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Traumatic near amputation secondary to hippopotamus attack: lessons for surgeons

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ABSTRACT

A 34-y-old man presented to Naivasha District Hospital (NDH) in Naivasha Town, Kenya, with near-complete below-knee amputation and hemorrhage after a hippopotamus attack. Residents from the University of Washington (UW), Departments of Surgery, Anesthesia, and Medicine, were rotating at NDH with the Clinical Education Partnership Initiative, a joint venture of UW and University of Nairobi. These providers met the patient in the operating theater. The leg was mangled with severely traumatized soft tissues and tibia–fibula fractures. The visiting UW Surgery resident (R3) and an NDH medical officer (second-year house officer) performed emergency below-knee completion amputation—the first time either had performed this operation. The three major vessel groups were identified and ligated. Sufficient gastrocnemius and soleus were preserved for future stump construction. The wound was washed out, packed with betadine-soaked gauze, and wrapped in an elasticized bandage. Broad-spectrum antibiotics were initiated. Unfortunately, the patient suffered infection and was revised above the knee. After a prolonged course, the patient recovered well and was discharged home. NDH house officers and UW trainees collaborated successfully in an emergency and conducted the post-operative care of a patient with a serious and challenging injury. Their experience highlights the importance of preparedness, command of surgical basics, humility,

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learning from mistakes, the expertise of others, a digitally connected surgical community, and the role of surgery in global health. These lessons will be increasingly pertinent as surgical training programs create opportunities for their residents to work in developing countries; many of these lessons are equally applicable to surgical practice in the developed world.

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1. Introduction

The hippopotamus is considered by many to be the most dangerous animal in sub-Saharan Africa [1]. To our knowledge, there is but one case report in the medical literature describing surgical care for a patient attacked by a hippopotamus, that of an American zookeeper attacked at work [2]. In developing countries, musculoskeletal injuries requiring “urgent care” are among the most common conditions seen in frontline hospitals such as health centers and district hospitals [3], and traumatic injury is a major contributor to the world’s disease burden. In 2010, according to recent estimates from the Global Burden of Disease Study, nearly 50 million years were lived with disability as a consequence of injury [4]. As surgical residency programs increasingly develop programs for their residents to work in resource-limited settings, lessons learned from challenging clinical situations faced by previous visiting surgeons may contribute to future successes. Many of these lessons are equally applicable at home.

2. Background

2.1. Naivasha District Hospital

Naivasha District Hospital (NDH) in Naivasha, Kenya, is a 150-bed Ministry of Health public hospital located approximately 1.5 h northwest of Nairobi. There are male, female, pediatric, and maternity wards, an operating theater with two operating rooms (ORs), and a casualty unit (emergency department). Basic laboratory studies are available during business hours as are plain radiographs and ultrasound. No radiology or laboratory services are available after hours. Critical care services are not available locally and require transport to a provincial hospital, the closest of which is approximately 45 min away, or Nairobi. A small supply of uncrossmatched whole blood is available for emergency transfusion (typically used for obstetric emergencies). Emergency care is available 24 h/d and is provided by clinical officers (similar to midlevel providers in the US), medical officer interns (first-year physician trainees), medical officers (MOs), and specialists in selected areas. MOs, generally 2–3 y from medical school, are on call 24 h/d. Attending physicians, called “consultants,” participate in decision making and provide surgical care that is beyond the experience level of MOs. Consultants take call and are available by phone 24 h if they are not immediately available in person. MOs are taught and expected to have the skills necessary to treat acute, life-threatening conditions. Indeed, MOs are the only care providers in many smaller or remote clinical settings, and, although they may refer to a higher level facility, MOs must independently stabilize sick patients before transfer.

