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Risk Assessment for Healthcare Workers After a Sentinel Case of Rabies and Review of the Literature

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Background. After a case of rabies, healthcare workers (HCWs) had fear of contagion from the infected patient. Although transmission of rabies to HCWs has never been documented, high-risk exposures theoretically include direct contact of broken skin and/or mucosa with saliva, tears, oropharyngeal secretions, cerebrospinal fluid, and neural tissue. Urine/kidney exposure posed a concern, as our patient's renal transplant was identified as the infection source.

Methods. Our risk assessment included (1) identification of exposed HCWs; (2) notification of HCWs; (3) risk assessment using a tool from the local health department; (4) supplemental screening for urine/kidney exposure; and (5) postexposure prophylaxis (PEP) when indicated.

Results. A total of 222 HCWs including diverse hospital staff and medical trainees from university affiliates were evaluated. Risk screening was initiated within 2 hours of rabies confirmation, and 95% of HCWs were assessed within the first 8 days. There were 8 high-risk exposures related to broken skin contact or mucosal splash with the patient's secretions, and 1 person without high-risk contact sought and received PEP outside our hospital. Nine HCWs (4%) received PEP with good tolerance. Due to fear of rabies transmission, additional HCWs without direct patient contact required counseling. There have been no secondary cases after our sentinel rabies patient.

Conclusions. Rabies exposure represents a major concern for HCWs and requires rapid, comprehensive risk screening and counseling of staff and timely PEP. Given the lack of human-to-human rabies transmission from our own experience and the literature, a conservative approach seems appropriate for providing PEP to HCWs.

Keywords. rabies exposure; healthcare worker; risk assessment; rabies postexposure prophylaxis.

Rabies is extremely rare in the United States, with an estimated rate of 1–5 cases per year, and virtually always leads to fatal human infection [1]. A renal transplant recipient who was hospitalized for 23 days on our medical and intensive care units had antemortem serum and tissue results that were suspicious for rabies; this was confirmed from postmortem brain examination [2]. An extensive investigation led to the subsequent discovery that the transplant donor was the source of our sentinel patient's rabies infection and allowed for successful rabies prophylaxis for the remaining 3 transplant recipients [2].

On the basis of a 1912 report, the risk of animal-to-human transmission has been estimated at 0.1% from open wound or mucous membrane contact with saliva from rabid wolves, dogs, or cats in persons who did not receive any preventive measures [3]. Fomite transmission of rabies has not been reported [4]. Unusual nonbite transmission routes leading to human infections from rabies have included contamination of mucous membranes, aerosol exposure from spelunking or laboratory activities, transplanted organs, and improperly inactivated vaccines [5, 6]. There has been no documented human-to-human transmission of rabies,

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and only a single anecdotal report of transmission from a child to his mother in Ethiopia [7].

Transmission of rabies has been documented in cases of organ and/or tissue transplant [8]. Similar to our case, there have been 2 other reports of rabies transmission to multiple solid organ transplant recipients from single undiagnosed donors in the United States [9] and Germany [10]. However, there has been no reported transmission to healthcare workers (HCWs) during their care of patients with rabies [11]. Theoretically, high-risk exposures to HCWs include broken skin and/or mucosal contact with saliva, tears, respiratory secretions, cerebrospinal fluid, and neural tissue from a patient with rabies [12–14]. We describe our risk assessment and postexposure prophylaxis (PEP) for HCWs, and provide a comprehensive review of the literature, after a sentinel case of rabies was diagnosed at our teaching hospital.

METHODS

Plans for our risk assessment were developed in collaboration with the Maryland Department of Health and Mental Hygiene (MDHMH) and the Centers for Disease Control and Prevention (CDC) after confirmation of rabies in our patient and the discovery of the renal transplant as the source of his infection. Our assessment program included 5 steps: (1) identification of potentially exposed HCWs; (2) prompt notification of these HCWs; (3) risk assessment by staff from infection control, infectious diseases, or occupational health using an instrument provided by the MDHMH (Supplementary Data 1); (4) supplemental assessment for urine and/or kidney tissue exposure (Supplementary Data 2) before CDC guidance was given; and (5) PEP given by occupational health when indicated.

