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Interventions to Control Virus Transmission during an Outbreak of Ebola Hemorrhagic Fever: Experience from Kikwit, Democratic Republic of the Congo, 1995

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On 6 May 1995, the Médecins sans Frontières (MSF) coordinator in Kinshasa, Democratic Republic of the Congo (DRC), received a request for assistance for what was believed to be a concurrent outbreak of bacillary dysentery and viral hemorrhagic fever (suspected Ebola hemorrhagic fever [EHF]) in the town of Kikwit, DRC. On 11 May, the MSF intervention team assessed Kikwit General Hospital. This initial assessment revealed a nonfunctional isolation ward for suspected EHF cases; a lack of water and electricity; no waste disposal system; and no protective gear for medical staff. The priorities set by MSF were to establish a functional isolation ward to deal with EHF and to distribute protective supplies to individuals who were involved with patient care. Before the intervention, 67 health workers contracted EHF; after the initiation of control measures, just 3 cases were reported among health staff and none among Red Cross volunteers involved in body burial.

Médecins Sans Frontières (MSF) is a nongovernmental organization that lends assistance, without discrimination and irrespective of race, religion, creed, or political affiliation, to populations in precarious situations and to victims of disasters and conflict. The international movement is represented by 19 national sections. Each section functions autonomously, but coordination is achieved through a single international council. The Belgian section of MSF has been implementing health projects in several districts in the Democratic Republic of the Congo (DRC) since 1985. On 6 May 1995, the MSF coordinator in Kinshasa, DRC, received a request for assistance from a physician at a private voluntary organization with which MSF was collaborating. The physician requested help for what was believed to be a concurrent outbreak of bacillary dysentery and viral hemorrhagic fever in the town of Kikwit, DRC.

Herein, we describe some of the common problems encountered in the African health care setting, certain aspects of the international response to those problems, and the MSF approach to assessing and setting up adequate health infrastructures during a medical emergency.

The Initial Situation

Kikwit is a town with an estimated 200,000 inhabitants and two hospitals (Kikwit General Hospital and Kikwit II Hospital). The in-country coordinator of ongoing MSF projects was notified as early as 6 May 1995 of an ongoing disease outbreak, which had not been diagnosed etiologically, in Kikwit. Following MSF's initial

contacts with health authorities in Kikwit, mention was made of an unusually high number of cases of "bloody diarrhea," suspected by some to be bacillary dysentery, and some cases suspected to be viral hemorrhagic fever, possibly due to Ebola (EBO) virus. The decision was made on 8 May to send a team from Europe to Kikwit to set up an emergency intervention. As a result of this decision, shipments of medicines, medical equipment, water, and sanitation equipment were prepared in Brussels and sent to Kikwit. The content of this shipment was determined by the hypothesized absence of any barrier-nursing supplies in the hospitals and health centers and the need for an adequate supply of water and disinfectant to deal with an outbreak of an infectious disease likely to be transmitted through contact with fomites. Some of these supplies were standardized kits and some were special purchases that were made because of the possibility of an EBO hemorrhagic fever (EHF) outbreak (table 1).

The diagnosis of EHF was confirmed by the Centers for Disease Control and Prevention (CDC) in Atlanta on 10 May. On 11 May, an MSF intervention team—1 physician, 1 sanitation expert, and 1 logistician—arrived in Kikwit from Brussels. At that time, 76 suspected cases of EHF had been identified, of which 57 had died.

Most patients suspected of having EHF were hospitalized in pavilion 3 of Kikwit General Hospital. Although this ward had been earmarked as an isolation ward for the treatment of suspected EBO cases, it was not physically isolated from the rest of the hospital and not clearly identifiable as a special isolation unit. The majority of patients were lying on the floor of the ward, and family members walked in and out. Bodies were lying unburied in the hospital, and used needles and other contaminated equipment were scattered about. The staff (1 physician and 3 nurses), who had volunteered to care for the patients, were working without adequate protection. Under these conditions, the risk of becoming infected for both health care providers and family members was judged to be extremely high. Furthermore, the staff had not received salaries for months, the hospital was without running water or electricity, and no functional waste disposal system or latrines existed.

