

This Is Africa

Bites, Stings, and Rigors: Clinical Considerations in African Operations

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ABSTRACT

The natural health threats in Africa pose daunting clinical challenges for any provider, as evidenced by the current Ebola epidemic in West Africa, but the threat is multiplied for the Special Operations provider on the continent who faces these challenges with limited resources and the tyranny of distance. The majority of operationally significant health risks can be mitigated by strict adherence to a comprehensive force health protection plan. The simplest, yet most effective, technique for preventing mosquito-borne diseases is the prevention of mosquito bites with repellent, bed nets, and appropriate clothing in addition to chemoprophylaxis. Some of the more likely or lethal infectious diseases encountered on the continent include malaria, Chikungunya, dengue, human immunodeficiency virus, and Ebola. Venomous snakes pose a particular challenge since the treatment can be as deadly as the injury. Providers supporting African operations should educate themselves on the clinical characteristics of possible envenomations in their area while promoting snake avoidance as the primary mitigation measure. To succeed in Africa, the Special Operations provider must consider how to meet these challenges in an environment where there may not be reliable evacuation, hospitalization, or logistics channels.

KEYWORDS: *Africa, tactical medicine, tropical infectious disease, chemoprophylaxis, malaria, dengue, Chikungunya, HIV, Ebola, snake envenomation, antivenin, wilderness medicine*

Introduction

This is Africa—TIA. This second part in the *Journal of Special Operations Medicine* “This is Africa” series will focus on some of the more pertinent clinical

considerations for Special Operations Forces (SOF) providers supporting operations in Africa.¹ The natural health threats in Africa pose daunting clinical challenges for any provider, but the threat is multiplied for the SOF provider on the continent facing these challenges with limited resources and the tyranny of distance. We hope to reinforce the importance of prevention by highlighting FHP measures critical to survival in Africa. We will then detail clinical considerations for some of the more likely or lethal infectious diseases encountered on the continent and conclude with special focus on the venomous snake threat in Africa.

Force Health Protection

Numerous diseases, vectors, and environmental conditions in Africa pose a very high health risk to deployed personnel. However, the majority of these operationally significant health risks can be mitigated by strict adherence to a comprehensive FHP plan. US Africa Command (AFRICOM) and Special Operations Command Africa (SOCAFRICA) have published recommendations that detail such a multilayered FHP program.² Disease prevention is a command responsibility. However, the importance of accurate disease prevention education from SOF providers to unit command teams cannot be understated. A formally trained Preventive Medicine Officer (SSI 60C) or Preventive Medicine Non-Commissioned Officer can be invaluable to assist with FHP risk assessments and detailed unit level plans. Immunizations are only one piece of a comprehensive unit health protection plan. Table 1 lists the immunizations required for military forces deploying to Africa. Additional FHP topics will be more fully addressed in a future JSOM article in the “This Is Africa” series.

Table 1 Immunization Requirements for SOF Personnel Deploying to Africa²

Immunization	Requirement	Notes
Yellow fever	Within 10 years of date of deployment	Must be administered at least 10 days prior to arrival in Africa. Must be documented on CDC 731 Yellow Shot Record with official Yellow Fever certificate stamp, card must be carried on person.
Tetanus/diphtheria/acellular pertussis (Tdap)	1 time dose of Tdap, receive tetanus if more than 10 years since Tdap or tetanus booster	
Varicella		Documentation of one of the following: born before 1980, documented history of disease by laboratory confirmation, sufficient varicella titer, or administration of two doses of vaccine
Polio, inactivated polio vaccine	Single adult booster; if travelling to Cameroon, must have documentation of additional booster 4 to 12 months prior to departure from country	Must be documented on CDC 731
Seasonal influenza	Annual	
Hepatitis A	Completed series or documented immunity through titer	Required for third country and local national personnel employed by US forces
Hepatitis B	Completed series or documented immunity through titer	
Rabies	Completed series, boosters administered when titers indicate	Pre-exposure vaccination required for veterinary personnel, military working dog handlers, animal control personnel, security personnel, SOF, and SOF enablers
Meningococcal	Every 5 years	

Note: CDC, Centers for Disease Control and Prevention; SOF, Special Operations Forces.