The period of potential transmission was 14 days prior to our patient's onset of symptoms to the time of his death. We used our electronic medical record to identify HCWs from different services who documented care for our sentinel patient during his outpatient visits and hospitalization on the medical ward and medical intensive care unit. During his hospitalization, the patient was on standard precautions. Staff from dietary service, facility management, and pharmacy working in these clinical areas were also considered for potential exposure. We also used information during our screening interviews to identify additional HCWs on work teams who were not documented in our electronic medical record.

Immediately after confirmation of rabies in our sentinel patient on a Friday afternoon, all hospital department chiefs were advised to notify their employees to report for risk assessments. As our teaching hospital is also staffed by trainees from 4 affiliated universities, the 4 academic program directors were advised to send all trainees who may have been exposed to our patient during their rotations at our medical center to our rabies risk screening clinic. Our rabies risk screening clinic was promptly organized and began to interview staff within 2 hours of rabies confirmation on Friday afternoon. This risk screening clinic was staffed by 4 infection control nurses and 2 infectious diseases senior staff physicians to interview and counsel exposed HCWs. Using the risk assessment instrument provided by the MDHMH (Supplementary Data 1), specific high-risk rabies exposures included direct contact with our patient's saliva, respiratory secretions, tears, cerebrospinal fluid, or laboratory specimens without personal protective equipment. Our rabies screening clinic was held for 8 consecutive days from 7 AM to 5 PM to accommodate all work tours. Remaining HCWs who did not come to the screening clinic during these first 8 days were contacted in person or by telephone for risk assessment by infectious diseases staff physicians.

When information emerged that the source of our sentinel patient's rabies was his renal transplant [2], urine and kidney tissue exposures posed additional concerns, as both urine [15] and kidney [9] have been known to harbor rabies antigen and virus. We identified HCWs at potential risk to be from the nursing, laboratory, interventional radiology, and nephrology services. Prior to receiving official guidance from the CDC regarding the transmission risk from urine and kidney tissue, we developed our own risk assessment instrument and implemented supplemental screening for urine and/or kidney tissue exposure (Supplementary Data 2).

Persons identified as having high-risk exposure(s) or concerns for transmission risks were referred to the occupational health clinic. Specific risks were readdressed with these HCWs. PEP was recommended to those with high-risk exposures and given at this medical center using rabies immune globulin and rabies vaccine on day 0, and further doses of rabies vaccine on days 3, 7, and 14 for persons not previously vaccinated and days 0 and 3 for persons previously vaccinated [16]. PEP was not recommended to those who were not at high risk. Additional extensive counseling was provided to HCWs who had fear of rabies transmission.

A literature review for 1978 through 2013 was conducted on PubMed using the terms "rabies" and "healthcare workers" or "hospital" or "prophylaxis" or "postexposure prophylaxis." Additional searches for and verification of rabies cases were made using the CDC human rabies surveillance website at http://www.cdc.gov/rabies/location/usa/surveillance/human_rabies.html.

RESULTS

Our medical center is a tertiary care teaching hospital with trainees from 4 local universities in the greater metropolitan area of Washington, District of Columbia. These trainees from our 4 academic affiliates include third- and fourth-year

Table 1. Number of Risk Assessments, Supplemental Urine/Kidney Exposure Risk, and Postexposure Prophylaxis for Healthcare Workers, by Hospital Department

Hospital Department	Risk Assessment	Urine/Kidney Risk	PEP Given
Chaplain	6	0	0
Dietary	4	0	0
Emergency department (total)	6	3	0
Administrator	1		
Health technician	1		
Physicians	4	3	
Facility management	4	0	0
Laboratory (total)	9	6	0
Technologists	6	3	
Pathologist	1	1	
Pathology residents	2	2	
Medical (total)	55	6	3
Staff physicians	19	3	
Subspecialty fellows	9	2	
Residents	19		3
Medical students	8	1	
Neurology (total)	15	0	5
EEG technician	1		
Staff physicians	4		1
Residents	4		3[a]
Medical students	6		1[b]
Nursing (total)	91	75	1
Emergency department	5	5	
Outpatient clinics	12	9	
Medical ward	62	52	
Intensive care unit	12	9	1
Pharmacy	2	0	0
Radiology (total)	15	5	0
Technicians	13	3	
Interventional radiology nurse	1	1	
Interventional radiologist	1	1	
Respiratory therapy	10	0	0
Social work	1	0	0
Surgery (total)	4	0	0
Physician's assistant	1		
Surgeons	2		
Surgical resident	1		
Total	222	95	9

Specific numbers of staff members are given in the indented sections under department headings.

