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CASE REPORT

Managing Anaphylaxis in a Jungle Environment

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Anaphylaxis is a medical emergency requiring prompt action to prevent death from cardio-respiratory collapse. It can be a biphasic, unpredictable, and challenging reaction to deal with even in a hospital environment. The wilderness environments afforded by expeditions, remote health posts, and military exercises pose additional challenges often involving casualty evacuation. This article identifies and addresses some of these points using a case report from the Costa Rican jungle.

Key words: anaphylaxis, epinephrine, allergy

Introduction

In November 2009, the Expedition Medicine Jungle Course took place by the Pacuare River in a remote area of Costa Rica (Figure 1). The team consisted of 4 leaders (2 doctors, 2 nonmedical) and 22 expedition participants who were health professionals with a wide variety of expertise. After 4 days of preparation, the group trekked for three and a half hours to a planned overnight camp at 600 m elevation. The timeline on day 5 was as follows:

Case Presentation

1710 hours: One of the 5 persons heading to collect water was stung multiple times by wasps. This person was a fit and healthy 26-year-old woman with no known allergies. On returning to camp, she used a topical antihistamine on the 6 sting sites.

1720 hours: As dusk approached, several of the same team went to a second water source. The patient was found sitting by the side of the path, pale and vomiting. The other people present shouted for assistance and carried the casualty back to the main camp area. The 2 lead medics arrived with medical kits and an EpiPen (ALK Abello, Berkshire, UK), an injector device preloaded with 0.3 mg 1:1000 epinephrine.

1720 hours: The patient was sitting up, retching and itchy, complaining of feeling lightheaded and nauseated. She appeared pale, with a weak radial pulse (90 beats/min) and a respiratory rate of 12 breaths/minute. At this point, the diagnosis of anaphylaxis was made, and treatment commenced with 0.3 mg 1:1000 intramuscular (IM) epinephrine. After this, the patient showed a transient improvement with a stronger pulse, and she was able to sit up. Attempts at intravenous (IV) access failed. The patient recalls: "Within a few minutes [of being stung] I noticed I was salivating excessively and started to feel sick. As I climbed back toward camp I started vomiting, feeling dizzy, and had to sit down. My face and body were extremely itchy, and I remember an odd sensation of tingling in my mouth."

1730 hours: Within minutes, her condition deteriorated again. Blood pressure was low (radial pulse assessment); her pulse was 100 beats/min and weak. She was still retching and scratching her face, and became confused and disorientated. That necessitated a second dose of 0.5 mg IM epinephrine to be given (0.5 mL dose drawn with needle and syringe from 1 mL vial 1:1000 epinephrine; dose according to UK Resuscitation Council guidelines). The decision was made to evacuate the patient, and a 12-man team was formed. The evacuation team also took a radio (VHF, but connected to a repeater system, which gives it a range of several hundred miles), rope, and lightweight medical kit composed of a size 7 nasopharyngeal airway (NPA), size 3 oropharyngeal airway (OPA), surgical airway, 4 EpiPens, analgesia, and rescue breathing mask. Communications were established before departure through the VHF radio with the base office in San Jose. Throughout the evacuation, constant communication was maintained with the expedition coordinators in the office as they liaised with emergency

