SUPPLEMENT ARTICLE

Use of Protective Gear and the Occurrence of Occupational Marburg Hemorrhagic Fever in Health Workers from Watsa Health Zone, Democratic Republic of the Congo

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Background. Occupational transmission to health workers (HWs) has been a typical feature of Marburg hemorrhagic fever (MHF) outbreaks. The goal of this study was to identify cases of occupational MHF in HWs from Durba and Watsa, Democratic Republic of the Congo; to assess levels of exposure and protection; and to explore reasons for inconsistent use of protective gear.

Methods. A serosurvey of 48 HWs who cared for patients with MHF was performed. In addition, HWs were given a questionnaire on types of exposure, use of protective gear, and symptoms after contact. Informal and in-depth interviews with HWs were also performed.

Results. We found 1 HW who was seropositive for MHF, in addition to 5 cases of occupational MHF known beforehand; 4 infections had occurred after the introduction of infection control. HWs protected themselves better during invasive procedures (injections, venipuncture, and surgery) than during noninvasive procedures, but the overall level of protection in the hospital remained insufficient, particularly outside of isolation wards. The reasons for inconsistent use of protective gear included insufficient availability of the gear, adherence to traditional explanatory models of the origin of disease, and peer bonding with sick colleagues.

Conclusions. Infection control must not focus too exclusively on the establishment of isolation wards but should aim at improving overall hospital hygiene. Training of HWs should allow them to voice and discuss their doubts and prepare them for the peculiarities of caring for ill colleagues.

Between October 1998 and September 2000, a major Marburg hemorrhagic fever (MHF) outbreak occurred in Durba and Watsa, northeastern Democratic Republic of the Congo (DRC). Repeated introductions of Marburg virus (MARV) from the unknown animal reservoir are thought to have occurred in the Gorumbwa gold mine. Numerous primary cases occurred among illegal gold miners, who transmitted MARV to family members and health workers (HWs) [1, 2].

Until May 1999, HWs in Durba and Watsa had worked with hardly any protection, because the economic crisis and armed conflict in eastern DRC had left health services with insufficient supplies. This resulted in 2 cases of occupational MHF in HWs, including in the *médecin chef* of Watsa Health Zone (HZ) [3]. After his death, outbreak control started, in early May 1999 [1]. Two isolation wards in Durba and Watsa were established; HWs were trained in the clinical diagnosis and management of MHF, including barrier nursing; and supplies were provided for isolation wards [4, 5]. The outbreak investigation in May 1999 included a serosurvey of 103 HWs; all serum samples were neg-

Potential conflicts of interest: none reported.

Presented in part: Filoviruses: Recent Advances and Future Challenges, International Centre for Infectious Diseases Symposium, Winnipeg, Manitoba, Canada, 17–19 September 2006 (poster 22).

Financial support: Fonds voor Wetenschappelijk Onderzoek—Vlaanderen, Framework Agreement between the Belgian Directorate for Development Cooperation and the Institute of Tropical Medicine, Antwerp.

This article is dedicated to the health workers of Watsa Health Zone who risked their lives responding to the Marburg hemorrhagic fever outbreak.

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The Journal of Infectious Diseases 2007; 196:S168–75

0022-1899/2007/19610S2-0009$15.00
DOI: 10.1086/520540

ative for Marburg IgG [2]. Until September 2000, Durba and Watsa were visited repeatedly by experts from the World Health Organization (WHO) and Médecins Sans Frontières (MSF), who reinforced training and replenished stocks of protective gear.

Between May 1999 and September 2000, 3 more cases of occupational MHF occurred in HWs [1]. On the basis of the assumption that difficulties in supplying protective material and in maintaining appropriate hospital hygiene could have resulted in further cases of occupational MHF, we conducted another HW serosurvey in 2001–2002 and explored the use of protective gear and reasons for any inconsistent use.

METHODS

Most patients with MHF were known through surveillance initiated in May 1999 and our own investigations [6]. We targeted HWs who had had a professional contact with a patient with MHF or with his or her body fluids. This patient had to have laboratory-confirmed MHF (positive results of polymerase chain reaction, antigen-capture ELISA, or virus isolation), or, if laboratory confirmation was not performed, the patient had to be epidemiologically linked to a confirmed case (i.e., the patient had to fulfill the MHF clinical case definition and report physical contact with a laboratory-confirmed case within 3 days to 3 weeks before onset of symptoms, while no attempt at laboratory confirmation had been undertaken). HWs who had contact only with suspected cases were ineligible.