Vector-borne Disease Personal Protective Measures

The simplest, yet most effective, technique for preventing mosquito-borne diseases is the prevention of mosquito bites. Measures include the use of *N,N*-diethyl-met-toluamide (DEET)-based insect repellents (at least 33%) on exposed skin (Figure 1), sleeping under a permethrin-treated bed net (Figure 2), wearing long pants and long sleeves during hours of peak mosquito activity, and treating uniforms and clothing with permethrin. While this seems obvious, mission profiles often dictate modified uniforms or even civilian attire. Long sleeves and long pants, preferably impregnated with permethrin, provide the best protection and should be encouraged whether in uniform or casual wear. Insect repellent containing DEET is safe and effective and ample stock should be accounted for in unit packing lists.

Select Diseases of Significance

Malaria

Malaria is a mosquito-borne illness caused by a parasite that infects red blood cells. An estimated 207 million cases of malaria occurred worldwide in 2012 resulting in an estimated 627,000 deaths. Approximately 90% occur in sub-Saharan Africa³ and (87%) of the African



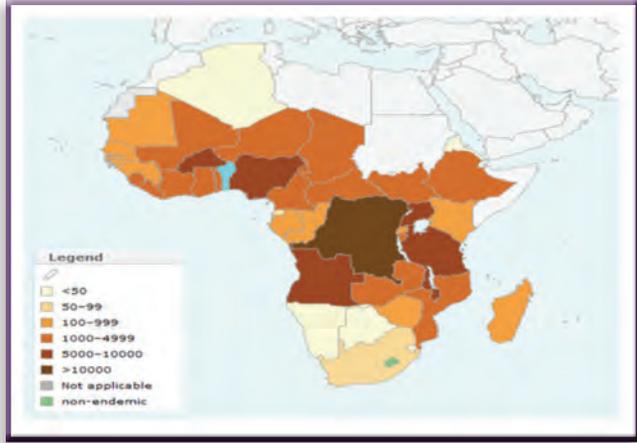
Figure 1
N,N-Diethyl-met-toluamide (DEET).

Figure 2 Permethrin-treated pop-up bed net.



population who live in the areas with the highest malaria transmission rates can be found in just 10 countries: Guinea, Togo, Mali, Mozambique, Burkina Faso, Ghana, Côte d'Ivoire, Uganda, Nigeria, and Democratic Republic of Congo (Figure 3).⁴

Figure 3 Malaria map showing number of reported malaria deaths in 2012.³



Source: World Health Organization

The four primary species of malaria parasites that infect humans are: *Plasmodium falciparum*, *P. malariae*, *P. ovale*, and *P. vivax*. *P. falciparum* is the predominant strain of malaria in Africa. It causes severe disease and can be fatal without timely and proper treatment. To prevent severe disease and death, SOF forces deployed to Africa must adhere to all personal protective countermeasures, especially chemoprophylaxis, and unit protective measures. The primary means of contracting malaria is via the *Anopheles* mosquito bite; *Anopheles* mosquitos are active from dusk to dawn. Therefore, mosquito control and protection from mosquito bites are the mainstay of reducing malaria transmission.

While are several options for malaria chemoprevention exist, SOCAFRICA policy recommends atovaquone/proguanil (Malarone®; GlaxoSmithKline plc, Brentford, Middlesex, England; www.gsk.com) for SOF units deploying to malarious areas where the risk of transmission is greater than 10%, according to the National Center of Medical Intelligence (NCMI).⁵ Malarone is a combination of atovaquone and proguanil in a single tablet. It is effective everywhere, including areas with multidrug resistant parasites. Atovaquone/proguanil prophylaxis is safe and well tolerated, with the most frequent adverse events reported as nausea, vomiting, abdominal pain, or diarrhea.⁶ Atovaquone/proguanil should be taken 1 to 2 days prior to travel and for 7 days after returning from Africa.