Abbreviations: EEG, electroencephalography; PEP, postexposure prophylaxis.

[a] One trainee sought and received PEP outside our hospital despite no reported high-risk exposure.

[b] One trainee with high-risk exposure received his PEP outside of our medical center as he traveled outside our area.

Table 2. Summary of Staff Time for Risk Assessment After a Sentinel Case of Rabies

Service	Staff	Time, h	Role
Infection control	4 nurses	183	Identification of staff at risk
			Notification of service chiefs
			Notification of healthcare workers
			Perform risk assessments
			Participate in rabies teleconferences
Infectious diseases	3 physicians	106.25	Coordinate risk assessment efforts
			Perform risk assessments
			Counsel healthcare workers
			Participate in rabies teleconferences
Occupational health	1 physician	21.25	Counsel healthcare workers
	3 nurses	35.5	Discuss prophylaxis
			Approve prophylaxis
			Administer prophylaxis
			Maintain records and documentation
			Participate in rabies teleconferences
Total	11 staff	346	

medical students, interns, residents, and subspecialty fellows. Our own hospital staff includes approximately 2200 persons; there are an estimated 250 trainees. During his 4-day stay on the medical ward and 20-day stay in the medical intensive care unit, our patient had interactions with many HCWs from diverse services throughout the hospital.

As shown in Table 1, 222 persons provided care to our sentinel patient with confirmed rabies, and thus were potentially exposed to rabies. Of these, 167 HCWs were identified via documentation in the electronic medical record and 55 through discussions during screening interviews. All 222 underwent risk assessment using the MDHMH instrument. Of 113 persons with potential exposure to the patient's urine and/or kidney tissue, 95 reported such an exposure and had supplemental screening for these exposures, although rabies was not subsequently detected in our patient's transplanted kidney or his urine.

Screenings were conducted in person at our medical center by 4 infection control nurses, 2 infectious diseases section staff physicians, and an occupational health staff physician, who addressed all questions and concerns about personal acquisition of rabies from anxious HCWs. For HCWs not at the medical center, telephone interviews using the MDHMH instrument with extensive counseling were conducted by the 2 infectious diseases section staff physicians. Every HCW with high-risk exposure or the potential need for PEP was discussed between a senior infectious diseases physician and the occupational health physician before the final treatment decision.

Additional help in screening was provided by outside physicians administering the MDHMH risk assessment instrument for 3 medical students outside our hospital. Table 2 outlines the staff roles and time expenditure in screening, counseling, PEP administration, and coordination with local health departments and CDC, including the education and counseling provided to HCWs during their interviews. A total of 346 person-hours was expended for our efforts in risk assessment, PEP provision, and education, nearly the equivalent of 9 staff members working a 40-hour week.

As seen in Figure 1, the time course of our screening program allowed for the prompt evaluation of HCWs, as a screening clinic was set up on Friday afternoon, within 2 hours of rabies confirmation. Our response resulted in assessment and PEP of 65% of HCWs within the first 3 days and 95% within the first 8 days. Screening was completed 32 days after rabies confirmation, when a trainee notified us of his exposure.