Kikwit II Hospital and all other health care facilities in the town had been closed temporarily from 8 May onward in order to limit transmission and concentrate all patients in the same location. Some deceased persons who were suspected of having had EBO

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Table 1. Content of initial shipment sent to Kikwit, Democratic Republic of the Congo, 1995, by Médecins sans Frontières for the implementation of an intervention to reduce Ebola hemorrhagic fever transmission.

Description	Quantity
Dispensary tent, 27.5 m ²	6
Camp installation module	2
Logistic materiel module (module 001)	1
Cholera administrative module (module 001)	1
Disinfection module (module 001)	1
Tool kit, small project	1
Water chlorination and control kit	1
2-m ³ water bladder kit	3
Distribution ramp module	1
3.3-kVa diesel generator kit	1
Module for lighting, 1300 W	1
Camp beds, dispensary	30
Surgical aprons, rubber	100
Surgical caps, nondisposable	100
Disposable plastic aprons	50
PCM2000 orange fluid-shield protection masks, high filtration	1200
Disposable blouses, nonwoven, long sleeved	100
Disposable surgical masks	1000
Nondisposable surgical trousers	100
Body bags, white	200
Plastic 100-L garbage bags	100
Plastic goggles	50
Rubber kitchen gloves, large	100
Nondisposable surgical gowns, long sleeved	100
Disposable protection gloves, latex, large	5000
Disposable surgical latex gloves, size 8	1000
Disposable surgical latex gloves, size 7	1000
Rubber boots, size 41	40
Rubber boots, size 42	40
Rubber boots, size 44	40
Protection socks	200
Jerrycan, 20 L	20
Sprayer, 12 L	6
Cresol 50%, soapy solution	100
Food ration, 1 day	1000
22-L coolbox and 24 ice packs	2
Mat for dispensary tent	6

were reportedly lying unburied in town. No formal surveillance system had been set up; an appropriate case definition was in the process of being established by experts. An information and communication campaign about the outbreak had been initiated in Kikwit on 8 May.

A committee of national and international experts, the International Scientific and Technical Committee, was in charge of patient care and surveillance.

The MSF Intervention

Relying on previous MSF experience in outbreak control and the needs assessment, the MSF team decided to reinforce the surveillance system and to limit the risk of virus transmission inside health facilities and at the household level.

The prospects for control of the outbreak in this urban setting seemed impossible if all patients could not be drawn to one loca-

tion, where care could be provided under the best available conditions in order to limit the risk of transmission. The stigmatization of patients and families and the collapse of the hospital system were already leading to possible EBO cases being hidden in homes without any precautions taken to prevent infection of family members and frustrating attempts to assess the progress of the epidemic. The transformation of pavilion 3 of Kikwit General Hospital into an effective isolation ward was considered a top priority.

The team organized an isolation ward divided into three areas (figure 1). The existing brick building (the infected area), with a 20-bed capacity, accommodated the patients. Four tents were erected in order to create a "clean area" for the health staff and a neutral area for family members. As is customary in most African hospitals, meals and much of the day-to-day patient care were provided by relatives. An independent chlorinated water supply, a waste disposal system, showers, and latrines were set up for each area. The water supply was guaranteed through a system of water cisterns that were filled from the hospital's regular water supply system. This water supply had been restored when MSF paid for 18 barrels of fuel to operate the generators pumping water into the town's canal system. The clean area and the neutral area were mainly used for rest and changing clothes. Individuals going from one area to the other had to wade through a tray filled with disinfectant (Pedi-Luve or foot bath). The material used had been developed, adapted, and tested by MSF during previous emergency interventions [1]. The organization of the isolation ward remained the same throughout the outbreak.

Calcium hypochlorite 70% was the main disinfectant used. Three solutions of different concentrations were prepared each day: the 0.02% solution for disinfection of hands; the 0.2% solution for disinfection of floors, clothing, noninfected latrines, and the foot bath; and the 2% solution for disinfection of the latrines used by the patients and for safe body burial (the body was sprayed with the solution before being transferred into a body bag, which was sprayed after closure).