The signs and symptoms of malaria at the outset of presentation include: fever, rigors (shaking chills), sweats,

headache, myalgias, exhaustion, nausea, vomiting, and diarrhea. Malaria must be considered in all febrile patients in a malarious area. Critically ill patients will have a detectable parasitemia during their illness; however, symptoms can occur before parasites are detectable by blood smear. Therefore, patients with suspected malaria should be tested with a total of three blood smears or rapid diagnostic tests (RDT), one every 8 to 12 hours. The BinaxNOW® RDT (Alere Inc., Waltham, MA, USA; www.alere.com) can detect plasmodium parasites using whole blood from a finger stick and is the diagnostic tool of choice when a skilled microscopist is not available.⁷ This RDT is suitable for point-of-care field use, is disposable, and can be ordered through standard medical supply channels (NSN 6550-01-554-8536/box of 12 tests). Thick and thin blood smears should be obtained simultaneously to confirm diagnosis and speciation and should be forwarded to the closest medical treatment facility (MTF) or the SOCAFRICA Surgeon's office for diagnosis. Many deployed providers have established relationships with local health clinics that employ a laboratory technician with extensive experience in malaria diagnosis. These relationships can be leveraged for confirmation of the rapid test results and for refresher training on thick- and thin-smear testing, since malaria diagnosis by microscopy is an advanced and perishable skill. Initial treatment for adult patients with uncomplicated malaria is artemether/lumefantrine (Coartem®; Novartis International AG, Basel, Switzerland; www.novartis.com) 20/120mg per tablet: 4 tablets as a single dose, 4 tablets again after 8 hours, and then 4 tablets twice daily for the following 2 days (total course is 24 tablets). Alternatively, atovaquone/proguanil may be used to treat uncomplicated malaria; however, experts recommend using artemether/lumefantrine instead for those who have been using atovaquone/proguanil for prophylaxis. If applicable, this regimen consists of atovaquone/proguanil (250mg/100mg per tablet) 4 tablets by mouth per day for 3 days.⁸ The treatment of severe malaria for SOF forces in Africa is a challenging dilemma since the only US Food and Drug Administration (FDA)-approved drug is intravenous (IV) quinidine. Quinidine carries the risk of fatal dysrhythmias and should not be administered without adequate cardiac monitoring, limiting its use in austere settings. IV artesunate is considered the drug of choice to treat severe malaria.⁷ While artesunate is widely available in Africa, there is a real and valid concern on the continent for counterfeit drugs or drugs that do not meet Western quality control standards. Therefore, the best plan for treating severe malaria is rapid evacuation off the continent to a USMTF where IV artesunate is available as an investigational new drug (IND) that can be administered under controlled protocols (e.g. Landstuhl Regional Medical Center in Germany). This scenario may require emergency treatment during evacuation,

perhaps with pharmacologic options outside the typical US-approved protocols, but these case-by-case decisions should be made in consultation with higher headquarters medical authorities. A valuable resource is the US Centers for Disease Control and Prevention (CDC) Malaria Hotline: during duty hours +1-770 488-7788 or after hours +1-770 488-7100.⁷

The need for terminal prophylaxis with primaquine for *P. vivax* or *P. ovale* in Africa is controversial. Experts agree that most travelers to Africa do not need terminal prophylaxis, because the overall risk of developing malaria caused by *P. vivax* or *P. ovale* is very low.⁹ Terminal prophylaxis should be considered for those who have lived 6 months or longer in high-risk areas with intense exposure to *P. vivax*, such as can be found along the Omo River in Ethiopia.⁹ The recommended adult dose of primaquine for terminal prophylaxis based on clinical trials and expert opinion is 30mg base daily for 14 days, started on the return from a malarious region. Persons with glucose-6-phosphate dehydrogenase (G6PD) deficiency must not take primaquine for malaria prophylaxis.⁹ Both the AFRICOM and SOCAFRICA policy for primaquine use reflect this recommendation.

Chikungunya

Chikungunya virus (CHIKV) is a mosquito-borne viral disease characterized by acute onset of fever and severe polyarthralgia. CHIKV is a single-stranded RNA virus whose primary vectors are the *Aedes aegypti* and *A. albopictus* mosquitoes. Both are aggressive *daytime* biters, which makes them a serious threat to troops who have been accustomed only to using personal protective measures (e.g., DEET, sleeves down) at dusk or dawn.