As shown in Table 1, 9 persons received PEP, of whom 8 were considered high risk and 1 not high risk. No HCWs sustained any bites from our patient. The specific high-risk exposures included broken skin contact with patient's respiratory secretions or tears by 2 neurology trainees during their examinations; handling soiled instruments by 1 nurse with chapped hands; mucosal splashes during examination by 1 staff physician and 1 medical student; and mucosal splashes during intubation or suctioning by 3 medical residents. None of the 95 HCWs who received supplemental screening for urine and/or kidney tissue exposure reported any direct contact with the patient's samples. Seven HCWs with high-risk exposure received PEP at this medical center; another person with high-risk exposure was given PEP at another hospital, where he was stationed for an elective outside of our area. An additional person did not recall a specific high-risk exposure, but sought and received PEP outside of our hospital. Eight HCWs who were previously unvaccinated had PEP using rabies immune globulin and the 4-dose vaccine series, whereas 1 HCW who had prior vaccination required the 2-dose vaccine series. All persons reported good tolerance of PEP with none of the adverse reactions described previously with other vaccine preparations [17, 18]. There have been no secondary cases or reports of adverse effects from PEP to date, now >21 months after our sentinel patient's presentation, which is the same amount of time as our patient presented after receiving his undiagnosed infected renal transplant.

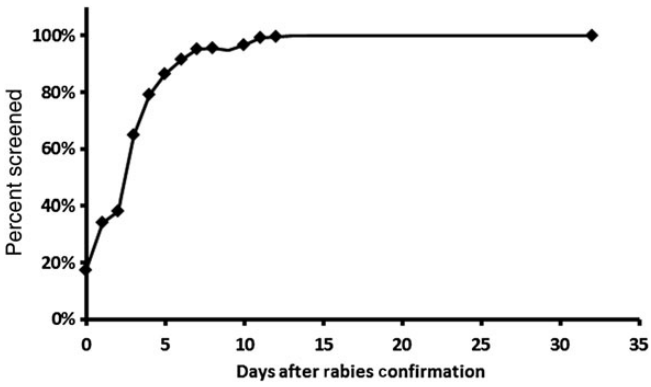

Figure 1. Time to completion of rabies risk screening for all exposed healthcare workers.

Table 3 provides a review of available information for general and HCW risk assessment and provision of PEP from the literature of rabies cases from 1978 to 2013, both in the transplant [19–27] and nontransplant [28–60; Supplementary References 61–81] settings. For nontransplant settings, if the source was known, most exposures were related to animal bite or contact, both in the United States and abroad. Data on persons assessed and given PEP were sometimes combined for the personal contacts and HCWs in the transplant [19, 25] and nontransplant [41] settings. However, numbers of total exposed persons or total HCWs assessed and given PEP were often not stated. Several reports documented that PEP was given to persons with high risk and to those with no high risk reported, in both the transplant [27] and nontransplant [29, 32, 37, 41; Supplementary References 72, 73, 76–78] settings.

DISCUSSION

After confirmation of rabies in our patient, our infection control, infectious diseases, and occupational health staff screened 222 HCWs at potential risk, and 9 of these persons received PEP. Eight persons had high-risk exposures and 1 HCW without high risk sought PEP outside our hospital. Because the specific high-risk exposures included broken skin or mucosal contact with the patient's secretions, some of these exposures were avoidable had HCWs practiced standard precautions [11] when handling bodily fluids or contaminated medical equipment or had they used personal protective equipment.

Rates of PEP after hospitalized cases of rabies have varied widely, ranging from 0% to 100% of those exposed (Table 3). During 1980–1996, the CDC reported that after potential exposure to rabies, PEP was given to a mean of 64.6 persons per case (SD, 40.8 persons per case) [51]. For HCWs, PEP is warranted after specific risk exposures and not simply after routine healthcare delivery [Supplementary Reference 62]. Early rabies consideration in the differential diagnosis, proper use of personal protective barriers with adherence to Advisory Committee on Immunization Practices guidelines during the care of the patient [50], and prompt, thorough risk assessment of exposed persons [Supplementary Reference 76] can help to avoid providing unnecessary PEP.

