

## Aerospace Medicine Clinic

This article was prepared by Dierick R. Sparks, Jr., B.S., Jelaun K. Newsome, D.O., M.P.H., and Joseph J. Pavelites, M.D., Ph. D.

You are a military flight surgeon working at an aviation medicine clinic. Your colleague asked you to cover her patients while she is away at training. She provided a detailed spreadsheet that tracks the medical status of the pilots and aircrew she sees in clinic. You compare the list with the patients you will be seeing today, and one patient in particular catches your eye. Reviewing his electronic medical record, you see that this rotary wing crew chief has not flown in 2 yr due to complications from a centipede envenomation.

During the appointment, the patient describes how his medical evacuation unit was supporting a medical readiness training exercise in the South Caribbean. After retiring to an open shack after the duty day, he accidentally laid down on what the locals called an Amazonian centipede. He immediately felt a stabbing pain in his right popliteal fossa. After seeing the centipede scuttle off, the service member inspected his leg to find a red and swollen area surrounding what appeared to be two puncture sites.

1. Which of the following is most likely the initial cause of injury?
  - A. *Latrodectus variolus*.
  - B. *Scolopendra gigantea*.
  - C. *Scutigera coleoptrata*.
  - D. *Microtityus fundorai*.

### ANSWER/DISCUSSION

1. **B.** *Scolopendra gigantea* is also known as the Amazonian centipede, 42-legged centipede, or the Peruvian giant yellow-leg centipede and is found in the Caribbean and parts of South America. *Scolopendra* spp. are responsible for the majority of serious centipede envenomations. Envenomation will most likely result in severe pain with localized swelling and erythema. Reports of paresthesias at the site of the bite, local numbness, itching, burning, edema, bruises, blisters, hemorrhagic vesicles, necrosis, cellulitis, necrotizing fasciitis, lymphangitis and lymphadenitis, and allergy-like reactions

have been documented. Furthermore, numerous serious constitutional symptoms and systemic manifestations, including rhabdomyolysis, myocardial infarction, and acute renal failure, have also been reported.<sup>8</sup> *Latrodectus variolus* is a species of black widow spider found in North America, and *Scutigera coleoptrata*, although a species of centipede, is found in the Mediterranean. Neither of those fits the geographic location of this envenomation. *Microtityus fundorai* is found in the Caribbean but is a tiny scorpion approximately 0.5 in long and does not align with this scenario.

You ask the patient what kind of care he received at the point of injury. Unfortunately, the medic who examined him was not concerned with this “bug bite.” The medic provided no treatment despite the patient’s continued pain, growing erythema, and development of local blood clots and pustules (**Fig. 1**).

2. Which of the following are treatments for centipede envenomation?
  - A. Local injection of anesthetics.
  - B. Topical and/or systemic corticosteroids.
  - C. Oral antihistamines.
  - D. All of the above.

### ANSWER/DISCUSSION

2. **D.** All of the aforementioned may be used to treat centipede envenomations. In addition, antibiotics for possible secondary infections, as well as local application of cold or heat, heated water immersion of the site (in an attempt to deactivate toxins), and limb elevation, have been suggested.<sup>10</sup>

The patient and his unit returned to the United States 3 days after the envenomation. Barely able to walk on the affected leg due to pain and noting increased redness, swelling, and growing pustules, he proceeded to the emergency department (ED) of the local military treatment facility. At the ED, the patient’s

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**Fig. 1.** Envenomation site: note two puncture marks with a pustule below.

leg received an incision and drainage of the initial envenomation site as well as two sinus tracts just below the popliteal fossa and the upper calf. He was also given oral antibiotics and pain medication. The following day he saw his flight provider, who examined the wound, changed the dressings, and issued a temporary 2-wk down slip.

Despite the medications and daily dressing changes, the pain increased and malaise and fever set in, while the erythema and swelling progressed down his lower leg. Most disturbingly to the patient, a bluish-black-colored patch of skin with neighboring bullae appeared near the initial injury site. Reporting to the ED once more, he was immediately referred to orthopedic surgery and was taken to the surgery suite.

3. At this point, what is the most likely diagnosis?
- Necrotizing fasciitis.
  - Fournier's gangrene.
  - Noma.
  - Impetigo.

## ANSWER/DISCUSSION

**3. A.** The signs and symptoms most closely match what is seen in necrotizing fasciitis. The most common site of infection in necrotizing fasciitis is the lower leg, but it can also affect upper limb, perineum, buttocks, trunk, head, and neck. Symptoms usually appear within 24 h of a minor injury, with pain becoming severe over time. The affected area becomes edematous, with eventual bullae formation and blackening of the skin as necrosis sets in. Constitutionally, there may be flu-like symptoms with nausea, fever, diarrhea, dizziness, and general malaise. Necrotizing fasciitis is a surgical emergency and can be misdiagnosed initially as the early symptoms of pain, swelling, and erythema are often seen with other less severe soft tissue infections.<sup>4</sup> Fournier's gangrene is not the best answer, as it is a form of necrotizing infection of the male genitalia, perineum, and lower abdomen.<sup>6</sup> Noma (also known as necrotizing ulcerative stomatitis, gangrenous stomatitis, or cancrum oris) is a rapidly progressive and often fatal infection of the mouth and