The incubation period of CHIKV is typically 3 to 7 days, and the majority of those infected are symptomatic. CHIKV infection presents with acute onset of fever and debilitating symmetric arthralgias, often in the hands and feet.¹⁰ Associated signs and symptoms include: headache, myalgia, conjunctivitis, nausea, vomiting, and maculopapular rash. Symptoms of CHIKV infection usually resolve in about a week; however, there may be relapses of arthralgias for months to years following this acute infection.

Blood samples should be collected for diagnostic testing at the closest reliable laboratory. Testing reveals lymphopenia, thrombocytopenia, and elevated levels of creatinine and liver transaminases. There is no rapid diagnostic test available; however, CHIKV testing is available at the CDC Uganda Viral Research Institute (UVRI) in Entebbe. Definitive testing can be accomplished here using polymerase chain reaction (PCR) testing on the patient's blood sample. This can be coordinated through the SOCAFRICA Surgeon's office.

The illness is usually self-limiting, and treatment is supportive. There is no specific antiviral therapy. Acetaminophen should be used to treat the pain and fever. If there is a question of whether the patient has dengue, nonsteroidal anti-inflammatory drugs (NSAIDs) should not be used until the patient has been afebrile for longer than 48 hours and has no warning signs of severe dengue fever (discussed in the following section). Because the clinical findings of both CHIKV and dengue fever are similar, patients with suspected CHIKV should be managed as having dengue fever until dengue has been ruled out. There is no vaccine or medication available to prevent CHIKV infection.¹¹ This, again, stresses the importance of reducing mosquito exposure through FHP measures.

Dengue

Dengue fever and dengue hemorrhagic fever are caused by the transmission of one of four dengue viruses through the bite of an *A. aegypti* mosquito. Unlike malaria, there is no chemoprophylaxis available for dengue and no cure. The only way to prevent the disease is through bite avoidance.

According to the CDC, there are nearly 400 million people infected with dengue fever yearly worldwide.¹² The principal symptoms of dengue fever are high fever sustained for 5 to 6 days, severe headache with retro-orbital pain, photophobia, arthralgias, myalgias, rash, and mild bleeding (e.g., nose or gums, easy bruising). The course of dengue fever is self-limited, and treatment is supportive. Laboratory samples may be sent to the UVRI in Entebbe, as mentioned, for definitive diagnosis. This is important to provide feedback to commanders who may assist with the enforcement of FHP measures.

Dengue hemorrhagic fever (DHF) is a more severe form of dengue infection, with a mortality rate of approximately 20%. DHF is usually associated with secondary dengue infection. An infection with one of the four dengue virus serotypes produces immunoglobulin antibodies that provide lifelong immunity against that serotype. During the second infection with a different serotype, these preexisting antibodies from the first infection may fail to neutralize and instead enhance viral uptake and replication in the phagocytes. Such infected cells become the target of an immune elimination mechanism with activation of complement and the clotting cascade, and eventually produce DHF. DHF is characterized by a fever that lasts from 2 to 7 days and in addition to dengue fever symptoms, patients experience petechiae, purpura, gingival bleeding, hematemesis, melena, hematuria, hepatomegaly, and shock, due to plasma leakage (dengue shock syndrome). Once the fever subsides, symptoms include persistent vomiting, severe abdominal pain, and dyspnea. Laboratory tests in DHF reveal

thrombocytopenia, followed by hematocrit elevation (greater than 20%), leukopenia, and elevated transaminase levels. The tourniquet test may also aid in determining hemorrhagic tendency and diagnosing dengue infection. This is performed by application of a blood pressure cuff inflated to the midpoint between systolic and diastolic blood pressures for 5 minutes. More than 20 petechiae per square inch is considered positive. Treatment includes acetaminophen for pain and fever, maintenance of hydration, and evacuation to a higher echelon of care. Aspirin or NSAIDs should be avoided due to the risk of bleeding.¹²

Ebola

The 2014 Ebola outbreak in West Africa is an ongoing public health disaster that has involved Guinea, Liberia, Sierra Leone, Nigeria, and Senegal at the time this article was submitted for publication. It is critical for SOF providers on the continent to be familiar with the transmission and presentation of Ebola virus disease (EVD) to protect their units on the ground from this disease, as well as to intelligently educate their commanders as to the impact this outbreak may have on operations. For example, the present outbreak has modified evacuation plans where certain countries have closed their borders to airflow.