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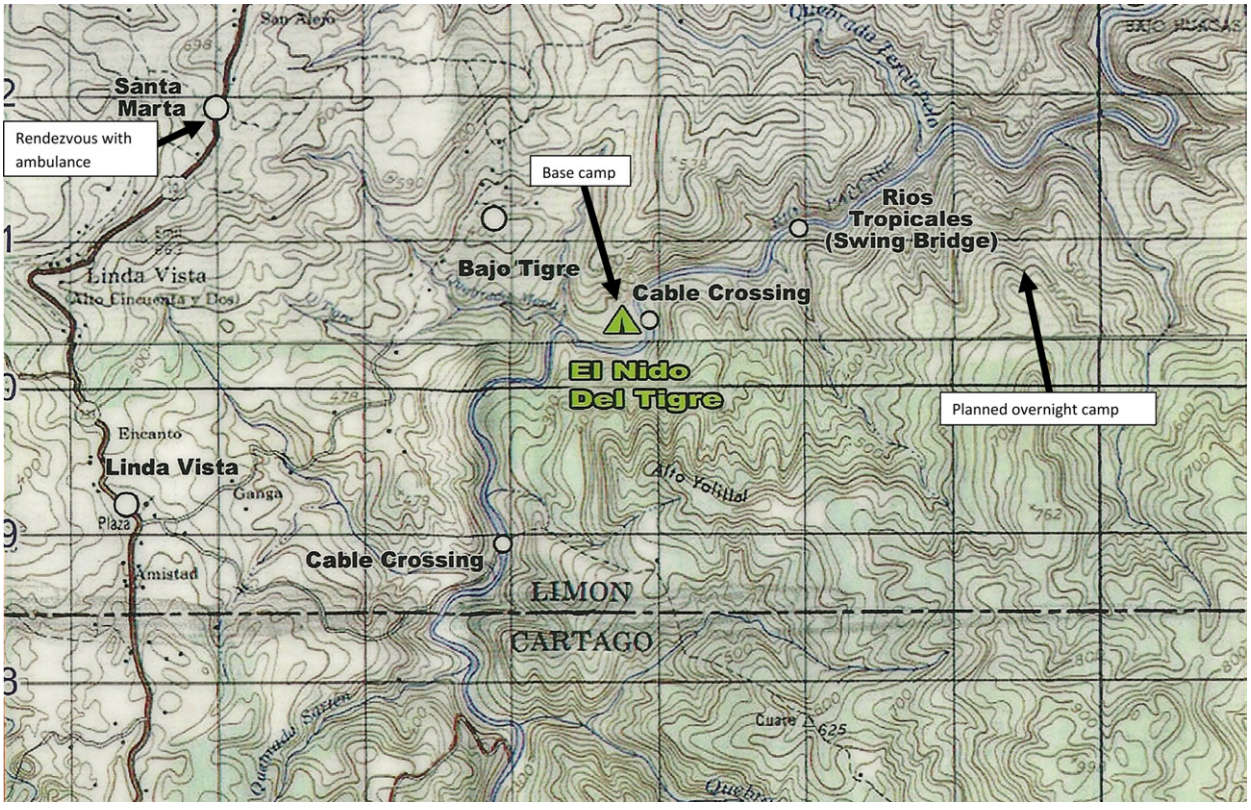

Figure 1. Map of the area. One grid square = 2 kilometers.

services. A satellite phone was left with the team that stayed in the jungle, in case they had any problems.

1740 hours: After the repeated dose of epinephrine, the patient improved to the extent that she could walk. She was given 30 mg prednisolone and 8 mg chlorpheniramine orally.

1750 hours: The evacuation team departed but had only walked 10 yards before the patient collapsed again. She had altered mental status and her radial pulse weak (but with a strong carotid pulse rate >100 beats/min).

1752 hours: The patient was placed into split-rope piggyback carry, and carried by a volunteer over very difficult terrain for 10 minutes. The patient was able to partially hold the rescuer.

1802 hours: A second volunteer carried the patient until 1809 hours over very hard terrain until the patient became unconscious, unable to hold on, and too unstable to carry as her feet kept catching on jungle foliage. The terrain became difficult to navigate, with very steep paths, precipitous drops, and crossing deep river cuttings. It was decided that the patient needed a stretcher, and several members of the team moved to flat ground to build one using tee-shirts and trees as poles. The local guide decided on a more direct evacuation route straight down to the river, which would mean cutting a route down through the jungle but would allow the team to quickly reach easier ground by the river. A nonmedical member of the evacuation team recalls: "After the initial 10 minutes [the patient] had become harder to carry as she was by now completely unconscious and [the team leader] decided a stretcher was needed. Two poles were presumably cut by [the local guide] who had been leading the way and clearing the trail of snakes, and on request we removed our shirts for use as the stretcher bed as this was the quickest method available."