**Fig. 2.** Results of initial debridement of necrotic tissue and wound drainage.

face. It does not affect the lower limb as with this patient. This disease predominantly affects children between 2 and 6 yr of age in underdeveloped areas and is a product of poor sanitation and malnutrition. Impetigo (also known as infantigo) is an epidermal infection caused by group A *Streptococcus* and *Staphylococcus aureus*. Symptoms include erythematous, pruritic sores that break open, and leaking a clear fluid or pus that crusts over into a yellow or "honey-colored" scab. The patient had no yellow crusting, and it is likely that such an infection would have responded to initial antibiotic treatment.

The results of the patient's first surgery (**Fig. 2**) were not curative. The patient returned to surgery numerous times, where more infected and necrotic soft tissue was debrided, including a significant portion of the belly of the gastrocnemius muscle. After the infection was finally eliminated, a portion of the skin required grafting to cover the wound.

4. Which of the following techniques for definitive reconstruction of this patient's defect measuring approximately 25.0 cm<sup>2</sup>, involving all layers of the skin, would most likely be used?
- Healing by secondary intention.
  - Epidermal micrografts.
  - Full thickness skin graft (FTSG).
  - Porcine heterograft.

## ANSWER/DISCUSSION

**4. C.** An FTSG would be a better replacement of the required epidermis and dermis that were lost due to the extensive tissue debridement. Notably, FTSG also shows less contracture and better healing compared to the other methods mentioned.<sup>9</sup> Healing by secondary intention occurs when a wound's edges cannot be approximated and closed, often due to a large amount of tissue loss, as in this case. This is not the best choice, as healing by secondary intention generally incurs a prolonged healing time, greater chance of infection, and the possibility of

debilitating scarring in a physically active service member. Epidermal micrografts, as the name implies, are transplanted small plugs of autologous epidermis to aid in wound healing. This lacks the dermis needed to repair the large defect seen in this service member. Porcine heterografts are not a definitive treatment, as their use is for temporary coverage of the wound before the final skin graft can be applied.<sup>5</sup>

In total, the patient had 13 surgeries, including a successful FTSG, and spent 6 mo in physical therapy. After examining his leg, you find a well-healed wound with skin graft intact and a noticeable loss of calf mass. He has no sensation over the skin graft. Considering the extensive number of surgeries that the patient had and the extended physical therapy he received to rehabilitate his lower leg, you have hesitations about honoring the patient's request to return to full flight duties today. At this point, you tell him that you will have to consult the aeromedical regulations for his condition, and you schedule a follow-up appointment in a few days to discuss the possible options.

Curious about how each of the U.S. military services, as well as civilian flight organizations, would approach this patient's aeromedical disposition, you begin reviewing the appropriate regulations and guidance. With regard to the U.S. Army, two primary documents are directly applicable: Aeromedical Policy Letters and Aeromedical Technical Bulletins (APLs) and Army Regulation 40-8, Temporary Flying Restriction Due to Exogenous Factors Affecting Aircrew Efficiency. Within the APLs, the three main subsections that may pertain to the case are: 1) allergic reactions to insect venom/exogenous exposure; 2) amputations; and 3) Table 11: Conditions That May Not be Granted Temporary Clearance. According to the APLs' proponent, the U.S. Army Aeromedical Activity, "reactions to insect bites, stings, dietary exposure and/or any other exogenous exposure may cause symptoms ranging from just mild local reactions to more severe reactions, i.e., generalized hives, angioedema, shortness of breath, wheezing, cardiac arrhythmias, and even death."<sup>13</sup> No waiver is required for mild, local reactions. However, more severe reactions will require waiver submission, including allergy consultation and medical records of previous treatments.<sup>13</sup> Fortunately in this case, the envenomation took place without allergic reaction.

Although not a complete amputation of an extremity, this patient did have partial loss of use of an extremity. Partial loss of the use of extremities may adversely affect aircrew performance, including physical agility, which could impact safe egress. It is imperative that the soldier prove successful functional adaptation. Per the APLs, aviation personnel must demonstrate that: 1) they are in excellent general health with a limited, static loss and have completed maximal rehabilitation; 2) their ability to perform specific military tasks relating to survival, evasion, resistance, and escape has been demonstrated through retention via a Medical Evaluation Board as well as passing the service's fitness test; and 3) performance-based evaluation for aviation duties has been completed by an appropriate unit-level trainer or supervisor, including standard and emergency procedures. Following these conditions, waiver may be recommended on a case-by-case basis.<sup>14</sup>

Considering the extent of the injury and subsequent treatments, Table 11: Conditions That May Not be Granted Temporary Clearance is applicable. Specifically, "Any condition which obviously impairs personal safety, safe flight, or mission completion"<sup>15</sup> may not be granted temporary clearance. Such a condition would require consultation with a flight surgeon and the U.S. Army Aeromedical Activity for waiver submission or clearance to fly.