The earlier the disease can be identified, the greater is the chance for survival. Historically, Ebola outbreaks have had fatality rates as high as 90%. The fatality rate for the current outbreak in West Africa is approximately 50%.¹³ Signs and symptoms of EVD include, but are not limited to, fever between 103°F and 105°F, intense weakness, sore throat, headache, profuse vomiting, and diarrhea. Severe symptoms include bleeding from nasal and oral cavities, hemorrhagic skin blisters, and renal failure leading to multisystem organ failure. The incubation period of Ebola is between 2 and 21 days. Infected patients usually begin to show signs and symptoms around 8 to 10 days. Only infected patients showing signs and symptoms are infectious to others. Ebola virus is not spread by casual contact. It is transmitted by direct contact of secretions such as vomit, diarrhea, and blood of an infected person, but also through exposure to saliva, sweat, tears, or objects that have been contaminated with infected secretions. Contact with eyes, nose, mouth, or nonintact skin surface increases the risk of transmission.¹³ Ebola cannot be contracted through food, air, or water, although preparation or consumption of fruit bats has been implicated in the spread of EVD.

How to recognize and handle a suspected case of EVD is a critical skill for SOF providers in Africa now. A suspected Ebola case is a person who has both consistent symptoms and risk factors as follows: (1) clinical criteria, which include temperature higher than 101.5°F

and symptoms such as severe headache, muscle pain, vomiting, diarrhea, abdominal pain, or unexplained hemorrhage; and (2) epidemiologic risk factors in the 3 weeks before the onset of symptoms, such as contact with body fluids of a patient known to have or suspected to have EVD, travel to an area where EVD transmission is active, or direct handling of bats, rodents, or primates from disease-endemic areas.¹⁴

There is no known vaccine or cure for Ebola. EVD diagnosis may be made through blood samples sent to approved EVD testing centers, which is an evolving system at this point in the current outbreak as part of the US Department of Defense response plan. Laboratory PCR confirmation of suspected EVD requires a 2mL to 4mL blood sample in an ethylenediaminetetraacetic acid (EDTA) purple- or red-top tube kept cold during transport, preferably in an International Air Transport Association specimen transportation box. The standard of care remains in limited supportive therapy that consists of balancing the patient's fluids and electrolytes, maintaining their oxygen status and blood pressure, and treating them for any complicated infections. Malaria diagnostics should be a part of the initial testing because it is a common cause of febrile illness with similar presenting signs and symptoms in persons with travel history to the affected countries. If treating a suspected Ebola-infected patient, the SOF medic must use the proper personal protective equipment such as eyewear/goggles, facemask, gloves, and gown to reduce exposure as well as to maintain strict isolation precautions of any suspected patients to prevent spread to others on the team.^{13,14}

Human Immunodeficiency Virus

The human immunodeficiency virus (HIV) attacks and destroys CD4 cells of the immune system, resulting in decreased ability to fight infections and certain cancers. HIV is spread through the blood, semen, vaginal fluids, or breast milk, and is most commonly transmitted through oral, vaginal, and anal sex and sharing needles with a person infected with HIV.¹⁵ The HIV prevalence rate of female sex workers in Africa varies by region, but is as high as 30% to 51% in countries with average or high HIV rates in the general population.¹⁶

The principal HIV concern for SOF forces deployed to Africa, though, is from the accidental exposure to HIV-contaminated blood or body fluids. This is important especially for SOF medical personnel, since the prevalence of HIV-positive local nationals can be as high as 25% in some regions on the continent.¹⁶ Therefore, the safest practice for the prevention of HIV in the deployed setting is to assume an African patient is HIV positive until proven otherwise. In prospective studies of healthcare workers, the average risk for HIV transmission after a percutaneous exposure to HIV-infected

blood has been estimated to be approximately 0.3%¹⁷ and that after a mucous membrane exposure to be approximately 0.09%.¹⁸ Preventing exposures to blood and body fluids is the most important strategy for preventing occupationally acquired HIV infection. Individual healthcare providers and leaders in SOF units should ensure strict adherence to the principles of standard precautions, including consistent use of personal protective equipment.¹⁹