1809 to 1930 hours: With a Glasgow Coma Scale score of 8, the patient's airway became intermittently difficult, with stridorous noises, and a variety of airway opening maneuvers were required. During this period, the third, fourth, and fifth doses of 0.3 mg IM epinephrine were given. It was necessary for the carrying team to rotate positions as the work became exhausting. The local guide was leading the group and clearing the route, having grave concerns about snakes. There were numerous yellow-kneed (venomous) tarantulas on the route when the stretcher was placed on the ground during brief rest stops. Communications were maintained on the VHF repeater radio, and further arrangements were made for a 4×4 vehicle to pick up the casualty and lead medic on a track out of base camp. An ambulance was then planned

to rendezvous with them at the main road head, ensuring they had adequate supplies of epinephrine, steroids, and a life support kit for the journey to the clinic, which was 1 hour away.

Approximately 1930 hours: The team arrived at the camp of another company and requested further epinephrine as the patient's blood pressure remained low and her airway difficult. She was given the sixth dose from the group's supplies. Now on easier terrain, the insertion of a size 7 NPA and OPA were attempted, but both were found to be too large. The patient was transferred onto a borrowed spinal board and into the back of a quad vehicle. At a grade 4 river rapids, she was carried by 2 rescuers onto a zip-wire cage to make the crossing, remaining unconscious throughout.

1940 to 1952 hours: On the other side of the river, the patient was carried on the spinal board to meet the 4×4 vehicle, and all but 3 members of the team returned to camp, planning to rejoin the team the next morning. The 1 remaining dose of epinephrine was not used in case there was a prolonged delay with the vehicle.

2010 hours: Rendezvous was made with an ambulance staffed by 2 community responders with only basic medical training. Nevertheless, the treating medics had to provide evidence that they were doctors before being allowed to continue managing the patient. Intravenous access was gained, and a 1-L bolus of 0.9% sodium chloride was given, followed by 12 mg dexamethasone IM and 0.5 mg epinephrine IM. The patient's level of consciousness improved, and her airway remained secure. Transfer to the local clinic took another hour.

2115 hours: On arrival at the clinic, the patient's Glasgow Coma Scale score was 15, she felt better, although still itchy and covered in urticarial rash, so chlorpheniramine IM was given. Oxygen saturations were 84% in room air, and high flow oxygen was commenced. The chest examination was clear, and the low saturations may have been secondary to hypovolemia and poor peripheral perfusion.

2240 hours: The patient was transferred by ambulance to a larger hospital for overnight observation, due to the severity of her reaction and low saturations.

0030 hours: More than 7 hours after the initial incident, the patient arrived at the referral hospital and continued to recover well. After a chest roentgenogram (normal), blood tests (raised white cell count, normal cardiac enzymes), electrocardiogram (lateral T-wave inversion with sinus tachycardia), and 5 L of IV fluids, she spent a comfortable night on a ward. The lead medic reflects: "Running a casualty evacuation is always a draining and difficult experience. This one in particular reinforced the difficulties of working and running an evacuation in a jungle environment. The terrain is very hard and claustrophobic, and the fauna and flora are a true hazard."

The next morning, the patient was discharged with oral prednisolone 50 mg daily and omeprazole 20 mg daily for a week. Gastrointestinal upset, presumably due to gut edema, continued for a further 24 hours. The next day, the patient and remaining rescuers rejoined the group for the expedition debrief. On returning to the United Kingdom, she was prescribed personal EpiPens.

