Original Article

Post-disaster medical rescue strategy in tropical regions

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BACKGROUND: Earthquakes, floods, droughts, storms, mudslides, landslides, and forest wild fires are serious threats to human lives and properties. The present study aimed to study the environmental characteristics and pathogenic traits, recapitulate experiences, and augment applications of medical reliefs in tropical regions.

METHODS: Analysis was made on work and projects of emergency medical rescue, based on information and data collected from 3 emergency medical rescue missions of China International Search and Rescue Team to overseas earthquakes and tsunamis aftermaths in tropical disaster regions — Indonesia-Aceh, Indonesia-Yogyakarta, and Haiti-Port au Prince.

RESULTS: Shock, infection and heat stroke were frequently encountered in addition to outbreaks of infectious diseases, skin diseases, and diarrhea during post-disaster emergency medical rescue in tropical regions.

CONCLUSIONS: High temperature, high humidity, and proliferation of microorganisms and parasites are the characteristics of tropical climate that impose strict requirements on the preparation of rescue work including selective team members suitable for a particular rescue mission and the provisioning of medical equipment and life support materials. The overseas rescue mission itself needs a scientific, efficient, simple workflow for providing efficient emergency medical assistance. Since shock and infection are major tasks in post-disaster treatment of severely injured victims in tropical regions, the prevention and diagnosis of hyperthermia, insect-borne infectious diseases, tropic skin diseases, infectious diarrhea, and pest harms of disaster victims and rescue team staff should be emphasized during the rescue operations.

KEY WORDS: Disasters; Tropical regions; Earthquake; Emergency medical rescue

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INTRODUCTION

Earthquakes, floods, droughts, storms, mudslides, landslides, and forest wild fires, are serious threats to human lives and properties. Since the severity and scale of similar calamity vary with geographical environments, the emphasis of post-disaster medical reliefs should react accordingly. Analyses and experiences gained from three medical rescues missions — 2004 Indonesia-Aceh tsunami rescue, 2006 Indonesia-Yogyakarta earthquake rescue, and 2010 Haiti-Port au Prince earthquake — taken by China International Search and Rescue Team (CISAR)

have helped to derive a set of scientific regularities, formations, and methods for medical rescue operations and the application of that for different climate and geographical regions to augment medical rescue theory and benefit inhabitants in the disaster areas.

METHODS

Disasters in tropical regions

Between December 2004 and January 2010, there were 3 large-scale earthquakes in world's tropical regions (Table 1).

Research methods

Based on information and data collected from 3 CISAR's overseas earthquake medical rescue operations in tropical regions during December 2004 to January 2010, systematical analyses, induction, and compiling of results were dependent on feedback survey of emergency rescue teams from the perspective of workflow and mission operations.

RESULTS

Rescue team staff, service duration, number of patients, and medical operations performed in 3 CISAR's tropical region medical rescue missions are shown in Table 2.

DISCUSSION

Characteristics of tropical weather

The tropics is hot year-round, with diurnal variations in temperature exceeding seasonal variations, lacking the turn of seasons like in subtropical and temperate regions.

The seasonal changes are between dry and rainy, with characteristics of high temperature, high humidity, and high precipitation in both air and environment, during rainy season in particular, which is highly conducive to the proliferation of microorganisms and parasites. In addition to dysentery, cholera and other diarrheal diseases commonly seen in Indonesian and Haiti, incidences of dengue fever, malaria and other insect-borne diseases are also frequent.

Emphasis of rescue mission preparations in tropical regions

Emphasis of rescue mission preparations

After earthquake, shortage of medical resources is considerable and supports from local governments are extremely limited. Therefore, resources must be prepared with self-sufficiency.^[1] High humidity and precipitation, severe propagation of insects and mosquito breeding, and the catastrophic destruction of the region usually result in a hazardous environment that easily leads to heat stroke, malaria, dengue fever, tropical skin

Table 1. Large-scale earthquakes in tropical regions in the year 2004-2010

Country/Region	Date	Magnitude (Richter)	Death toll	Climate
Indonesia/ Aceh	26 December, 2004	8.7	Death and missing counts over 280 000	Tropical, hot, humid, rainy
Indonesia/ Yogyakarta	27 May, 2006	6.4	Death counts 5716	Tropical, hot, humid, rainy
Haiti/ Port au Prince	13 January, 2010	7.3	Death counts over 110 000	Tropical, hot, dry, light rain

Table 2. Emergency medical operations of the three CISAR's rescue missions in tropical regions