The point-of-care diagnostic kit, OraQuick Advanced Rapid HIV-1/2 Ab test (NSN 6550-01-526-7431, available through medical supply channels; OraSure Technologies Inc., Bethlehem, PA, USA; www.orasure.com) has an extremely high sensitivity and results are available in about 30 minutes. If the test is negative, the patient is highly likely to be HIV negative. This may be useful to test the source of an accidental needle stick or blood splash, but should not be used to screen for acute HIV infection (sensitivity will be much lower under these circumstances). For a US Servicemember with body-fluid exposure from a person whose HIV status is unknown, it is prudent to begin postexposure prophylaxis as soon as possible and begin the evacuation procedures off the continent.

The US Public Health Service Working Group published new HIV postexposure prophylaxis (PEP) guidelines in 2013.¹⁹ A new recommendation was for all PEP medication regimens to contain three (or more) antiretroviral drugs for all occupational exposures to HIV. The preferred HIV PEP regimen recommended by SOCAFRICA is: raltegravir (Isentress®; Merck & Co., Whitehouse Station, NJ, USA; www.merck.com) 400mg by mouth twice daily plus tenofovir 300mg/emtricitabine 200mg (Truvada®; Gilead Sciences Inc., Foster City, CA, USA; www.gilead.com), by mouth once daily. Medical personnel participating in activities that put them at high risk

for exposure should deploy with a full regimen of HIV PEP to be started as soon as possible after occupational exposure to HIV, but evacuation off the continent is recommended to complete the full 4 weeks of treatment. Complete blood counts and renal and hepatic function tests should be obtained at baseline and 2 weeks after exposure (further testing may be indicated if abnormalities are detected). HIV testing is recommended at baseline and at 6 weeks, 12 weeks, and 6 months after exposure.¹⁹ Because of the potential for toxicities associated with PEP regimens and the need for further laboratory follow-up, the SOCAFRICA policy is for all personnel undergoing HIV PEP treatment to be transferred off the continent to a US MTF for further evaluation and treatment. In addition to supplying patients with enough PEP medications for travel, it is wise to supply them with an antiemetic, as well.

Snake Envenomation

It is no surprise that snake envenomation is one of the most feared consequences of operations on the African continent. Africa is home to more than 400 snake species and 30 of these are known to have caused human death.²⁰ The incidence of snakebites in Africa is difficult to characterize, as reporting methods are fragmented. Based on literature meta-analysis, the incidence of African snakebites is around 315,000 per year with more than 700 amputations and between 7,000 and 32,000 deaths.²¹ The majority of snake envenomations occur among the rural indigenous population. Current disease and nonbattle injury (DNBI) statistics for the AFRICOM area of responsibility reveal a 0% incidence of snake envenomations for personnel deployed to the continent.

Six main clinical syndromes, outlined in Table 2, characterize snake bites. While it is often difficult to identify the snake, syndromic classification of envenomation is