A shortage of individual-protection equipment had been anticipated, and a first shipment arrived in Kikwit (from Brussels via Kinshasa) the day after the arrival of the MSF team. The equipment consisted of disposable nonsterile and sterile gloves; surgical masks of different types (cotton, disposable single layer, disposable with HEPA filter); long-sleeved cotton surgical blouses; cotton surgical trousers; long, plastic aprons; rubber boots; rubber kitchen gloves; plastic goggles; and body bags. This protective equipment was distributed to the hospital staff and Red Cross volunteers in charge of body burial. During the first 10 days of the intervention, 99% of the protective equipment that was distributed in Kikwit was flown in by MSF. Overall equipment needs were high during the outbreak. The MSF contribution was joined by large amounts of equipment and drugs from other international agencies. MSF's contribution (through its donors) in equipment totaled 5342 kg and was worth US\$47,200.

Groups of persons were identified according to their estimated risk of infection so that the supplies could be allocated in a rational way. Risk was estimated on the assumption that certain persons were at higher risk of infection because of their work site and the type of activity they performed (e.g., body burial was considered more dangerous than interviewing a household). We worked with CDC staff in Kikwit to establish standard lists of equipment to be used by each individual (table 2). Using this list, equipment was distributed to the staff working in the isolation ward, the family

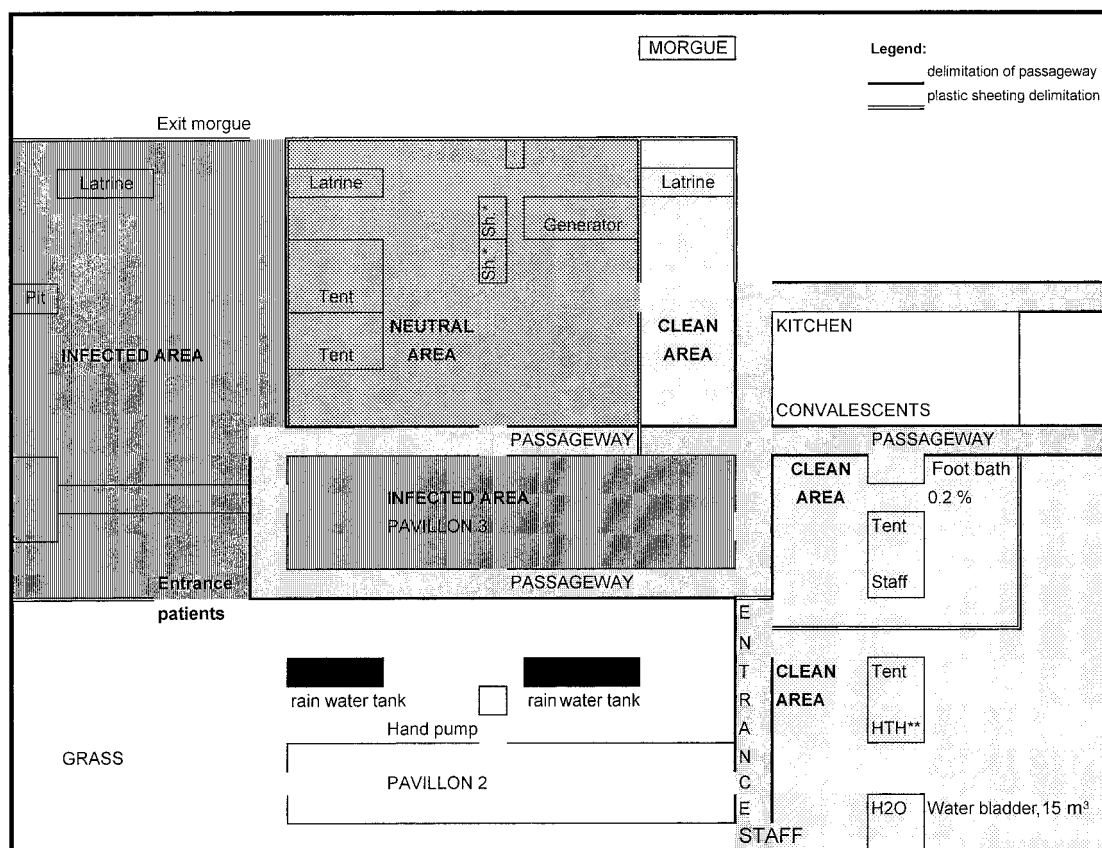


Figure 1. Layout of isolation ward for care of Ebola hemorrhagic fever patients, Kikwit General Hospital, Kikwit, Democratic Republic of the Congo, 1995. Sh.* denotes shower; **HTH denotes calcium hypochlorite.

members staying with the patients, and the staff of the emergency ward. The Red Cross volunteers in charge of body burial were provided with full protective equipment, body bags, and technical advice on safe burial practices.