Country/Region	Indonesia/ Aceh	Indonesia/ Yogyakarta	Haiti/ Port au Prince
Team staff	75	40	50
Medical staff	37	20	15
Duration (days)	26	17	15
Patient counts	10 402	3015	2500
Medical operations	1. Set up mobile hospital & performed operations; 2. Medical rotation (refugee camp and airport surroundings); 3. Disaster area and camp health and disease prevention; 4. Victims and team member psychological counseling; 5. Protected the health of the rescue team; 6. Restored and reconstructed 3 hospitals in disaster area; 7. Built Chinese wards in General Hospital of Aceh; 8. Trained medical personnel in disaster area; 9. Collaborated with foreign rescue teams on patient transfers.	1. Set up mobile hospital & performed operations; 2. Medical rotation (disaster region villages); 3. Disaster area and camp health and disease prevention; 4. Victims and team member psychological counseling; 5. Protected the health of the rescue team; 6. Restored and reconstructed county hospital in disaster area; 7. Built Chinese wards in county hospital; 8. Trained medical personnel in disaster area.	1. Set up mobile hospital & performed operations; 2. Medical rotation (medical camp and refugee camp); 3. Disaster area and camp health and disease prevention; 4. Victims and team member psychological counseling; 5. Protected the health of the rescue team; 6. Performed medical treatment at collapse site of United Nations Stabilization Mission in Haiti (MINUSTAH); 7. Performed international medical collaboration & joint treatments on patients with foreign rescue teams.
Diseases	Dysentery, cholera and other diarrheal diseases; Dengue fever, malaria and other insect-borne diseases; 5 cases of malaria; 27 team members showing symptoms of actinic dermatitis; 6 team members showing symptoms of tick bite and insect bite dermatitis.	6 cases of malaria.	847 cases of mild to moderate traumatic wound infection; 92 cases of mild to moderate shock; 12 cases of seriously wounded (6 cases of severe traumatic wound infection, 3 cases of general extrusion, 2 cases of acute renal failure, 1 case of severe shock).

diseases, infectious diarrhea, injury and other diseases harmful to plants and animals. Thus, CISAR formulates the preparation work into steps by order of priority to include the establishment of an emergency responding command group, followed by collection, sorting, analyzing, and compiling of information of the affected regions, with consideration of the impact of the tropical climate, selectively provisioning of medical supplies and assembling of the rescue team. Fast and thorough pre-rescue preparations are critical to perform high quality and successful emergency medical rescue operations.^[2] For example, frequent activities of the active volcano in Yogyakarta, Indonesia erupting excessive amount of dust into the air, 10 folds over the standard safety level, result in a high number of patients with asthma. Therefore, sufficient supplies of respiratory-related drugs should be prepared.^[3]

Selection of team members

Staff list of rescue team is first provided by medical and nursing departments according to rescue mission requirements, followed by joint discussion, evaluation, repetitive screening and selection of team members by all members of the standing committee of the hospital. The selection criteria are based on general qualification, professional competence not just in professionally skilled on able to perform independently but also good political quality and work attitude, mission experience, foreign language capability, and strong competence in field operations. Medical specialties cover over 20 areas such as internal medicine, dermatology, general surgery, orthopedics, and ENT. In dealing with tropical infectious diseases and skin diseases in case of Indonesian Aceh Tsunami, physicians with expertise in infectious diseases and dermatology played crucial roles in the rescue mission.

Supplies provisioning

Simulation analysis is conducted on information and data collected for the disaster region to aid the assortment of materials needed for CISAR's rescue mission. The proliferation of insects and mosquitoes and their epidemics in disaster area impose tough challenges to the rescue team in protection and treatment of victims and the risk of iatrogenic infection. Therefore, medicines and protective measures need to take into account of the risks of infectious diseases such as cholera, malaria and dengue fever. In dealing with characteristics of hot and humid tropical climate, the assortment and volume of general medicines for prevention of heat stroke, tropical

skin diseases and anti-venom tablets, water disinfection tablets, skin cleansing agents, and mosquito repellent drugs need to be increased. Whereas medical equipment is required to include compact surgical equipment, first-aid equipment and portable aid clinical test equipment. Health supplies should be primarily concentrated on orthopedic bandages, splints, plaster, and surgical kits.

Summer clothing, raincoats rubber boots, cooling products, and sunscreens should be included in the life support supplies. Because of the impetuous nature of disasters, leaving short time for preparation yet not bit relaxation in quality, and the quantity of supplies needed in life subsistence materials, medicines and medical equipment, rescue mission preparation must be executed in accordance with emergency plan, which requires the full collaboration and coordination of the entire hospital.