Table 3. Literature Review for Postexposure Prophylaxis and Healthcare Worker Exposure After Human Rabies

Reference[a]	Year of Illness	Location of Illness[b]	Exposure	Time of Diagnosis	PEP Given/All Assessed	PEP Given/HCWs Assessed
Transplant exposure						
[19]	1978	US (ID)	Cornea	Postmortem	93/unknown	
[20]						71/161 (44%)
[21]	1979	France	Cornea	Postmortem	Unknown	Unknown
[22]	1981	Thailand	2 cornea	Postmortem	Unknown	Unknown
[23]	1987	India	1 cornea	Postmortem		1/1 (100%)
			1 cornea	Antemortem		
[24]	1994	Iran	2 corneas	Antemortem		15/15 (100%)
[25, 26]	2004	US (AL, AK, OR, TX)	Kidneys + liver	Postmortem	174/917 (19%)	Unknown
[27]	2005	Germany	Cornea, lung, kidney, liver, pancreas	Antemortem		128/176 (73%)
Our case	2013	US (DC)	Kidney	Antemortem	Unknown	9/222 (4%)
Nontransplant exposure						
[28]	1981	US (OK)	Unknown	Postmortem	102/unknown	98/unknown
[29]	1981	US (AZ)	Dog in Mexico	Antemortem	41/unknown	32/unknown
[30]	1983	US (MA)	Dog in Nigeria	Antemortem	28/132 (21%)	26/unknown
[31]	1983	US (MI)	Possible bat	Antemortem		54/254 (21%)
[32]						47/209 (20%)
[33]	1984	US (TX)	Unknown	Antemortem	142/unknown	123/unknown
[34]	1984	US (PA)	Unknown	Antemortem	Unknown	Unknown
[35]	1984	US (CA)	Dog in Guatemala	Postmortem	179/unknown	
[36]	1985	US (TX)	Unknown	Postmortem		85/140 (61%)
[37]	1987	US (CA)	Unknown	Postmortem	87/unknown	75/177 (42%)
[38]	1989	US (OR)	Unknown	Postmortem	9/unknown	2/unknown
[39]	1990	US (TX)	Bat	Postmortem	67/100 (67%)	
[40]	1992	US (CA)	Dog in India	Antemortem	17/unknown	14/unknown
[41]	1992	France	Possible dog in Algeria	Antemortem	143/unknown	unknown
[42]	1993	US (NY)	Unknown	Postmortem	55/unknown	40/unknown
[43]	1993	US (TX)	Unknown	Postmortem	58/unknown	55/110 (50%)
		US (CA)	Dog in Mexico	Antemortem	25/unknown	20/unknown
[44]	1994	US (CA)	Unknown	Postmortem	26/unknown	25/unknown
[45]	1994	US (FL)	Unknown	Postmortem	Unknown	16/unknown
[46]	1994	US (AL)	Bat	Postmortem	99/unknown	87/unknown
		US (TN)	Unknown	Antemortem	47/unknown	35/unknown
		US (TX)	Dog	Antemortem	54/unknown	38/unknown
[47]	1994	US (WV)	Bat	Antemortem	48/unknown	37/unknown
[48]	1995	US (WA)	Bat	Antemortem	72/unknown	16/unknown
[49]	1995	US (CT)	Bat	Antemortem	83/unknown	46/unknown
[50]	1995	US (CA)	Bat	Antemortem	12/unknown	1/unknown
		US (CA)	Unknown	Postmortem	76/unknown	72/unknown
[51]	1996	US (FL)	Dog	Antemortem	Unknown	4/unknown
[52]	1996	US (NH)	Dog in Nepal	Antemortem	Unknown	1/unknown
[53]	1996	US (KY)	Possible bat	Antemortem	87/unknown	82/unknown
	1996	US (MT)	Possible bat	Antemortem	26/unknown	23/unknown
[54]	1997	US (MT)	Bat	Postmortem	60/unknown	58/unknown
	1997	US (WA)	Unknown	Postmortem	55/unknown	54/unknown
[55]	1997	US (TX)	Bat	Antemortem	46/unknown	42/unknown
	1997	US (NJ)	Bat	Antemortem	50/unknown	42/unknown
[56]	1998	US (VA)	Unknown	Antemortem	48/unknown	16/unknown

Table 3 continued.