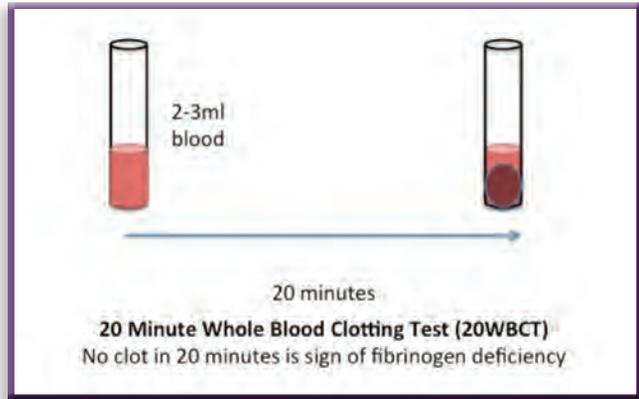
Table 2 *Envenomation Syndromes**

Syndrome	Clinical Presentation	Treatment
Syndrome 1	Marked local swelling with coagulable blood	Polyspecific antivenin and volume repletion
Syndrome 2	Marked local swelling with incoagulable blood and/or spontaneous bleeding	South of Sahara and north of equator use monospecific <i>Echis</i> antivenin, all of Africa: polyspecific antivenin
Syndrome 3	Progressive paralysis (neurotoxicity) weakness syndrome	Polyspecific antivenin Consider trial of anticholinesterase therapy Advanced airway
Syndrome 4	Mild swelling alone	No antivenin Palliative treatment only
Syndrome 5	Mild or negligible swelling with incoagulable blood	Monospecific antivenin for boomslang (<i>Dispholidus</i>) Supportive treatment for vine snake
Syndrome 6	Moderate to marked local swelling associated with neurotoxicity	No antivenin available Supportive treatment

Source: *From World Health Organization Guidelines for the Prevention and Clinical Management of Snakebite in Africa.

a practical method to guide treatment. Epidemiologic awareness and clinical assessment, supplemented by the 20-minute whole-blood clotting test (20MWBCT; Figure 4) is sufficient to determine an appropriate treatment algorithm.

Figure 4 Twenty-minute whole-blood clotting test.



The decision to administer antivenin is the crux of therapy; however, administration of antivenin should be performed in at least a Role 2 facility with appropriate monitoring and emergency treatment resources available. All antivenins carry a risk of anaphylaxis and subsequent serum sickness. Currently available antivenin has a defined range of therapeutic efficacy and there are several species for which no antivenin is available (Table 3). Antivenin is in short supply, has a limited shelf life, requires dependable cold storage, and is available only through a select few manufacturers.²² Up-to-date information on reputable antivenin manufacturers and product availability can be obtained at the websites listed in Table 3.

Table 3 Sources for Antivenin Information

Internet Hyperlinks
www.toxinfo.org/antivenoms/synopsis.html http://globalcrisis.info/latestantivenom.htm http://www.who.int/bloodproducts/animal_sera/en/ http://www.toxinology.com/ https://intellipedia.intelink.gov/wiki/Antivenom_Resources

The criteria for administering antivenin include neurotoxicity, spontaneous systemic bleeding, incoagulable blood (20MWBCT), cardiovascular instability, extensive swelling, rapidly progressive swelling, and bites on fingers or toes.²³ Antivenin is not FDA approved for use unless waiver authority has been granted through command medical channels and procedures are followed to administer the antivenin under IND protocols. In the event of a suspected envenomation, there are a series of administrative and clinical steps to facilitate care of the patient (Table 4). Many of these steps should occur

Table 4 Snakebite Management Guidelines

- Notify evacuation authority.
- Notify medical chain of command.
- Move all suspected envenomation patients to a level of care capable of resuscitation/antivenin administration, if indicated.
- Immobilize entire patient and splint affected limb. Do NOT apply a tourniquet.
- If snake has been killed, transport with patient but DO NOT seek snake for identification. Be aware that a dead snake is still venomous.
- Initiate cardiopulmonary monitoring and appropriate documentation (serial vital signs, mental status/ Glasgow Coma Scale score, and clinical signs of envenomation).
- Airway management per standard protocols. Please note that antivenin is unlikely to reverse respiratory paralysis in neurotoxic envenomations, so aggressive airway management should be considered early regardless of the availability of antivenin.
- Initiate two large-bore IV lines (IO access if unable to obtain IV).
- Pain management with acetaminophen or opioids (do not administer NSAIDs).
- Prepare adjunctive measures for antivenin administration.
 - o Advanced airway management (endotracheal intubation equipment, LMA, cricothyroidotomy kit)
 - o IVF (NS or LR)
 - o Epinephrine (or other vasopressor as clinical situation dictates)
 - Patient with cardiopulmonary compromise may not respond to IM injection of epinephrine and IV epinephrine may be necessary. 1mg of 1:1000 epinephrine can be diluted in 9mL of NS to make 1:10,000 solution for IV use. Central line is preferred, but proximal large-bore IV access can be used if emergent.
 - o Antihistamine – diphenhydramine 25–50mg or equivalent
 - o Antipyretic – acetaminophen or equivalent
 - o Corticosteroid – Solumedrol 125mg IV or equivalent
- Be aware that resuscitation can lead to increased circulation of venom from previously underperfused tissue and appropriate supportive care precautions should be applied.
- When laboratory services are available, draw pertinent laboratory studies
 - o CBC, electrolytes, glucose, renal function, liver enzymes, urinalysis, type and cross, fibrinogen, fibrin degradation products, creatinine kinase, PT/PTT (consider cardiac enzymes if significant cardiopulmonary compromise)
- Fasciotomy is rarely indicated for snake envenomation. Every effort should be made to document an elevated compartment pressure before deciding to perform a fasciotomy.
- Empiric antibiotics are not indicated for snakebites.