Procedures for overseas emergency medical rescue missions

Highly efficient scientific workflow

As an international humanitarian medical relief operation, overseas medical rescue mission has its own characteristics of requiring good coordination and collaboration between the United Nations and the local government of the disaster country. CISAR has established a set of scientific, highly efficient, and coherent workflow for medical rescue operations of ensuring the execution of the operations in a orderly and coherent fashion, laying a foundation for providing high-quality and high-level medical services.^[4]

Workflow implementation

After arriving at the disaster region, CISAR will report to the United Nations' On-Site Operations Coordination Centre (OSOCC) and the Local Emergency Management Agency (LEMA) and carries out rescue operation in accordance with unified planning, abiding by the principle of "adjoining three sources and avoiding the hazardous" (adjacent to water, road, and mission site, and avoiding any hazardous materials) to settle the camp and select appropriate place for the setup of Mobile Hospital (MH), followed by starting performing emergency medical rescue operations. CISAR has formulated a 3-stage emergency medical rescue procedure — on-site emergency operation → MH categorized treatment → hospitalization, which can provide streamline medical treatments to a large number of patients in a short period. This substantiates efforts that providing large-scale rescue operations for home and abroad at disaster regions possible.^[5] Search, rescue and medical treatment

are three-in-one operation at disaster site that requires medical team to move rapidly to the crushed site and evaluates the condition of victims for accurate diagnosis followed by prompt medical treatments. However, the disruption of transportation system, roadblocks and severe injuries often prevent victims to reach MH or other medical camps for treatments. In these events, CISAR will offer medical rotations in resolving this kind inconvenience. Water contamination and proliferation of insects and mosquitoes make health and epidemic prevention work difficult in a rather complicated environment and conditions in the aftermath of disaster. But it is necessary to provide health education, organize epidemiological surveillance and investigation, monitor food, drinking water and sanitation, block the disaster-epidemic chain, and prevent the occurrence of epidemics of infectious diseases. When victims have reported fear, anxiety, insomnia, mental disorders, trance, and other symptoms of psychological trauma, the medical rescue team must provide psychological counseling and spiritual healing for the victims. OSOCC chairs a daily coordination briefing, which provides a good medical rescue information sharing and exchange platform. CISAR has established a good collaboration relationship with other foreign rescue teams in complementary context to put effectively medical resources into good use through this platform. After OSOCC declaring the commencement of the reconstruction phase of the disaster area, the focus of the medical rescue team shifts to assist the reconstruction effort of local hospitals, re-establish the medical order and provide training of medical, nursing and emergency operations to local medical personnel.

Treatment of seriously injured victims in tropical regions

The mortality of the injured in the aftermath of disaster is mostly caused by shock and infection. Shock and infection incurred by open wound and injury under tropical climate showed different characteristics in pathological changes, injury, and clinical treatment from those of similar cases under normal climate conditions, such as early infection with severity, prolonged wound healing, and complex bacterial assortments. The trauma causes dehydration with shock, dehydration with hypovolemia, and easily leads to circulatory failure. Efforts to increase on-site treatment, early triage, priority treatment of severe injuries, early debridement, tight bandaging the wound and prevent suppurative and anaerobic infections, and early applications of anti-shock

and antibiotics and tetanus antitoxin are necessary for the wounded. All medicines and equipment should be maintained with cooling and dehumidification devices, being equipped by the rescue team during preparation, with sustainability of tropical climate conditions. During CISAR's Haiti rescue operation, MH admitted over 2500 cases, of which 847 cases had mild to moderate traumatic wound infection, 92 had mild to moderate shock, 12 had serious injuries including severe traumatic wound infection in 6 cases, crush syndrome in 3, acute renal failure in 2, and severe shock in 1. Debridement, use of antibiotics, fluid expansion and decompression therapy were applied respectively according to patient's conditions. Ten cases were discharged with a stable recovery and 2 cases were transferred to local hospitals for dialysis.^[6]

Hyperthermia prevention in tropical regions

Hyperthermia is common for rescue operations in hot and humid tropical areas, which are tense and last for long hours, and in severe cases will cause heatstroke. Comprehensive prevention measures for hyperthermia include:

- 1) Hyperthermia prevention education to increase awareness and resistance;
- 2) Applications of cooling devices and materials to improve environment health protection measures;
- 3) Reasonable work time and stress with scheduled operation shifts to reduce the possibility of overheating and increase heat dispersion and prevent fatigue;
- 4) Strengthening the management of daily routines to ensure adequate rest and sleep;
- 5) Improving nutrition, food, supply of water and salt, 10 L person/day, 20-25 g sodium chloride, 5-6 g potassium chloride;
- 6) Having health care team members to provide health monitoring to detect early hyperthermia syndrome, and apply timely cooling measures to aggressively prevent and treat complications;
- 7) Carrying sufficient hyperthermia relief medicines such as Rendan, Shi Dishui tincture, and Huoxiang Zhengqi Liquid, and soft drinks including plum, mint and other herb-makes;
- 8) Moving the diagnosed to areas with good ventilation, cool, and dry, and laying the diagnosed supine, unlock buttoned, and applying physical cooling and rehydration therapy.