Heads of health facilities provided lists of HWs who had treated patients with MHF. We approached these HWs unless we were prevented from doing so by distance or lack of security. After giving informed consent, HWs were asked which patients with MHF they had treated, to differentiate contacts before and after the outbreak response began, and they were asked whether they had given noninvasive (e.g., taking temperatures, blood pressure, nursing) or invasive (e.g., injections, venipuncture, surgery) care. For each type of activity, we asked whether gloves or full protective gear (FPG; gum boots, scrub suit, gown, apron, mask, goggles, headwear, and 2 pairs of gloves) had always, sometimes, or never been used, as well as whether patients had started vomiting, having diarrhea, or bleeding when the activity was performed. Scores for glove use, FPG use, and overall protection were computed (table 1). We asked whether HWs had experienced symptoms corresponding to the clinical case definition (table 2) in the 4 weeks after contact.

We collected 5–10 mL of venous blood, let the blood clot for ~12 h, extracted serum, and kept it at 4°C until arrival at the National Institute for Communicable Diseases, Johannesburg, South Africa. ELISA [7] (with antigen derived from MARV Musoke) and indirect immunofluorescence assay [8] (with antigen prepared by the National Institute for Communicable Diseases) were used to detect IgG antibodies as markers for earlier MARV infection. Given their undefined specificity, both test results had to be positive for serum to be considered positive for anti-Marburg IgG.

Interview and serological data were double entered, validated using Epi Info (version 6.04; Centers for Disease Control and Prevention), and analyzed with STATA (version 9.0; StataCorp), using 2-sided Fisher exact tests for differences in proportions.

We estimated the frequency of occupational MHF, using as the denominator the duration of the outbreak (7 vs. 16 months), the number of all patients with MHF in the zone (80 vs. 77 patients [1, 2, 6]), or the number of patients with MHF seeking health care (56 vs. 47 patients [M.B., unpublished data]), before and after the introduction of barrier nursing. Because most cases of MHF before the introduction of barrier nursing were ascertained retrospectively, the denominators included suspected cases.

To explore the circumstances of transmission and the reasons for inconsistent use of gloves and FPG, we had informal discussions with study participants and 2 in-depth interviews with key HW informants, both of whom were significantly involved in MHF surveillance and clinical care of patients with MHF. The interviews were recorded and analyzed manually.

This study was approved by the ethics committee of the Institute for Tropical Medicine in Antwerp, Belgium, and by the local representative of the Ministry of Health in Watsa.

RESULTS

Study participants. Sixty-three HWs were listed as having treated patients with MHF; 4 of them had died of confirmed MHF, and 1 (Mr. C; see the Appendix, which appears only in the online edition of the *Journal*) had survived confirmed MHF but was unavailable for interview. The whereabouts of 3 HWs were unknown, but they were reported to have survived the outbreak. Five HWs now worked outside of Watsa HZ; distance or lack of security prevented us from contacting them. All 8 absentees had reportedly not had typical MHF symptoms. Of the 50 interviewed HWs, 2 were excluded from analysis because they lacked direct contact with a patient with MHF. Our study population, therefore, included 48 (84%) of the 57 eligible HWs, including 2 HWs from outside of Watsa HZ.

Distributions of sex, age, workplace, and profession are reported in table 3. Six HWs had been assigned to an isolation ward during the outbreak; the others had treated patients with MHF before isolation wards were established or afterward but outside of isolation wards (either before MHF had been diagnosed or after diagnosis but before referral to an isolation ward).

Exposure and protection. In total, 96% of the participants had provided noninvasive health care, and 83% had provided invasive health care (table 1). Approximately 90% of these activities were performed on patients experiencing diarrhea, vom-

Table 1. Health worker (HW) ($N = 48$) contacts of patients with Marburg hemorrhagic fever (MHF): level of protection by type of occupational activity.