Discussion

Anaphylaxis is a potentially life-threatening allergic reaction that manifests in a multisystemic and variable fashion. It involves prior sensitization to an allergen that may take the form of a food product, insect, medication, material, or environment (eg, cold, water). Lifetime prevalence is 0.05% to 2%.[1] Anaphylaxis is responsible for 1500 deaths in the United States yearly, with Hymenoptera stings accounting for 533 deaths in the United States between 1991 and 2001, more than any other envenomation.[2]

After exposure to the inciting substance, allergen binding occurs to antigen-specific immunoglobulin E that are attached to previously sensitized mast cells and basophils. This causes immediate mediator release through degranulation. These mediators are responsible for the secondary effects on smooth muscle tone, mucous membrane secretion, and airway resistance that cause the classical symptoms. Persons of all ages and races can be affected by anaphylaxis.[3]

The diagnosis of anaphylaxis is a clinical one. The classical and alarming skin manifestation is an urticarial rash with red, raised, irregularly shaped, and intensely itchy lesions. They can occur anywhere on the body and are not necessarily in proximity to the original agent. Involvement of the respiratory tract is common, and frequently worse in patients with reactive airways disease. Cough, hoarseness, rhinorrhea, and even stridor may be seen in severe cases when airway patency is compromised by tongue and pharyngeal swelling. Dyspnea, tachypnea, and wheeze may be evident. Minor reactions may have no cardiovascular implications. However, chemomediator-related peripheral vasodilation can lead to capillary leakage, hypotension, tachycardia, and fulminant shock, which may occur without other prominent features. Cardiovascular collapse and subsequent arrest are the endpoint of untreated anaphylaxis. Nausea, vomiting, abdominal cramps, and diarrhea are all common, particularly when the allergen is a food. Gastrointestinal edema may lead to temporary malabsorption. Anxiety and tremor are frequently seen, and progressive neurological impairment and unconscious-

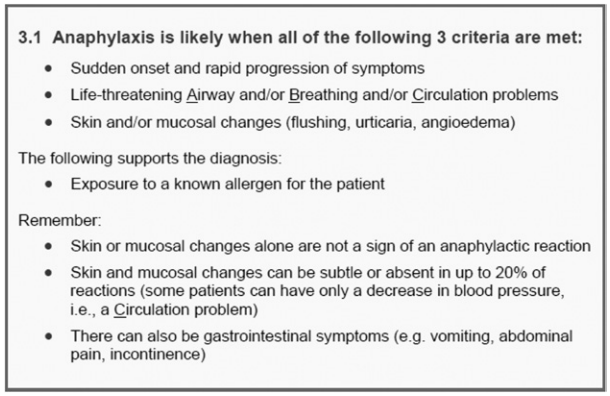

Figure 2. The diagnosis of anaphylaxis (from Resuscitation Council UK 2008).[4]

ness are secondary to both cerebral hypoperfusion (as a result of hypotension) and hypoxemia (Figure 2).[4]

Prehospitalization care of anaphylaxis involves management of airway, breathing, and circulation according to standard resuscitation protocols. Management should be tailored to the severity of the reaction and the proximity to advanced medical care. Rapid delivery of epinephrine is paramount to aborting severe attacks. The recommended dose is 0.5 mg 1:1000 epinephrine IM, repeated after 5 minutes if there is no improvement. Several doses may be needed in 25% to 35% of cases, and in resistant cases, epinephrine infusion (or other alpha-adrenergic drug)— although an option not available in the wilderness situation—may be required to maintain sufficient cardiac output. In addition to a fluid challenge, H1 antihistamines (eg, chlorpheniramine), H2 antagonists (eg, ranitidine), inhaled B-agonists (eg, albuterol), and steroids (eg, prednisolone, hydrocortisone, or dexamethasone) are recommended for the acute phase and for several days after discharge.[4]

Once the initial reaction has subsided, it is vital to continue observing the patient as 1% to 20% will have a biphasic reaction (usually within 6 hours), which can also be life-threatening.[5] Overall, mortality is low, with a case fatality rate of 1%.[6] Risk of death is increased for persons with preexisting poorly controlled asthma or for those with asthma who delay use of epinephrine.[7] The most common cause of death with anaphylaxis is complete airway obstruction. In fatal cases, death is usually soon after exposure. In a large case series, no deaths were reported after 6 hours.[8]

The EpiPen can be carried on expeditions and by persons who are known to have severe allergic reactions. It is available in adult and pediatric doses (EpiPen Junior for patients <30 kg). It is quick and easy to use, but even medical professionals benefit from familiarization with it. Online resources are available with demonstration videos, guidance, and free dummy pens for order.[9] Alternatively, doses of epinephrine can be drawn up from a vial with needle and syringe, although this is associated with significantly more dosing errors.