Finally, this clinical case would also be subject to the provisions of Army Regulation 40-8, Temporary Flying Restriction Due to Exogenous Factors Affecting Aircrew Efficiency:

*Aeromedical providers [must be] aware of the exogenous factors affecting flight duties and the appropriate preventative measures to mitigate the potential associated aeromedical risk. The aeromedical provider will supervise and coordinate all medical treatment of all aircrew members for reasons of flight safety... [Additionally,] aircrew members will notify their aeromedical provider when they have participated in activities or received treatment for which flying restrictions may be appropriate.<sup>12</sup>*

According to the U.S. Navy Aeromedical Reference and Waiver Guide, "in general, any condition which results in surgery will require a package to be submitted with all available documentation (including operative reports) for review of waiver consideration via AERO [Aeromedical Electronic Resource Office]."<sup>17</sup> The waiver guide does not specifically mention loss of limb function. With reference to the envenomation reaction, the waiver guide stated that "any history of systemic or anaphylactic reaction to insect venom, foods, or food additives"<sup>17</sup> is considered disqualifying, requiring venom-specific immunotherapy prior to waiver submission. However, it does not mention requirements for severe local reactions, other than being released from allergy/immunology care with recommendation of return to flight status with no restrictions.

In reference to the Air Force Medical Standards Directory, "any disease, condition, or deformity of the musculoskeletal system, which impairs duty performance or restricts deployments and persists despite appropriate treatment," is disqualifying.<sup>11</sup> The Medical Standards Directory specifically references the Department of Defense Instruction 6130.03 (Medical Standards for Military Service: Retention) section on the musculoskeletal system. Section 5.19.e states that a "history of neuromuscular paralysis, weakness, contracture, or atrophy that is not completely resolved" is disqualifying if medical clearance cannot be given.<sup>1</sup> The Air Force only requires a waiver for allergic reactions for "a reliable history to stinging insect venom manifested by venom anaphylaxis or severe systemic reactions."<sup>11</sup> It does not discuss severe local reactions. However, it does include two general clauses for disqualifying conditions that would be applicable: 1) "Any disease or condition that causes chronic or recurrent disability for duty assignment or has the potential of being exacerbated by the hyperbaric environment or diving duty is disqualifying," and 2) "Chronic complications or effects of surgery that present a significant risk of infection, duty limitations, or require frequent specialty care resulting in an unreasonable requirement on mission execution" is disqualifying.<sup>11</sup>

The Federal Aviation Administration (FAA) would address return to flight related to this patient's condition with a special issuance or Statement of Demonstrated Ability. The FAA would require that the examiner submit a current status report including functional status (degree of impairment as measured by strength, range of motion, and pain), medication with side effects, and all pertinent medical reports for the FAA to make a decision.<sup>2</sup>

The medical standards and recommended practices of the International Civil Aviation Organization (ICAO) are found in Annex 1: Personnel Licensing of the ICAO Manual of Civil Aviation Medicine. However, Annex 1 is not available free of charge. The guidelines for medical assessment of the musculoskeletal system in the ICAO Manual of Civil Aviation Medicine note that “problems relating to orthopaedic deformities, amputations, limitations in the range of movement of joints, weakness of muscle groups, etc., must all be assessed on an individual basis.”<sup>3</sup> However, ICAO itself does not make medical fitness decisions in individual cases. The Manual of Civil Aviation Medicine does not mention allergy or envenomation reactions.

After months of physical therapy, the patient was able to easily pass his service's retention standards and physical fitness test. Evaluation of his gait by physical therapy revealed no gait disturbances and the patient denied any pain or loss of sensation in the tissue surrounding the skin graft or in his foot. Furthermore, an evaluation that you helped supervise determined that he had no difficulties or deficiencies in performing the aviation tasks required of his job.

5. What is the final disposition of this patient?
  - A. Fly again, no waiver needed.
  - B. Fly again, waiver needed.
  - C. Permanently grounded; retrain for another job in the military.
  - D. Permanently grounded and remove from military.

## ANSWER/DISCUSSION

**5. B.** It was determined that this flier had no significant medical sequelae that would require further treatment and he more than adequately demonstrated his ability to perform his basic military and aviation duties. Therefore, his branch of service granted him a waiver and returned him to full flight duties. Answer A is not correct, as the injury to his lower limb necessitated appropriate follow-on studies and review by a waiver authority to help ensure safety in flight. Answers C and D are not optimal, as a trained and able individual who can safely perform his duties would have been removed from his unit and the military.

Checking in at 6 mo after the flight waiver is granted, you find that the patient is doing well medically. Talking with his first-line supervisor, the flier is completing his flight duties to standard and he has no concerns with his performance on the job. Satisfied with the patient's outcome, you ensure that all medical documentation is complete in the electronic medical

record and perform a thorough handover of the patient to his regularly assigned flight provider.

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