Activity	Total	Use of gloves				Use of FPG				Protection score, mean (% of maximum)[b]
		Never	Sometimes	Always	Score, mean (% of maximum)[a]	Never	Sometimes	Always	Score, mean (% of maximum)[a]	
Noninvasive[c]										
Nursing, no. (%) of HWs	27 (56)	18 (67)	3 (11)	6 (22)	0.56 (28)	19 (70)	3 (11)	5 (19)	0.48 (24)	1.04 (26)
Take temperature, no. (%) of HWs	35 (73)	16 (46)	11 (31)	8 (23)	0.77 (39)	22 (63)	8 (23)	5 (14)	0.51 (26)	1.29 (32)
Measure BP, no. (%) of HWs	30 (63)	14 (47)	9 (30)	7 (23)	0.77 (38)	17 (57)	7 (23)	6 (20)	0.63 (32)	1.40 (35)
Other noninvasive, no. (%) of HWs[d]	10 (21)	5 (50)	0 (0)	5 (50)	1.00 (50)	6 (60)	1 (10)	3 (30)	0.70 (35)	1.70 (43)
Any noninvasive, no. (%) of activities	102 (100)	53 (52)	23 (23)	26 (25)	0.74 (37)	64 (63)	19 (19)	19 (19)	0.56 (28)	1.29 (32)
Invasive[e]										
Intramuscular injection, no. (%) of HWs	31 (65)	15 (48)	6 (19)	10 (32)	0.84 (42)	19 (61)	4 (13)	8 (26)	0.65 (32)	1.48 (37)
Venipuncture, no. (%) of HWs	35 (73)	15 (43)	8 (23)	12 (34)	0.91 (46)	21 (60)	5 (14)	9 (26)	0.66 (33)	1.57 (39)
Surgery, delivery, no. (%) of HWs	5 (10)	0 (0)	1 (20)	4 (80)	1.80 (90)	4 (80)	0 (0)	1 (20)	0.40 (20)	2.20 (55)
Other invasive, no. (%) of HWs[f]	6 (13)	2 (33)	0 (0)	4 (67)	1.33 (67)	2 (33)	0 (0)	4 (67)	1.33 (67)	2.67 (67)
Any invasive, no. (%) of activities	77 (100)	32 (42)	15 (19)	30 (39)	0.97 (49)	46 (60)	9 (12)	22 (29)	0.69 (34)	1.66 (42)
Overall (noninvasive and invasive), no. (%) of activities	179 (100)	85 (47)	38 (21)	56 (31)	0.84 (42)	110 (61)	28 (16)	41 (23)	0.61 (31)	1.45 (36)

NOTE. BP, blood pressure; FPG, full protective gear.

[a] Score for use of gloves or FPG: 0, never; 1, sometimes; 2, always.

[b] Protection score: 0, never gloves (hence never FPG); 1, sometimes gloves, never FPG; 2, sometimes gloves, sometimes FPG *or* always gloves, never FPG; 3, always gloves, sometimes FPG; 4 (maximum), always FPG (hence always gloves).

[c] A total of 46 HWs (96%) reported having performed a noninvasive procedure.

[d] Wash dead body (3), touch dead body (3), disinfect dead body/body bag (2), clean rooms/items on isolation ward (2).

[e] A total of 40 HWs (83%) reported having performed an invasive procedure.

[f] Skin biopsy (4), cardiac puncture (2), lumbar puncture (1), examine blood slide (1). More than 1 "other invasive exposure" was possible per study participant.

Table 2. Symptoms experienced by seronegative health workers (HWs) in the 4 weeks after exposure to Marburg hemorrhagic fever (MHF) and symptoms and laboratory results in health workers with confirmed cases of MHF.

Symptom or result	Seronegative HWs, no. (%)	HWs with confirmed MHF					
		Dr. A[a]	Ms. B[b]	Mr. C[b]	Ms. D[a]	Mr. E[a]	Mr. F[a]
Fever	9 (19)	+	+	+	+	+	+
General symptoms							
Headache	13 (28)	+	−	+	+	+	+
Fatigue	12 (26)	+	−	+	+	+	+
Loss of appetite	8 (17)	+	−	+	+	+	−
Joint or muscle pain	8 (17)	+	−	+	+	+	+
Back pain	8 (17)	−	−	−	+	+	−
Abdominal pain	7 (15)	+	−	−	−	+	−
Chest pain	4 (9)	−	−	−	+	−	−
Cough	NI	−	−	−	+	−	−
Nausea, vomiting	5 (11)	+	−	−	+	−	+
Diarrhea	4 (9)	−	−	−	−	+	+
Dyspnea	3 (6)	+	−	+	+	−	−
Sore throat	2 (4)	+	−	−	+	+	−
Hiccough	1 (2)	+	−	+	−	−	−
Conjunctivitis		+	−	+	−	−	+
Any general symptom	20 (43)	+	−	+	+	+	+
Hemorrhage							
Bleeding gums	NI	+	−	−	+	−	−
Nosebleed	0 (0)	+	−	−	−	−	−
Petechiae	NI	+	−	−	−	−	−
Bloody/black stool	0 (0)	+	−	−	−	+	+
Coughing blood	1 (2)	−	−	−	+	−	−
Bloody vomit	1 (2)	+	−	+	−	−	+
Hematuria	NI	−	−	−	−	−	−
Vaginal bleeding	0 (0)	NA	−	NA	−	NA	NA
Any hemorrhage	1 (2)	+	−	+	+	+	+
Combinations							
Fever plus ⩾3 general symptoms	8 (17)	+	−	+	+	+	+
Fever plus hemorrhage	0 (0)	+	−	+	+	+	+
Clinically suspected case[c]	8 (17)	+	−	+	+	+	+
Total	47 (100)						
Laboratory results							
Antigen capture ELISA	…	+	ND	+	ND	ND	ND
PCR	…	+	ND	+	ND	ND	ND
Virus isolation	…	+	ND	+	ND	ND	ND
IgM ELISA	…	−	ND	+	ND	ND	ND
IgG ELISA	…	−	+	+	ND	ND	ND
Immunohistochemical analysis (skin)	…	ND	ND	ND	ND	+	+