MANAGEMENT CHALLENGES AND RECOMMENDATIONS

The challenges of managing anaphylaxis in wilderness environments are plentiful. Equipment for continuous monitoring of saturations and pulse may be available with a portable miniature saturation probe but are battery dependent. Blood pressure assessments may have to rely on the presence or absence of certain pulses and the general condition of the patient. Basic airway maneuvers and adjuncts are vital, although the impracticalities of assisted ventilation (eg, with bag and mask) during an evacuation are numerous. Life-saving airway interventions such as surgical airways and invasive ventilation are technically difficult in the wilderness, and consideration has to be made of the sustainability of these measures.[10]

It is worth noting that most medications are equally efficacious whether delivered through the IM route or the IV route (for anaphylaxis, epinephrine should only be given subcutaneously or IM, except under expert guidance/in cardiac arrest). That allows for rapid provision of life-saving drugs without the need for IV access. For profound shock, however, there may be a delay in the onset of action of IM drugs as muscles become hypoperfused. Ideally, if a large-caliber line can be safely sited, adjunctive medications and IV fluid replacement can be instigated, although few expeditions carry IV fluids owing to weight and storage issues. If cardiac output were to be lost in a patient remote from advanced medical care, resuscitation attempts would have to consider the sustainability of the effort, likelihood of survival, and danger it might pose to the rescuers.[10]

For persons who have had all but the mildest of allergic reactions, evacuation to secondary care is warranted. Evacuation from remote environments may be by land, sea, or air, and preferably requires prior stabilization. A number of learning points were identified by the team after the complex, prolonged, evacuation case described. When planning an expedition, particularly when traveling in hazardous environments far from help, sufficient epinephrine should be carried to manage multiple severe reactions.[11] Selected expedition members should carry an EpiPen, know how to use it, and be prepared to administer it. Even if no medical personnel are available, an expert panel supports the concept that ". . .properly trained, non-medical professionals, whose work responsibilities require them to provide emergency medical

care, be trained to appropriately administer epinephrine for the treatment of anaphylaxis."[11]

The varied and sometimes protracted nature of allergic emergencies and the fluctuating response of some patients requires that the medical kit contain a plentiful supply of all the basic treatment medications (steroids, antihistamines, and so forth) in easily identifiable kits. A small printed copy of anaphylaxis management guidelines should be carried if they are not familiar to all members. Ideally, the medic's primary survey kit should be carried in a waistbag so it is easily accessible without removing, and therefore not misplaced.

To carry out an effective evacuation, a large number of people need to be involved, particularly when the evacuation requires physical effort or is prolonged. To minimize rescuer fatigue, lightweight compact stretchers can be invaluable. To identify any potential barriers to a smooth casualty evacuation ("casevac") and familiarize all members with protocols, drills should be performed early in the trip. Designating roles for members of the evacuation team and for those left behind is essential to ensure that responsibility is taken for the medical kit, tasks around camp, and the welfare of remaining clients. Finally, the "casevac debrief" is a vital part of identifying learning points from these rare and challenging situations.

Despite numerous obstacles and a demanding evacuation, the outcome of the case presented here was favorable. In remote circumstances, both medical and nonmedical aspects of evacuation are critical to patient outcomes. Planning and practicing scenarios gives the team an opportunity to identify strengths, weaknesses, and potential challenges, and ultimately leave the group better prepared for the "real thing."

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