TESTIS TORSION

A time-sensitive trauma situation of high importance is testes torsion. Testis torsion presents as acute onset of testis pain and/or vomiting accompanied by a high-riding testis, acute scrotal edema, and significant tenderness (Figure 5A). Importantly, there will be no dysuria or voiding symptoms present. Diagnoses of testis torsion is achieved by examination and ultrasonography if available. The triad of nausea/vomiting, scrotal skin changes, and absence of the cremasteric reflex has been shown to enable diagnosis of torsion without a scrotal ultrasound, with a high specificity and a positive predictive value of 1.0 and 1.0 but a low sensitivity of 0.25 for all 3 findings to be present for a given patient.²⁹ In a case report of 2 separate episodes of testicular torsion, time from diagnosis to surgical treatment was shortened by 2 to 3 h with the assistance of point-of-care ultrasonography performed by emergency physicians, demonstrating the potential utility of ultrasound in confirming a diagnosis of torsion.³⁰ Patients not treated with manual detorsion or scrotal exploration with detorsion within 6 h will typically experience testicular infarction.³¹ In a remote setting, urology consultation likely will be unavailable. Thus, management of torsion will include narcotics and antiemetics to manage the pain and nausea and spermatic cord block for anesthesia to enable attempted detorsion

(Figure 5).^{23,32} Ultrasonography imaging should be used if available with comparison of the affected testicle to the normal contralateral testicle being critical for proper assessment of torsion. Although no data for testis torsion on wilderness expeditions exist, testicular torsion is fairly common, with 1 in 4000 males affected.³³ The authors are aware of such an occurrence from a unpublished, direct report of a wilderness physician who previously assisted in the evacuation of a young male 3 mi out of a park during an endurance hike in Maryland. Depending on the demographics of the expedition team, awareness and preparedness for management of this problem by a wilderness physician may be beneficial.

FRESH WATER UROLOGIC PARASITIC INVASION

In light of the potential communication between the urinary tract and the local water source with prolonged exposure from swimming or bathing, urinary tract invasion by endemic parasites is another scenario to consider.

The candiru, a parasitic toothpick-like fish that feeds on blood from the gills of its host fish, is indigenous to the Amazon River. The candiru has been of unfounded concern since 19th century explorers such as Carl Frederick Phillip von Martius traveled to the Amazon region and described local accounts of the fish and its affinity for the male urethra.³⁴ The work of Von Martius and other early explorers greatly contributed to the narrative of the candiru in popular culture, despite the lack of evidence in the medical literature. However, these fears appear to be unwarranted because there is a lack of objectively confirmed cases of candiru of the bladder to date.³⁴

Figure 7. Bladder leech, gross appearance. Whole leech showing anterior and posterior suckers. Leech length shown in centimeters, with length reaching 16 cm.³⁷ (Reprint permission courtesy of Elsevier, license number 4794950384097.)

Conversely, invasion of the urinary tract by another parasite—leeches—has been supported in the literature but may not be as widely recognized in expedition medicine. There are about 300 species of leeches known to be found in temperate/tropical climates, the most common aquatic species encountered being *H granulose*, *H viridis*, *H javanica*, and *H manilensis*.³⁵ Leeches in the urinary tract typically present with hematuria and suprapubic pain, although cases of urinary retention and even hypovolemic shock associated with vaginal leeches have been reported.^{36,37} Two large studies have been conducted in Bangladesh, with the most recent study in 2012.^{35,38} One such study demonstrates that visualization of intravesical leeches is possible with ultrasound, which could be used if available on an expedition (Figure 6).³⁵ In the retrospective series conducted, 117 patients were treated with catheter and saline irrigation (50 mL of saline instilled with Foley clamped for 3 h), with 57 patients having successful spontaneous expulsion and the remaining 60 requiring cystoscopic removal (Figure 7).^{35,38} Therefore, inclusion of a Foley catheter and saline in an expedition medical kit when there is concern about indigenous leeches is recommended.

One nonemergent consideration when venturing into indigenous tropical freshwater is schistosomiasis. Schistosomes, macroscopically visible flatworms, are found in Africa, South America, and South/East Asia.³⁹ Schistosomiasis invasion can lead to acute or long-term health complications. A common initial presentation of schistosomiasis is itching accompanied by a rash and later flu-like symptoms that result from allergic reaction in the weeks after primary infection.³⁹ *Schistosoma haematobium*, endemic to Africa, specifically migrates to the bladder, where it can cause chronic inflammation that has been shown to lead to squamous cell carcinoma of the bladder. Because this diagnosis is typically confirmed by microscopic evaluation, an expedition physician will likely only be able to rely on clinical history and examination to make the diagnosis of schistosomiasis. Recommended treatment for this infection consists of 1 to 2

d of praziquantel by mouth.⁴⁰ As compared to the other parasitic infections discussed, the overall incidence of urinary invasion for areas endemic to schistosomiasis is very high, with approximately 290 million people treated in 2018 alone. In light of both the acute symptoms and the significant potential long-term complications, inclusion of praziquantel when traveling to Africa or other areas endemic to schistosomiasis is recommended.

LIMITATIONS

Although data exist in the literature pertaining to urologic emergencies and urologic diseases in wilderness settings, the majority of the published literature consists of case reports and retrospective reviews with inherent potential underlying bias present. Furthermore, for the Google search component of the literature review, the authors' search history was not cleared before execution of the searches outlined. Future prospective and potentially multi-institutional or multinational studies are needed to better understand the full impact of urologic emergencies and urologic diseases in wilderness expeditions.

Conclusions

Major GU emergencies are very uncommon but involve serious life-threatening conditions that should be addressed with urgent stabilization and medical evacuation. GU problems such as renal calculi passage, urinary retention, GU trauma, and testis torsion are more common and typically can be managed effectively during a wilderness expedition. Parasitic infections in the urinary tract also have been reported to cause urinary symptoms and urinary retention in wilderness conditions and should be considered in preparation for an expedition. An effective medical kit should be prepared accordingly for patients with a history of such urologic conditions or predisposing factors to better manage these problems remotely.

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