NOTE. NA, not applicable; ND, not done; NI, no information available; PCR, polymerase chain reaction.

[a] Died.

[b] Survived.

[c] Fever plus ⩾3 general symptoms *or* fever plus hemorrhage.

iting, and/or bleeding. HWs reported consistent glove use for 31% of activities and consistent FPG use for 23% of activities (table 1). The proportion of activities always performed using gloves or FPG for invasive versus noninvasive activities was 39% versus 25% ($P = .073$) and 29% versus 19% ($P = .15$), respectively. Scores as a percentage of the maximum score for glove and FPG use were higher for invasive activities than for noninvasive activities (49% vs. 37% and 34% vs. 28%, respectively).

The timing of exposure in relation to the launch of the outbreak response could be determined unambiguously for 59% of HWs from Watsa HZ: 6 reported exposure only before

Table 3. Characteristics of study participants.

Characteristic	No. (%)
Age, median (range), years	34 (23–62)
Sex, male	34 (71)
Workplace during MHF outbreak	
Watsa General Hospital	20 (42)
Watsa Okimo Hospital (except isolation ward)	8 (17)
Watsa Okimo Hospital isolation ward	2 (4)
Watsa central office/surveillance	1 (2)
Durba Referral Health Centre (except isolation ward)	8 (17)
Durba isolation ward	4 (8)
Other health centers in Watsa HZ	3 (6)
Subtotal, Watsa HZ	46 (96)
Outside of Watsa HZ	2 (4)
Profession	
Nurse	34 (71)
Laboratory technician	5 (10)
Midwife, birth attendant	4 (8)
Hygienist	3 (6)
Surgeon	1 (2)
Physician	1 (2)
Total	48

NOTE. Data are no. (%) of study participants, unless otherwise indicated. HZ, health zone; MHF, Marburg hemorrhagic fever.

the launch and 21 only after the launch, and 19 reported exposure during both periods. The frequency of invasive activities remained unchanged, but consistent glove use increased significantly, from 0% to 23% of all activities ($P = .03$) (table 4). The score for glove use (as a percentage of the maximum score) rose from 6% to 39%, but care was still provided to patients with MHF without ever using gloves (45%) or FPG (68%).

Of 6 HWs assigned to isolation wards, 2 treated patients with MHF only after the introduction of barrier nursing. None of them reported consistent use of gloves and FPG.

Circumstances of transmission of MARV to HWs. One HW (Ms. B) was seropositive, and all other participants were seronegative, including 4 whose serum samples had low IFA titers (1:8–1:16) unconfirmed by ELISA; no samples had both positive ELISA results and negative IFA results. Eight HWs (17%) reported fever plus at least 3 general symptoms and had conditions that fulfilled the clinical case definition of MHF; nobody reported fever plus hemorrhage (table 2). Adding Ms. B (who reported only fever) to the previously identified cases gives a total of 6 HWs with occupational MHF (for detailed symptoms and laboratory results, see table 2; for details of exposure, see the Appendix). All had direct contact with patients with MHF, and 4 had contact with their blood. Five did not use gloves, 1 used gloves inconsistently, and none used FPG. Two cases occurred before barrier nursing was introduced, and 3 HWs acquired occupational MHF outside the isolation wards; these 5 infections were transmitted from patients who were not yet suspected to have MHF. The sixth HW acquired occupational MHF in the isolation ward, refusing to use protective gear when caring for a relative.

The frequency of occupational MHF among HWs before and after the launch of disease control, calculated using the 3 denominators described in Methods, was as follows: per year, $2/7 \times 12 = 3.4$ cases versus $4/16 \times 12 = 3.0$ cases; per 100 patients with MHF, $2/80 \times 100 = 2.5$ cases versus $4/77 \times 100 = 5.2$ cases; and per 100 health care–seeking patients with MHF, $2/56 \times 100 = 3.6$ cases versus $4/47 \times 100 = 8.5$ cases. These differences were not statistically significant, suggesting that the frequency of occupational MHF remained, at best, unchanged by the introduction of barrier nursing.