Prevention of insect-borne infectious diseases

The insect-borne infectious diseases in tropical

regions include malaria, dengue fever, encephalitis, and Lyme diseases, among which malaria is the most threatening. Mosquito control and prevention are essential for the eradication of malaria and dengue fever. Control measures usually include sanitation management of camp area, eradication of weeds, rubbish, sewage, filling potholes, food hygiene, daily application of peracetic acid sterilization, spraying "mosquito-fly extinguisher" cyromazine premix to remove breeding habitats. Prevention measures include personal protection, prevention of mosquito bites, sufficient stock of mosquito-repellent incenses for each camp, long sleeve and trousers wears, bed nets, sufficient stock of anti-mosquito agents and anti-mosquito water, and applications of mosquito repellent over exposed body parts as head, neck and hands. During Indonesia Aceh rescue mission, CISAR team had no recorded insect-borne infectious diseases, whereas there were 5 of 23 cases of positive response after applying plasmodium peripheral blood smear staining of local victims, which were reported immediately to the World Health Organization.^[7]

Skin disease prevention

The climate in tropical regions is hot, humid with high precipitation, in addition, together with the presence of insects, arthropods, snakes and plants, making the environment harsh and dangerous. It is the major reason for the appearance of skin diseases. In such hot and moisture regions, the rescue operations are arduous. Rescue personnel often are exposed to water and other media with shortage in water supply, seldom laundry and wear changes and fatigue, which lower disease resistance capability and vulnerable to outburst of skin diseases. In tropical skin diseases, ringworm is the most common one, followed by suppurative skin, insect dermatitis, which can cause rotten crotch, bad feet, and bad legs and impose great harm to the physical health of rescue operatives. Therefore, during rescue operations, besides clothing with UV protection, breathable, moisture permeability and comfort, clothing with good physical properties of antibacterial (fungi), anti-odor properties are also indispensable. During the fieldwork, skin protective measures against hot sunlight, and use of anti-mosquito lotion will effectively reduce the possibility of disease onset. Taking measures such as quarantine and disinfection of clothing and supplies for infectious skin diseases, enhancing personal protection, reasonable work schedule, attrition of contact of harmful factors, and using combined medical treatment for the

infected are essential to the prevention and diagnosis of infectious skin diseases. During Indonesian Aceh rescue operation, actinic dermatitis was found in 27 rescue team members and tick bites in 6 members with complication of dermatitis, but all recovered after returning home.^[8]

Prevention of infectious diarrhea

Infectious diarrhea includes dysentery, cholera, bacterial food poisoning, and viral gastroenteritis, etc. High incidence of infectious diarrhea is the major cause of the attrition of non-professional staff of the rescue team. CISAR has been treating infectious diarrhea as the major controlled disease in the disaster area. Efficacious diagnosis has been established for cholera, dysentery, and salmonella, and effective prevention and treatment for dysentery, cholera and other common infectious diarrheal diseases. During rescue mission for Yogyakarta, Indonesia, CISAR's mobile hospital treated 6 cases of dysentery associated with severe abdominal pain syndrome, 5-9 time thin water diarrhea, and excreta detected with a large number of red blood cells. The 6 cases were scattered in different villages and were isolated cases. After use of balanced treatment with added salt and anti-infective agents, the syndrome relieved.^[9]

Prevention of injuries from detrimental animals and plants

Detrimental animals and plants such as snakes, leech, wasps, and sumac can cause damage physically and physiologically. Combined treatment of western medicine and TCM for the injuries caused by these animals and plants are encouraged. Venomous snakes in tropics threatening rescue staff include cobra, king cobra, gold ring snake, coral snake, and acutus. Treatment includes use of snakebite antidote tablets such as Shanghaisheyao, Nantongsheyao, Qunshengsheyao, Guangxisheyao 1 and anti-venoms for coral, agkistrodon, and acutus, etc.^[10] There were 23 cases of viper bites treated by CISAR during medical rotation. The treatment was described in steps by ligating the injured superior limb with tourniquet, using a scalpel to incise over wounds, repetitively squeezing the wound toward the wound center and washing with cool water to remove venom, covering the wound with a gauze soaked with medicine, and giving the patient snakebite antidote tablets, followed by hospitalization.

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