2.2. Clinical Education Partnership Initiative

The Universities of Nairobi and Washington (UW) have maintained a research and training partnership for >30 y. One ongoing program, the Partnership for Innovative Medical Education in Kenya (PRIME-K), was designed to strengthen Kenyan medical student education through clinical rotations at “decentralized” sites across the country. A project recently initiated by the (PRIME-K) is the Clinical Education Partnership Initiative (CEPI), which was developed to (1) improve the education of University of Nairobi medical students, clinical officers, interns, and MOs and (2) provide UW trainees with a structured rotation in a resource-limited setting. The program began in the 2012–2013 academic year, and trainees from Radiology, Family Medicine, Internal Medicine, Obstetrics and Gynecology, Anesthesia, and Surgery have participated.

CEPI was conceived and developed as a multispecialty endeavor. The program is administered by the UW Department of Internal Medicine, and supervision of UW residents is accomplished by a Medicine Chief Resident who functions, as in the US, as a clinical faculty member and who commits to working full-time in Naivasha for 1 y. This role provides year-round continuity for the program, so that as residents from the US rotate through NDH, a clinical and educational presence is maintained. The model established in Naivasha is one of the integrated teams: UW residents do not work in parallel to their Kenyan colleagues, they work as a part of existing NDH teams (with consultants, MOs, interns, clinical officers, and students).

As CEPI grows and surgical specialties and subspecialties express increased interest in participating, it is recognized that structures for clinical supervision will also need to develop. Not only do surgical residents have different supervision needs than do nonsurgeons, but US trainees are accustomed to closer oversight than their Kenyan MO counterparts. A framework for adequate supervision was developed with the host NDH consultants while the UW Surgery resident was in Naivasha (for approximately 5 mo), but as CEPI grows and procedure-based specialties increasingly participate, a more formal supervisory mechanism is necessary. Although several training institutions in the US have implemented rotations for surgical residents in developing countries [5,6], the UW Department of Surgery has not yet taken that step. Currently, there is a Global Health Track within the residency structure that offers research and academic opportunities but no formal clinical experience. Development of such a rotation is on the agenda of several global health leaders in the Department of Surgery, and experience gained during the CEPI rotation has been invaluable to this discussion.

3. The hippo attack and its aftermath

A 34-y-old fisherman was brought to NDH with near-complete below-knee amputation and life-threatening hemorrhage after a hippopotamus attack on Lake Naivasha. The on-duty interns contacted the visiting UW Surgery resident and the on-call MO. The interns were directed to take the patient urgently to the theater. UW Surgery, Medicine, and Anesthesia residents joined them from home within 5–10 min. The ABCs (airway, breathing, circulation) were addressed: the patient was protecting his airway and talking, although intubation was planned for his imminent operation, access had already been obtained, and volume resuscitation with crystalloid was initiated. The patient had two rubber examination gloves tied around his leg proximal to the knee in an attempt to control bleeding, but hemostasis had not been achieved. A blood pressure cuff would have made an excellent tourniquet, but no manual cuffs were available. Appropriate hemostasis was quickly achieved by fashioning a windless-type tourniquet from a large elastic band and an Army–Navy retractor. At that point, the patient's systolic blood pressure was >100 mm Hg. Hemoglobin checked at presentation later came back at 7.4, suggesting substantial hemorrhage. Coagulation studies were not available. As the NDH anesthetist was required to attend to an emergency C-section in the adjacent OR, the visiting UW anesthesia resident induced, intubated, and provided anesthesia care for the remainder of the operation. The UW Medicine Chief Resident manually held the torqued Army–Navy retractor in place to maintain hemostasis. Because the consultant surgeon was not immediately available and this was an immediately life-threatening injury, the UW Surgery resident and NDH MO proceeded with the operation. This was the first emergency completion amputation for either physician. The NDH consultant was informed appropriately and participated in all postoperative decision making.