HWs became victims of the MHF outbreak even if they were spared from transmission of the virus. After the death of Dr. A, 2 HWs were accused of poisoning him (see the Appendix for details).

Reasons for not using gloves and FPG. Interviewees reported that glove use was rare before the introduction of barrier nursing. After the introduction, protective gear was available in principle, with stocks being replenished by visiting WHO or MSF teams. However, temporary shortages of single-use items, including gloves, allegedly occurred. This protective material was meant to be used in isolation wards, and supplies outside of the isolation wards were reported to be insufficient for systematic infection control. According to our interviewees, training focused on the use of protective gear when treating patients with suspected MHF in isolation wards; universal precautions when caring for any patients were less well covered. The key informants reported that the "limited awareness of the need to protect oneself when treating patients not suspected to suffer from MHF, and the limited availability of gloves on the surgical ward may have contributed to the transmission of MARV to nurses E and F" (see the Appendix).

We found that HWs sometimes chose not to use FPG, despite having awareness of the risks. One of our key informants, Dr. Z, reported that he embraced Dr. A at an advanced stage of his disease, without any protective gear. Although the exact nature of Dr. A's disease was unknown to them at that time, both suspected human-to-human transmission and were aware of the high case fatality. Dr. Z usually took precautions to protect himself but, on this occasion, took the risk, "feeling compelled to make this gesture of encouragement and solidarity for a colleague and close friend." He added that physicians in remote areas are few and far between and, therefore, form a family. The other key informant, Mr. Y, who was very experienced in handling patients with MHF, reported that, when his colleague Mr. F became ill with MHF, he felt "it would be too cruel to use FPG, as this would have signaled Mr. F that there was little hope for survival." Our informant "did not have the heart" to wear FPG and treated Mr. F without protection.

Table 4. Health worker contacts from Watsa Health Zone: use of gloves or full protective gear (FPG), by type of occupational activity and period of exposure.

Period, activity	Activities, no.	Use of gloves				Use of FPG				Protection score, mean (% of maximum)[b]
		No. (%)			Score, mean (% of maximum)[a]	No. (%)			Score, mean (% of maximum)[a]	
		Never	Sometimes	Always		Never	Sometimes	Always		
Only before introduction of BN										
Noninvasive	12	11 (92)	1 (8)	0 (0)	0.08 (4)	12 (100)	0 (0)	0 (0)	0.00 (0)	0.08 (2)
Invasive	6	5 (83)	1 (17)	0 (0)	0.17 (8)	6 (100)	0 (0)	0 (0)	0.00 (0)	0.17 (4)
Any activity	18	16 (89)	2 (11)	0 (0)	0.11 (6)	18 (100)	0 (0)	0 (0)	0.00 (0)	0.11 (3)
Only after introduction of BN										
Noninvasive	34	17 (50)	10 (29)	7 (21)	0.71 (35)	23 (68)	8 (24)	3 (9)	0.41 (21)	1.12 (28)
Invasive	26	10 (38)	9 (35)	7 (27)	0.88 (44)	18 (69)	4 (15)	4 (15)	0.46 (23)	1.35 (34)
Any activity	60	27 (45)	19 (32)	14 (23)	0.78 (39)	41 (68)	12 (20)	7 (12)	0.43 (22)	1.22 (30)

NOTE. BN, barrier nursing.

[a] Maximum score, 2.

[b] Protection score: 0, never gloves (hence never FPG); 1, sometimes gloves, never FPG; 2, sometimes gloves, sometimes FPG *or* always gloves, never FPG; 3, always gloves, sometimes FPG; 4 (maximum), always FPG (hence always gloves).

No transmission of MARV occurred on either occasion. Both informants underlined that, in general, patients do not like HWs to wear gloves and sometimes take offense, as if the use of gloves suggests that the patient is dirty.

The key informants declared that HWs may not use FPG because they do not fully accept the biomedical explanatory model of human-to-human transmission of a pathogen but remain attracted to the traditional model of deliberate poisoning; they suggested that the failure to clarify the etiology of the 1994 MHF outbreak in time may have reinforced this attitude. HWs were reported to reason that "as not everybody with a high level of exposure became infected there must be something else to it than transmission by contact." It was suggested that this may explain why Ms. D, despite warnings, refused to use FPG when caring for her relative or for her remains. Her medical background notwithstanding, Ms. D behaved like family members of other patients with MHF, who could not be prevented from embracing their loved ones or performing traditional burial rites without protection.