Reference[a]	Year of Illness	Location of Illness[b]	Exposure	Time of Diagnosis	PEP Given/All Assessed	PEP Given/HCWs Assessed
[57]	2000	US (CA)	Bat	Antemortem	37/unknown	33/unknown
		US (GA)	Bats	Postmortem	71/unknown	70/unknown
		US (MN)	Bat	Postmortem	20/unknown	20/unknown
		US (NY)	Dog in Ghana	Antemortem	24/unknown	23/unknown
		US (WI)	Bats	Postmortem	27/unknown	18/unknown
[58]	2002	US (CA)	Bat	Antemortem	46/unknown	28/unknown
[59]	2002	US (IA)	Unknown	Antemortem	124/unknown	71/unknown
[60]	2003	US (VA)	Raccoon	Postmortem	8/298 (2.6%)	3/173 (2%)
[61]	2003	US (CA)	Bat	Antemortem	6/44 (14%)	2/40 (5%)
[62]	2004	US (WI)	Bat	Antemortem	37/95 (39%)	5/35 (14%)
[63]	2005	US (MS)	Bat	Postmortem	55/unknown	32/79 (41%)
[64]	2006	US (TX)	Bat	Antemortem	Unknown	Unknown
[65]	2006	US (IN)	Bat	Antemortem	66/unknown	28/unknown
	2006	US (CA)	Possible dog in Philippines	Antemortem	24/64 (38%)	11/51(22%)
[66]	2007	Canada (Alberta)	Bat	Antemortem	19/unknown	16/unknown
[67]	2007	US (MN)	Bat	Antemortem	54/538 (10%)	51/524 (10%)
[18]	2008	French Guiana	Unknown	Postmortem	90/160 (56%)	48/100 (48%)
[68]	2008	US (CA)	Dog not in US	Postmortem	20/29 (69%)	4/9 (44%)
[69]	2008	US (MO)	No	Antemortem	5/unknown	1/40 2.5%)
[70]	2009	US (TX)	Bat	Antemortem	1/unknown	0 (0%)
[71]	2009	US (KY+IN)	Possible bat	Antemortem	18/159 (11%)	14/147 (10%)
[72]	2009	US (MI)	Bat	Antemortem	18/194 (9%)	6/180 (3%)
[73]	2009	US (VA)	Dog in India	Antemortem	32/174 (18%)	24/70 (34%)
[74]	2010	US (LA)	Bat in Mexico	Antemortem	95/204 (47%)	68/unknown
[75]	2010	US (WI)	Bats	Antemortem	7/unknown	5/178 (2.8%)
[76]	2011	US (NJ)	Dog in Haiti	Antemortem	14/unknown	10/246 (4%)
[77]	2011	US (CA)	Cats	Antemortem	27/208 (13%)	17/unknown
[78]	2011	US (NY)	Dog in Afghanistan	Antemortem	29/240 (12%)	9/unknown
[79]	2011	Italy	Dog in India	Antemortem	1/unknown	0/unknown
[80]	2011	US (SC)	Bats	Antemortem	22/188 (12%)	18/unknown
[81]	2012	UAE Switzerland	Bat in US (CA)	Antemortem	23/59 (39%)	15/36 (42%)

The reference, year and location of illness, transplant and nontransplant exposure, and time of rabies diagnosis are provided. The location of illness is given as the country (state/province) where the patient had clinical manifestations of rabies. Numbers of all persons given PEP and total assessed, as well as numbers of HCWs given PEP and total HCWs assessed, are given, as reported. PEP rates are calculated as percentages (%), if both number of those given PEP and those assessed are given.

Abbreviations: HCW, healthcare worker; PEP, postexposure prophylaxis; UAE, United Arab Emirates; US, United States.

[a] References [61–81] can be found in the Supplementary Data.

[b] US states: AK, Alaska; AL, Alabama; AZ, Arizona; CA, California; CT, Connecticut; DC, District of Columbia; FL, Florida; GA, Georgia; IA, Iowa; ID, Idaho; IN, Indiana; KY, Kentucky; LA, Louisiana; MA, Massachusetts; MI, Michigan; MN, Minnesota; MO, Missouri; MS, Mississippi; MT, Montana; NH, New Hampshire; NJ, New Jersey; NY, New York; OK, Oklahoma; OR, Oregon; PA, Pennsylvania; SC, South Carolina; TN, Tennessee; TX, Texas; VA, Virginia; WA, Washington; WI, Wisconsin; WV, West Virginia.