Radiographic studies were not available when the patient arrived. Clinical examination of the limb at surgery revealed a comminuted compound proximal tibial fracture. There was significant degloving of the muscle from the fracture fragments, crushing injury to muscle and skin, and complete disruption of the major vessels and nerves supplying the limb in the region of the high proximal tibia. Massive bleeding occurred when tourniquet pressure was relieved temporarily in the operating theater. Fracture classification was Gustilo III-C. The wound was oriented obliquely from posterior to anterior, and despite significant soft tissue damage, at least half of the gastrocnemius and soleus appeared viable for future stump construction. Only a small amount of anterior soft tissue remained connecting the distal and proximal segments of the injured limb, which was clearly not salvageable (Mangled Extremity Severity Score = 9) [7]. Perseverating on limb salvage could have catastrophically delayed lifesaving management, and the team proceeded with completion amputation. For safety reasons, the sharp bone fragments of proximal tibia and fibula were first removed with the handsaw. Each of the three major vessel groups was carefully identified within the severely traumatized soft tissues. Each vessel was double suture ligated. Devitalized muscle and skin were removed and muscle hemostasis was achieved. Given

the skin and muscle available for future stump construction, the tibia and fibula were shortened to appropriate length with the handsaw. The tourniquet was let down, some soft tissue bleeding was identified, and an additional suture ligature was needed in the peroneal vessels. The wound was copiously irrigated and hemostasis reconfirmed; then the stump was carefully packed with betadine-soaked gauze and left open. An additional deep wound just proximal to the knee that tracked down to the popliteal fossa was washed out copiously. A Penrose drain was placed; this wound was also packed with betadine-soaked gauze and left open. The stump was wrapped with an elasticized bandage and the patient was taken to the recovery room. The patient's lowest recorded intraoperative systolic blood pressure was 80 mm Hg. He received 2 U of whole blood and several liters of crystalloid. Considering the range of flora possible in the hippopotamus mouth and the lake, a broad-spectrum antibiotic regimen was started (intravenous ceftriaxone and metronidazole). Tetanus prophylaxis was administered. Once the patient was admitted to the ward, he was thoroughly examined in a secondary survey and no additional injuries were discovered.

Dressings on the stump were taken down on postoperative day (POD) 2 in the OR (this was recommended as a safer—and cleaner—setting than the male ward). The surgical team found some additional necrotic muscle, which was carefully debrided, no signs of infection, and continued good hemostasis. They washed out the wound and the patient returned to the ward. Over the next several days, there was substantial communication with attending providers in the US for guidance in further management of this patient, specifically with questions regarding when to attempt wound closure, where to leave drains, and strategies for guarding against osteomyelitis. Trauma, vascular, and orthopedic surgeons provided guidance *via* email and offered to be available by phone if necessary.

A care plan was developed for this patient. Unfortunately, his course was complicated by infection, and he was showing signs of sepsis by POD 7. He was taken to the OR by the senior consultant and revised to an above-knee amputation (AKA). He was profoundly hypotensive during the case, and there was pus and evidence of hemorrhage and clot tracking along the femoral artery and fascial planes above the knee, suggesting more proximal damage from blunt trauma than initially realized. The new level was closed over a Penrose drain and the patient continued on broad-spectrum antibiotics.

By POD 3 from the above-knee revision, the patient appeared clinically well. He was afebrile with a white blood cell count of 10,200 cells/ μ L. However, the wound began to drain pus from the medial aspect of the incision and both ends of the Penrose drain. Several sutures were removed from the medial aspect of the wound, and wet-to-dry dressing therapy was initiated. Because the AKA was fairly high given the ascending infection and soft tissue trauma noted at the second operation, the surgical team was extremely concerned about controlling the local process: proximal revision in this setting would have been catastrophic for the patient. As nurses in the ward are often overworked (nurse-to-patient ratio is around 1:20) and wound care can become a low priority, physicians on the team took on daily wound care

Box 1 Example: email correspondence.

December 1, 2012

The soft tissue in the open wound looks very good—beefy red granulation tissue, but there is still some pus draining out from deeper in the wound that I can see when I change the dressings. And the drain (which, remember, is in the fascial layer) usually has some small amount of pus draining around it (this has reduced A LOT since I opened the corner of the stump). The patient looks well clinically. He is up and about. He wants to go home and can get daily wound care at a clinic near his house. He's very motivated and has been purchasing his own dressing supplies already b/c he can buy better stuff than we have at the hospital.