Interviewees emphasized the history of similar, albeit smaller, outbreaks in the area. The local population, including local HWs, had become used to this recurrent phenomenon, coining the term "*Syndrome de Durba*"; this habituation reportedly reduced levels of concern and fear. The sociopolitical environment was also put forward as an explanation. Watsa and Durba had seen years of economic decline and insecurity and witnessed a gold rush with an influx of risk-taking *orpailleurs*. MHF was not necessarily the most important of the many risks people had to live with, and "HWs allowed themselves to be influenced by the prevailing risk-taking mentality" (Dr. Z).

Finally, the key informants made the point that a protracted outbreak requires continuous nosocomial infection control, which would necessitate a sustained change of behavior ingrained by routine for many years—a challenge in any setting.

DISCUSSION

One year after the MHF outbreak in Watsa and Durba, we conducted a survey of HWs who had treated patients with MHF. This delay may have reduced the accuracy of the reporting of exposures and protection, and we lost some statistical power by no longer being able to establish the precise timing of exposure for some HWs. Nevertheless, the finding of grossly insufficient levels of protection is clearly valid. It was corroborated by interviewing experienced and insightful key informants, who also provided possible reasons for nonuse of protective material.

In Durba and Watsa, 6 occupational MHF cases in HWs occurred in 1998–2000, and 3 occurred in 1994 [1]. This corroborates the observation that multiple cases among HWs are characteristic of filoviral hemorrhagic fever outbreaks in Africa whenever there is a formal health system at the epidemic site. We found serological evidence for past MARV infection in 1 HW, who reported only mild fever after the putative exposure. This is consistent with earlier findings that mild or asymptomatic MHF cases are rare [6]. Interestingly, this HW had a previous negative IgG test result 18 days after the putative exposure; the mildness of her disease and the delayed detectable IgG response may both have been due to a small infectious dose. Many seronegative HWs reported symptoms fulfilling the MHF case definition, which underlines the difficulty in diagnosing early MHF on clinical grounds alone and the importance of swift laboratory confirmation. The ranking of symptoms was

almost the same as in seronegative community contacts [6], but symptoms were less frequent in HWs.

Hospital hygiene and the use of protective gear were insufficient in Watsa and Durba, despite improvement compared with the period before disease control was in place. Glove use should have been universal. Universal FPG use cannot be realistically expected outside of isolation wards—but, then again, this calls into question the impact of barrier nursing on overall biosafety for HWs. The frequent use of invasive techniques, including IM injections, further suggests the absence of a comprehensive infection control strategy.

However, HWs used resources rationally: they used gloves and FPG more frequently for invasive than for noninvasive procedures. Given the need for protective material outside of the isolation wards, they bent the donor-imposed rules and employed multiple-use material in the operating theater.

None of the 6 cases of occupational MHF occurred in HWs who used FPG at the time of exposure. Although the availability of protective material was inadequate before May 1999, stocks were later sufficient to cover the isolation wards' needs; all items were still available in 2001 (S.M., unpublished data). Outside of the isolation wards, the availability of protective material did not fundamentally improve. HWs, confronted with an unexpected hemorrhage, were therefore tempted to handle the problem without appropriate protection. Not surprisingly, we found no evidence that the frequency of occupational MHF in HWs decreased after the introduction of barrier nursing. In this setting, the availability of postexposure prophylaxis, which should be given within a half hour after exposure [9], would have made no difference either: the 6 HWs who became infected did not realize their exposure before the onset of symptoms. For these 6 "health-care workers in an outbreak of Marburg virus or Ebola virus," the advent of postexposure prophylaxis was not really "good news" [10, p. 1374].

Our results underline the importance of not focusing too narrowly on barrier nursing in isolation wards, which should be only 1 element of a wider strategy for infection control in health facilities. The clinical diagnosis of filoviral hemorrhagic fever can be difficult in the first days of disease; unsuspecting HWs may not protect themselves sufficiently if universal precautions are not firmly established in their daily routine. General precautions (including the use of gloves, hand disinfection, and sharps management) need to be reinforced everywhere, alternatives to invasive therapies need to be established where possible, and a filoviral hemorrhagic fever screening mechanism needs to be set up at hospital entry. This task is logistically challenging and resource intensive, and conditions in Watsa and Durba were not conducive to implementing it. The task also suffered from the absence of a single protagonist with overall responsibility. As in past outbreaks, field epidemiology was carried out by the WHO, the Centers for Disease Control and Prevention, and others, and isolation wards were established by MSF. Nosocomial infection control outside of isolation wards was, at least in Watsa, "no man's land." The MHF outbreak in Uige, Angola, in 2005 may have changed this for the good: nosocomial transmission of MARV fueled the outbreak to such an extent that MSF took responsibility for infection control in the whole hospital, and nosocomial transmission was brought to an end [11]. Furthermore, the challenge for protracted outbreaks like the one in Watsa is not only to introduce but to maintain high standards of hospital hygiene. Innovative, more energizing training methods—for example, drills—could be tried as a complement to standard supervision approaches.