Once the equipment was disbursed, it was necessary to establish confidence in the local hospital staff and to train them. This was initially accomplished largely by 2 CDC physicians, who cleaned and rehabilitated the ward and provided hands-on examples to the hospital staff. It is important to note that for the first time, it was shown that EBO patients can be cared for safely if protective gear is available and used properly [2].

MSF staff continued to manage the logistics of the hospital and other health facilities until 8 August. The maintenance of electrical power, disbursal of equipment, provision of drugs, preparation of disinfectant, disposal of medical waste, and other tasks were essential to continuing safe operation of the isolation ward.

On 20 May, the International Scientific and Technical Committee decided to reopen Kikwit II Hospital in order to attend surgical, obstetric, and other non-EBO emergency cases. Indeed, in a town the size of Kikwit, the number of deaths due to such untreated emergencies soon might have outnumbered the deaths due to EHF. MSF worked with other international organizations in the reorganization of the surgical ward of this hospital. The ward was set up, through provision of water and distribution of disposable medical supplies and protective equipment, to ensure the use of safe nursing techniques in dealing with non-EHF patients.

The emergency ward of Kikwit General Hospital and Kikwit II Hospital and 12 sentinel health centers were reopened in Kikwit and its surrounding areas to improve surveillance and triage of suspected EBO patients to the isolation ward and to provide emergency care for other medical emergencies. These facilities also received disinfectant, waste-disposal containers, and protective equipment (table 2).

Households identified through the active surveillance system as being at risk of infection or who refused to bring suspected EBO cases to the hospital were provided with a "household kit," which contained a plastic basin, a water container, rubber kitchen gloves, disposable surgical masks, and chloramine tablets for water disinfection. The contents of the household kit were determined by taking into account the fact that relatives of a suspected case were unlikely to use invasive procedures in dealing with the patient and that they needed supplies simple enough to use (e.g., kitchen gloves vs. surgical gloves) to guarantee effective use.

Training sessions on the proper use of protective equipment and disinfectants were necessary for the staff working in these sites and for the Red Cross volunteers who were involved in body burial. The sessions were organized by the international committee.

Participation in the surveillance system in the health centers also provided an opportunity to review the health workers' knowledge of the case definition and consistent use of the registration and reporting tools. Suspected cases were referred to Kikwit General Hospital and reported to the International Scientific and Technical Committee.

Table 2. Distribution scheme for protective equipment initially used in care of patients with Ebola hemorrhagic fever, Kikwit, Democratic Republic of the Congo, 1995.

Individuals involved with	Isolation ward			Burial	Emergency ward	Health center	Home visitor	Home health care giver
	Isolation	Cleaning	“Garde malade”*					
Protective equipment								
Plastic goggles	X	X	X	X				
Surgical mask with HEPA filter	X	X	X	X				
Disposable surgical mask					X	X	X	
Disposable gloves	X	X	X	X	X	X		
Surgical cap	X	X		X				
Long-sleeved surgical blouse (cotton)	X	X	X	X	X	X		
Surgical trousers (cotton)	X	X		X				
Long plastic aprons (multiple use)	X	X	X	X	X			
Rubber boots		X		X				
Rubber kitchen gloves		X		X				X
Burial								
Body bags				X		X		
Disinfectant and other material								
Hypochlorite		X		X	X	X		
Chloramine tablets			X			X		X
Jerrycan, 20 L						X		X
Plastic basin						X		X
Soap		X		X	X	X		X
Plastic container (100 L) with tap		X				X		
Sprayer		X		X				

* Relative taking care of patient.