So—what I'm worried about is some deeper, untreated source of infection and I'm not exactly sure what to do. Obviously we will continue daily wound care. I will have them check a CBC on Monday. Maybe he has osteomyelitis in the femoral shaft? Maybe there is a pocket of infection in the fascia that is draining through the skin and around the penrose drain?

I can try to take some photos tomorrow and send them to you. Everything I can see looks pretty good, but there is definitely pus coming from somewhere. Any thoughts?

December 1, 2012

Really difficult situation. If he is doing well, go back to the basics and be sure he doesn't have any signs of SIRS. I would not open the wound further. I understand there is a real chance he might have osteo; if you are lucky, the pus is coming from the fascia around the sartorius or another muscle, and not from the bone. He is how much, a month out now? I'd be surprised if he has an undrained deep tissue abscess and is clinically doing so well (again, my point on leaving a lot of drains!) you may just get lucky and get away with local care. If you have a lot of pus or are really concerned for infection, you should take him to the OR, open the wound, leave it open w washouts in the OR until it looks pristine, and at that moment, revise the amp to a high AK. High AKA are difficult cases...

Send pictures if you can.

responsibilities. In addition to the guidance provided by the NDH consultant surgeon, there was ongoing communication between the house staff team in Naivasha and attending providers in the US (Box 1). Nutrition was optimized and the patient was encouraged to be out of bed as much as possible. The open portion of the wound began to show signs of good healing. As the patient continued to look systemically well, intravenous antibiotics, which he had been on from the time of the first operation, were converted to an oral regimen (flucloxacillin and metronidazole). After an extended period of close observation, oral antibiotics, and daily wound care, the patient was discharged home (POD 26). He continued to perform wet-to-dry dressings at home and was evaluated in clinic by the UW Surgery resident on POD 40. The wound was nearly healed, the patient was getting around well with crutches, and he was quite happy.

The care provided in this case was clearly substandard to what one would receive, for example, in a large, level I Trauma Center in the US, where a pneumatic tourniquet would have been applied on arrival to the emergency department allowing a thorough multispecialty workup for trauma and a systematic evaluation of limb viability (although, even with microvascular surgical capacity, this limb was not salvageable). C-spine immobilization and radiographic evaluation for other injuries related to blunt trauma would have been incorporated into the patient's care. Transfusion could have been guided by laboratory and hemodynamic monitoring, and reliable culture data could have guided antibiotics after the wound became infected. None of the above is available at NDH. At smaller hospitals in

resource-limited settings, nonsurgeons and house officers are sometimes called on to perform surgery in life-threatening situations. The care described in this report is consistent with what patients who have sustained immediately life-threatening injuries might expect to receive on arrival to a small hospital in a resource-limited setting, and this patient's outcome was likely improved by the collaborative efforts of NDH and UW physician colleagues.

4. Discussion

Surgical trainees from UW and NDH collaborated to save a life in an emergency. Although the mechanism of injury and resource-limited setting are relatively unique, a traumatic amputation is not that uncommon for those who care for trauma patients. From our perspective, more important than novelty of injury and setting are the five main lessons drawn from this experience.

4.1. Preparation is key to success

By coincidence, the NDH surgical team, under supervision of the consultant surgeon, performed an elective below knee amputation 1 wk before the hippopotamus attack. The UW Surgery resident, currently a research fellow after his R3 year in clinical training, spent a substantial amount of time preparing for this elective case. Without this preparation, the emergency operation would have been substantially more

difficult, if not impossible. Clearly, one cannot be prepared, specifically, for every eventuality, but successful surgeons proactively equip themselves with the skills necessary to succeed. This mind-set is crucial regardless of the setting in which one practices, but those who practice in the developing world must develop a different skill set than the one they use in the relatively subspecialized US health care system. Trauma and burn care, laparotomy for the acute abdomen, basic fracture care, and Cesarean sections are just a few examples of necessary skills [8]. The World Health Organization has developed a list of essential surgical care for settings such as NDH, and review of this list is mandatory for surgeons who wish to work in resource-limited settings [9].