In our hospital, 4% of our screened HCWs received PEP. Our rate was relatively low compared with provision of PEP to 44%–100% of HCWs in previous reports describing similar settings after transplant exposure to rabies [19–27]. As seen in the section on transplant exposures in Table 3, PEP was given to 44% of HCWs after the first corneal transplant exposure described in the United States in 1978 [20] and 73% for multiple solid organ transplants in Germany in 2005 [27]. For settings with few exposed HCWs, PEP was given to all HCWs after rabies confirmation in the transplanted corneas, such as the single surgeon who performed both operations in India [23] and all HCWs who were involved in Iran [24].

As shown in the section for nontransplant settings in Table 3 [28–60; Supplementary References 61–81], although PEP was

recommended for HCWs with high-risk exposures, some with low or no risk received PEP as well [29, 32; Supplementary References 73, 76, 77]. In a report of 2 cases from California during the same year, the provision of PEP varied greatly, with 1 HCW receiving PEP for the patient who was diagnosed antemortem, and 72 HCWs receiving PEP for the patient who was diagnosed postmortem [50]. Low rates of giving PEP at 2.6% for non-HCWs and 2% for HCWs were credited to the careful risk assessments undertaken after postmortem diagnosis of rabies from a raccoon exposure in Virginia [60]. There was a single report of preexposure prophylaxis for 3 pathologists performing the autopsy on a patient whose rabies was diagnosed antemortem [30].

Because rabies usually leads to neurologic complications and fatal infection, fear of transmission among HCWs who cared for patients with rabies may lead to excessive use of PEP [Supplementary References 82, 83] and inappropriate deviations from PEP guidelines [Supplementary References 84, 85]. In addition, decisions for PEP provision may be subjective based on perceived risk [Supplementary Reference 86]. Our relatively low rate of giving PEP likely resulted from the close collaboration of our staff with local health departments, the use of the MDHMH tool to objectively standardize our risk assessment, and compliance with PEP guidelines by the evaluating physicians. Additionally, we addressed all concerns raised by HCWs in a timely and objective manner, and provided extensive education regarding rabies transmission risks and the use of PEP for all involved HCWs.

This investigation allowed for rapid mobilization of staff from infection control, infectious diseases, and occupational health, totaling 346 person-hours from 4 physicians and 7 nurses (Table 2). Our estimated pharmacy cost of providing PEP for 7 persons at our medical center was US$4454; 2 persons received PEP outside this facility. A rapid and complete investigation with specialized dedicated staff such as ours or broad provision of PEP [27] are likely more difficult in settings outside the United States and Europe with limited personnel and resources.

In summary, after confirmation of a sentinel case of acute rabies, a coordinated effort by staff from infection control, infectious diseases, and occupational health resulted in a prompt risk assessment of all potentially exposed HCWs including trainees rotating at our teaching hospital. Our staff evaluated and counseled 222 potentially exposed HCWs to allay their fears regarding the nosocomial risk of rabies transmission. Within the first 3 days, 65% were evaluated, and within 8 days of our screening program, 95% were assessed. A total of 9 (4%) HCWs received PEP. Our relatively low rate of provision of PEP was likely due to HCWs' use of standard precautions during patient care and to the extensive education and counseling regarding rabies transmission risk to HCWs. There have been no secondary cases now >21 months after our sentinel rabies patient. Given the lack of human-to-human transmission of rabies from the literature, as well as our own experience, a conservative approach seems appropriate for determining which HCWs should receive PEP after caring for a patient with rabies.

Supplementary Data

Supplementary materials are available at *Clinical Infectious Diseases* online (http://cid.oxfordjournals.org). Supplementary materials consist of data provided by the author that are published to benefit the reader. The posted materials are not copyedited. The contents of all supplementary data are the sole responsibility of the authors. Questions or messages regarding errors should be addressed to the author.

Notes

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Disclaimer. The findings and views expressed in this report are those of the authors and do not represent the official position of the Department of Veterans Affairs.

Potential conflicts of interest. All authors: No reported conflicts.

All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

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