Discussion

At the beginning of the MSF intervention, the high risk of virus transmission to patient care providers was well recognized and corroborated by the high number of care providers who contracted the disease [3]; however, the exact mechanism of transmission was not known. Close contact was considered to be contact with blood, feces, vomitus, or any other body fluid. Different groups were ranked from lowest to highest likelihood of infectious state. The medical and paramedical staff was considered to have the lowest likelihood of being infectious, and suspected EHF cases and relatives taking care of patients, respectively, were considered to have the highest and the intermediate likelihoods, respectively, of being infectious. MSF worked on the principle that the more these 3 population groups could be separated, the more the risk of virus transmission through contact with body fluids could be reduced. Considering the high infectiousness of the EBO virus, it seemed mandatory to isolate suspected EHF patients completely from patients with other illnesses. The question arose as to whether to keep these two units at the same site or in two physically separate sites. Keeping the units separate allowed for a better control of the flow of patients and their families. However, it may have created confusion among the general population, which had to make a decision where to go in case of illness.

An important issue was the lack of use of aseptic-nursing techniques during surgical and obstetrical care and patient care in general, especially during the care of EBO cases. A direct consequence of this was the high transmission of EBO virus in health care facilities. Health staff needed the necessary protective equipment and antiseptics, and they needed to be trained in correct

barrier-nursing techniques. However, an emergency situation is not the ideal setting to solve such a structural problem. A field manual appropriate for the African health care setting has been developed and may provide a means to train staff before another epidemic and upgrade the level of routine nursing protection [4].

Although not directly in charge of either patient care or body burial, MSF initially provided the staff involved in these activities with financial incentives. It was considered impossible to expect someone to work without appropriate remuneration, especially when exposed to such high risks. With remuneration, reliable teams of health care workers who were motivated to carry out the jobs assigned to them were established. The amounts paid were within the range of what was usually paid in DRC.

The MSF intervention probably contributed to the reduction of transmission of EBO virus. An indirect way to measure this is to look at the second-generation infections among individuals involved in patient care or in body burial. Before 12 May 1995, 67 health workers had been infected, of which 47 died. After the start of the distribution of the protective equipment and the organization of the isolation ward on 12 May, just 3 cases of EHF were reported among staff, and none were reported among Red Cross volunteers involved in body burial [5].

The delegation of decision-making to the field level, the speed of reaction, and the creativity and collaboration may have played an essential role in the effectiveness of the intervention. MSF organization is directed at maintaining these elements through several means. For example, its director must have solid field experience to maintain timely knowledge of field conditions. MSF has formed an “emergency pool,” consisting of several medical and nonmedical professionals with a minimum of 3 years of field experience.

rience and with experience in emergency interventions, to be sent out in such types of emergencies. Between the alert and the initiation of the distribution of protective equipment, only 6 days elapsed. Since no guidelines on the control of an EHF outbreak existed, the decision on the actions to be taken were based on the initial assessment, knowledge of the EBO virus, previous MSF experience in outbreak control, and information on what was already done by other partners of the international committee. Assumptions had to be made (e.g., the sensitivity of the virus to a common disinfectant, such as chlorine, or the effectiveness of the protective equipment that was flown in).

Conclusions

Key elements in the control of an EHF outbreak are the organization of an adequate isolation unit for suspected cases and the use of proper barrier-nursing techniques, using protective equipment in adequate quantities.

A major issue arising from this experience is the difficulty in controlling any severe disease outbreak in an area where the health care system is impaired and not functioning properly. The lack of correct barrier-nursing techniques in health facilities played a major role in disease transmission and was mainly due to the inadequate supply of disposable medical material and protective equipment and the chronic underpayment of medical staff. Under such conditions, the proper isolation of patients and the protection of health care staff are difficult to implement, and any emergency intervention has little or no sustainable impact on these aspects.

If an outbreak of viral hemorrhagic fever occurs in a populated or urban area, two types of in-patient referral facilities will have to function in parallel: One facility would provide care for the suspected EHF cases, and the other would provide general, especially surgical, emergency care. It is important that the latter is also equipped with an adequate water supply, a waste-disposal system, and protective equipment. Whether these two facilities function in the same location or not probably has to be decided on a case-by-case basis.

If the MSF intervention contributed to the control of the outbreak, it could not have happened without the collaboration and exchange of expertise, between the national and international members united in the International Scientific and Technical Committee in Kikwit.

Acknowledgments

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