4.2. *The basics of surgery provide the foundation for good care*

Skills that surgeons learn as interns, such as those highlighted here—the “ABCs,” principles of hemostasis, debriding devitalized or necrotic tissue, leaving contaminated wounds open, surgical techniques as simple as good knot-tying and suture ligation, meticulous attention to detail, hard work, caring for patients the way we want our own family members cared for—are applicable in every surgical practice and each contributes to good outcomes.

4.3. *Humility and an ability to learn from mistakes*

This case had a good outcome—a saved life and a healed, functional AKA—but there is always room for improvement. Although the ABCs (airway, breathing, circulation) were addressed deliberately and appropriately, the patient could have been more thoroughly evaluated for other injuries if the trainee surgeons had not been distracted by the hemorrhaging lower limb injury. As an additional learning point provided by one of the UW vascular attendings, a through-knee amputation may have been safer, better, and faster in this life-threatening situation. Although the patient’s infectious complication was probably unavoidable, the surgical team had a candid discussion about whether changes in management might have prevented it. Surgeons can and must learn from their near misses and mistakes and those of others [10]. This is why morbidity and mortality conference is such an important part of surgical tradition. One of the changes implemented during this patient’s recovery and, afterward, for other patients with large or complex wounds was that the surgical team began to perform its own wound care and did not rely solely on the already overworked nursing staff to perform this task.

4.4. *Appreciation for the worldwide and “wired” surgical community*

The world is increasingly interconnected, and distance no longer prohibits collaboration. As a relatively novice surgeon, the UW Surgery resident sought the expertise of colleagues from the US, in addition to guidance from the NDH consultant, to help steer this patient’s postoperative course toward a successful outcome. This was similarly true for a challenging pediatric blunt trauma patient and for several challenging

burn patients. This community is an immense resource for surgeons working in resource-limited settings, but the rewards, in fact, travel a two-way street. In many urban settings in North America, Europe, and Australia, surgeons take care of patients from all over the world. Personal relationships built with surgical colleagues working in Africa, Asia, and Latin America will prove equally important when those who practice in the developed world are required to care for patients with problems rarely or never seen in that setting. Email correspondence may be just the beginning in terms of the possibilities for collaboration [11–13]. One specific resource highlighted by this case (that others may find useful) is the amputation-related Web site www.ampsurg.org maintained by Dr Douglas Smith of the UW.

4.5. *Surgery is an integral component of public health and global health*

Surgical conditions are responsible for up to 15% of the disability-adjusted life years lost annually across the globe [8]. Global health advocates and policy makers are increasingly recognizing that surgical care is an integral component of improving health care for the developing world [8,9,14]. Moreover, there are data to suggest that cost-effective delivery of essential surgical services is possible in low- and middle-income countries [15]. Trauma care, as in this case, is one of the pivotal components of essential surgical services, and evidence suggests that basic trauma care is cost-effective [16]. Surgeons have been called on to advocate for the expansion of surgical care to those with the greatest need wherever they may be [8], and we echo this call.

5. Conclusions

UW and NDH trainees successfully collaborated in a life-threatening emergency and, guided by surgeons at NDH and in the US, conducted the postoperative care of a patient with a serious and challenging injury. This case highlights several of the Accreditation Council for Graduate Medical Education core competencies, in particular patient care, medical knowledge, professionalism, and interpersonal communication. Lessons for surgeons include the importance of preparation, knowledge of surgical basics, humility, learning from mistakes, turning to others for help, and surgery as public and global health—lessons that pertain both to surgical education and to lifelong practice, and that, we hope, ring true for surgeons wherever they practice.

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