However, a lack of resources or awareness does not fully explain the nonuse of protective gear. We identified 2 main reasons why HWs elected not to use available protective gear despite better knowledge or explicit warnings: peer bonding and traditional explanations.

HWs are part of the local community and may share popular or traditional beliefs, like the explanatory model of "deliberate poisoning," particularly if they have received little formal education. The accusation that 2 HWs poisoned Dr. A was even followed by health authorities seeking their imprisonment. This illustrates how modern and traditional belief systems coexist. Trainers should address doubts about the biomedical model, and its acceptance by HWs should not be taken for granted.

HWs were more inclined to take risks when the patients with MHF were HWs themselves. Rules may be bent in an open, controlled way, without increased risk; violated because of an impulse to peer bond with increased risk to the HW (Dr. Z and Mr. Y above); and broken in acts of resistance to hospitalization (see the Appendix for examples). Peer bonding among HWs may be particularly pronounced when they enjoy a high social status, distancing them from other community members, and when they work in remote settings, fostering preparedness to support each other in coping. The open definition of "family" may even further promote peer bonding. Because care for peers with filoviral hemorrhagic fever appears to constitute a particular occupational hazard, training should specifically address this emotional challenge.

Although we certainly have not exhausted this topic in the present article, we have demonstrated that providing knowledge and materials may not suffice to make HWs use protective gear with the rigor necessary for filoviral hemorrhagic fever outbreaks. HWs need to be prepared and supported beyond this.

Acknowledgments

We thank the authorities of Watsa Health Zone, who supported our study; the participating health workers, for their commitment and trust; Julius Lutwama (Uganda Virus Research Institute), for temporarily storing the samples and facilitating their shipment to Johannesburg; Robert Swa-

nepoel and his team (National Institute for Infectious Diseases, Sandringham, South Africa), for performing the laboratory tests on blood samples; Heinz Feldmann and the anonymous reviewers, for helpful comments on an earlier draft of this article; and Sara Thomas, for proofreading the final draft.

Supplement sponsorship. This article was published as part of a supplement entitled "Filoviruses: Recent Advances and Future Challenges," sponsored by the Public Health Agency of Canada, the National Institutes of Health, the Canadian Institutes of Health Research, Cangene, CUH2A, Smith Carter, Hemisphere Engineering, Crucell, and the International Centre for Infectious Diseases.

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Dovato
dolutegravir/lamivudine

EVIDENCE SUPPORTS THE HIGH BARRIER TO RESISTANCE OF DOVATO UP TO 5 YEARS[1-3]

CONFIDENCE IN DOVATO ACROSS TREATMENT SETTINGS[4–9]

Treatment-naïve resistance rates, with up to **3 years of evidence**[5–7]

0% (n=0/1,885)*[,4]
REAL-WORLD EVIDENCE

0.1% (n=1/953)**[,†,‡,§,5–7]
RANDOMISED CONTROLLED TRIALS

Treatment-experienced resistance rates, with up to **5 years of evidence**[1–3]

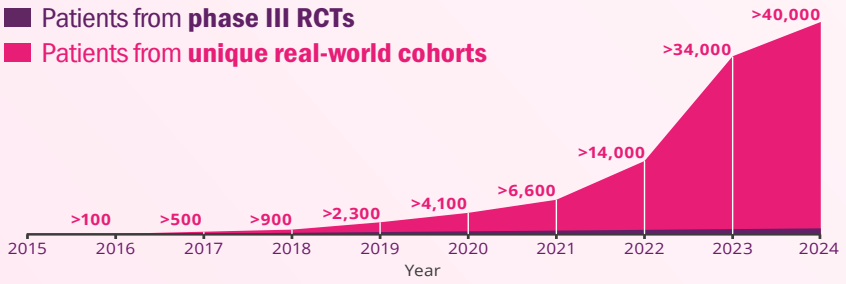
0.03% (n=10/35,888)*[,4]
REAL-WORLD EVIDENCE

0% (n=0/615)[||,¶,#,8,9]
RANDOMISED CONTROLLED TRIALS

>300,000 PEOPLE LIVING WITH HIV HAVE BEEN TREATED WITH DOVATO GLOBALLY[10]