(continues)

Table 4 Cont.

- The decision to administer antivenin is a clinical decision and should be based on evidence of severe or systemic symptoms.
 - o Sensitivity testing is not indicated. If antivenin is required, then the provider needs to be prepared to deal with anaphylaxis.
 - o Antivenin dosing: these guidelines refer to SAVP and Sanofi Pasteur polyvalent antivenin.
 - Antivenin should be dissolved in sterile water or diluted in isotonic solution.
 - Injection should not exceed 5mL/min.
 - Initial dose should be a minimum of 20mL. Certain species require much more antivenin and subsequent administration should be based on clinical response.
 - o Patients receiving antivenin require close monitoring and detailed documentation of clinical parameters.
 - o All patients receiving antivenin should be counseled about the likelihood of serum sickness. However, the risk of serum sickness should not be a factor in the decision to use antivenin.
- If blood products are required, they should be administered after antivenin has been given to prevent venom lysis of products.
- Clinical consultation can be obtained through toxicology.consult@us.army.mil or by contacting Poison Control +1-800-222-1212.
- The Antivenin Usage Report for the IND authorizing the use of antivenin must be completed and forwarded to appropriate command channels.

Notes: CBC, complete blood count; IM, intramuscular; IND, investigational new drug; IO, intraosseous; IV, intravenous; IVE, intravenous fluids; LMA, laryngeal mask airway; LR, lactated Ringer's solution; NS, normal saline; NSAID, nonsteroidal anti-inflammatory drug; PT, prothrombin time; PTT, partial prothrombin time; SAVP, South African Vaccine Producers.

simultaneously to expedite care. Supportive care and expeditious evacuation are the mainstay of treatment regardless of antivenin availability.

Care of the envenomated patient is extremely resource dependent and evacuation to a facility that has adequate personnel, supplies, and equipment necessary for aggressive resuscitation is critical for successful treatment. While it is tempting to stock antivenin remotely, administration of antivenin without adequate means for supportive care can be catastrophic to the patient and is not advised in the majority of the austere locations in Africa. Antivenin effectiveness for reducing morbidity and mortality extends beyond the 24-hour mark.²⁴ So even in the face of delayed transport typical in Africa, antivenin therapy should be aggressively pursued with rapid evacuation efforts for those who meet the clinical criteria for treatment. Providers supporting African operations should educate themselves on the

Figure 5 Black mamba snake.



epidemiology and clinical characteristics of the possible envenomations in their area of operation while promoting snake avoidance as the primary mitigation measure.

Summary

Being prepared to deal with the clinical challenges of Africa takes more than knowing the book solution for diagnosis and treatment of potential threats. To succeed, the SOF provider must consider how to do so in an environment where reliable evacuation, hospitalization, or logistics channels may not exist or may be deficient compared to US standards. The absence of reliable power and/or communications should be anticipated, and the SOF provider should be fully prepared to manage a patient without support for an extended period of time. The importance of prevention must be stressed to unit commanders by clearly communicating the environmental and infectious disease health risks in Africa today. Basic FHP measures should be strictly enforced. In a developed combat theater such as Afghanistan or Iraq, a sick medical patient could quickly and easily be evacuated to a well-equipped field hospital for definitive diagnosis and treatment. However, in Africa, when a hospital may be a 2-day drive away, and the road is impassable, it is a whole different ballgame. TIA.

Disclosures

The authors have nothing to disclose.

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