DOVATO is supported by a wealth of evidence, with the outcomes of **>40,000** people living with HIV captured within clinical trials and real-world evidence, including those with:[4–9,11,12]

- **NO PRIOR TREATMENT EXPERIENCE**[13]
- **NO BASELINE RESISTANCE TESTING**[13]
- **HIGH BASELINE VIRAL LOAD** (>100,000 copies/mL and even >1M copies/mL)[6,13]
- **LOW CD4 + COUNT** (≤200 cells/mm³)[13]



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DOVATO is indicated for the treatment of Human Immunodeficiency Virus type 1 (HIV-1) infection in adults and adolescents above 12 years of age weighing at least 40 kg, with no known or suspected resistance to the integrase inhibitor class, or lamivudine.[13]

Adverse events should be reported. Reporting forms and information can be found at **https://yellowcard.mhra.gov.uk/** or search for MHRA Yellowcard in the Google Play or Apple App store. Adverse events should also be reported to GSK on 0800 221441

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ABBREVIATIONS

3TC, lamivudine; **CD4,** cluster of differentiation 4; **DTG,** dolutegravir; **FDA,** United States Food and Drug Administration; **FTC,** emtricitabine; **HIV,** human immunodeficiency virus; **ITT-E,** intention-to-treat exposed; **NRTI,** nucleoside/nucleotide reverse transcriptase inhibitor; **RCT,** randomised controlled trial; **RNA,** ribonucleic acid; **TAF,** tenofovir alafenamide fumarate; **TDF,** tenofovir disoproxil fumarate; **XTC,** emtricitabine.

FOOTNOTES

*Data extracted from a systematic literature review of DTG+3TC real-world evidence. Overlap between cohorts cannot be fully excluded.

**The reported rate reflects the sum-total of resistance cases calculated from GEMINI I and II (n=1/716, through 144 weeks), STAT (n=0/131, through 52 weeks), and D2ARLING (n=0/106, through 24 weeks).[5–7]

†GEMINI I and II are two identical 148-week, phase III, randomised, double-blind, multicentre, parallel-group, non-inferiority, controlled clinical trials testing the efficacy of DTG/3TC in treatment-naïve patients. Participants with screening HIV-1 RNA ≤500,000 copies/mL were randomised 1:1 to once-daily DTG/3TC (n=716, pooled) or DTG + TDF/FTC (n=717, pooled). The primary endpoint of each GEMINI study was the proportion of participants with plasma HIV-1 RNA <50 copies/mL at Week 48 (ITT-E population, snapshot algorithm).[13]

‡STAT is a phase IIIb, open-label, 48-week, single-arm pilot study evaluating the feasibility, efficacy, and safety of DTG/3TC in 131 newly diagnosed HIV-1 infected adults as a first line regimen. The primary endpoint was the proportion of participants with plasma HIV-1 RNA <50 copies/mL at Week 24.[6]

§D2ARLING is a randomised, open-label, phase IV study designed to assess the efficacy and safety of DTG/3TC in treatment-naïve people with HIV with no available baseline HIV-1 resistance testing. Participants were randomised in a 1:1 ratio to receive DTG/3TC (n=106) or DTG + TDF/XTC (n=108). The primary endpoint was the proportion of participants with plasma HIV-1 RNA <50 copies/mL at Week 48.[7] Results at week 24 of the study.

||The reported rate reflects the sum-total of resistance cases calculated from TANGO (n=0/369, through 196 weeks) and SALSA (n=0/246, through 48 weeks).[8,9]

¶TANGO is a randomised, open-label, trial testing the efficacy of DOVATO in virologically suppressed patients. Participants were randomised in a 1:1 ratio to receive DOVATO (n=369) or continue with TAF-containing regimens (n=372) for up to 200 weeks. At Week 148, 298 of those on TAF-based regimens switched to DOVATO. The primary efficacy endpoint was the proportion of subjects with plasma HIV-1 RNA ≥50 copies/mL (virologic non-response) as per the FDA Snapshot category at Week 48 (adjusted for randomisation stratification factor).[8,13]

#SALSA is a phase III, randomised, open-label, non-inferiority clinical trial evaluating the efficacy and safety of switching to DTG/3TC compared with continuing current antiretroviral regimens in virologically suppressed adults with HIV. Eligible participants were randomised 1:1 to switch to once-daily DTG/3TC (n=246) or continue current antiretroviral regimens (n=247). The primary endpoint was the proportion of subjects with plasma HIV-1 RNA ≥50 copies/mL at Week 48 (ITT-E population, snapshot algorithm).[9]

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PM-GBL-DLL-BNNR-240004 May 2024