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Original Contribution

Perceived Vaccination Status in Ecotourists and Risks of Anthropozoonoses

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Abstract: Anthropozoonotic (human to nonhuman animal) transmission of infectious disease poses a significant threat to wildlife. A large proportion of travelers to tropical regions are not protected against vaccine-preventable illnesses, and a majority of these travelers demonstrate poor recall of actual vaccination status. Here we characterize self-perceived vaccination status among a large sample of ecotourists at the Sepilok Orangutan Rehabilitation Centre, Sabah, Malaysia. Despite their recognized travel itinerary to view endangered animals, tourists at wildlife sanctuaries are not adequately protected against vaccine-preventable illnesses. Of 633 surveys, over half reported being currently vaccinated against tuberculosis, hepatitis A, hepatitis B, polio, and measles. Fewer participants reported current vaccination status for influenza, rabies, and chickenpox. Despite the fact that the majority of visitors to Sepilok are from temperate regions where influenza is relatively more prevalent, 67.1% of those surveyed *with* medical-related occupations reported not being currently vaccinated for influenza. Ecotourists concerned about environmental protection are themselves largely unaware of their potential contribution to the spread of diseases to animals. The risks of negatively affecting animal populations must be communicated to all concerned parties, and this may begin by urging travelers to examine their actual vaccination status, particularly as the ecotourism industry continues its rapid expansion, and is seen increasingly as a possible tool to save great ape populations from extinction.

Keywords: orangutan, macaque, Sepilok, immunization, zoonoses, tourism, zoonotic infection, anthropozoonotic infection

INTRODUCTION

Human–wildlife contact can contribute to the global spread of infectious diseases (Daszak et al., 2004), which in turn can produce devastating health and economic outcomes. Ideally, ecotourism functions to facilitate awareness of cultural and natural histories in diverse environments, creating financial benefits to those local populations which invest in conservation of their cultural and natural histories. Such nature-based tourism can certainly serve as an important potential tool to assist conservation efforts in preserving populations of wildlife, particularly primates. A natural consequence of expanding tourism at wildlife tourism locations is increased human–wildlife contact.

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Unfortunately, anthropozoonotic (human to nonhuman animal) transmission of infectious disease poses a significant threat to wildlife (Daszak et al., 2000), particularly apes and other primates who are closely genetically related to humans and susceptible to common infections (Brack, 1987; Woodford et al., 2002).

Anthropozoonotic transmission between humans and wild primates has been confirmed to date in several cases. Human respiratory syncytial virus and metapneumovirus were transmitted to chimpanzees in Côte d'Ivoire (Köndgen et al., 2008). Intestinal pathogens *Giardia* and *E. coli* were also transmitted to mountain gorillas and chimpanzees, respectively, in western Uganda (Goldberg et al., 2007; Graczyk et al., 2002b). Numerous other gastrointestinal parasites and bacterial infections in wild nonhuman primates are suspected, but unproven, to be of human origins (Graczyk et al., 2002a; Nizeyi et al., 2002). Additional suspected transmission events to wild great apes include polio and pneumonia in chimpanzees (Hosaka, 1995; Kortlandt, 1996; Wallis and Lee, 1999) and measles in gorillas (Byers and Hastings, 1991). Wild primates also function as reservoirs for a number of human infections, including filariasis, yellow fever, and Chikungunya virus (Mak et al., 1982; McIntosh, 1970; Monath, 2001).

The majority of tourists that visit wildlife sanctuaries arguably underestimate their own risk of infection, as well as their potential contribution to the spread of diseases themselves. In fact, a major shortcoming of international travelers in general is their poor knowledge, attitudes, and practices about travel health (Hamer and Conner, 2004; Wilder-Smith et al., 2004). Many travelers do not utilize pretravel preventive health strategies, including physician advice and chemoprophylaxes (Crockett and Keystone, 2005; Van Herck et al., 2003). A significant proportion of travelers to tropical regions are not protected against vaccine-preventable illnesses (Lopez-Velez and Bayas, 2007; Prazuck et al., 1998; Schunk et al., 2001; Van Herck et al., 2004), and a majority of these travelers demonstrate poor recall of actual vaccination status (Falvo et al., 1996; Kollaritsch and Wiedermann, 1992; Wilder-Smith et al., 2004). Many do not understand basic risks of infection, nor are able to recognize common sources and causes (Van Herck et al., 2004; Wilder-Smith et al., 2004; Zuckerman and Steffen, 2000).

In the present study, we sought to characterize self-perceived vaccination status among a large sample of ecotourists at the Sepilok Orangutan Rehabilitation Centre located 22 km outside of the city of Sandakan in the Malaysian state of Sabah in northern Borneo (05′51.841″N, 117′57.003″E). Operated by the Sabah Wildlife Department, Sepilok was established in 1964 as a center for the rehabilitation of orphaned, injured, and/or confiscated orangutans (*Pongo pygmaeus morio*) and other endangered species. To facilitate public education and generate operational funds, the public is allowed to view two daily feedings (10 AM and 3 PM) of the free-ranging animals. In 2006, 97,367 visitors (55,889 foreign) attended these feedings (Ambu, 2007).

Methods

A brief questionnaire was distributed to tourists at the registration desk, cafeteria, and video presentation room at Sepilok. The questionnaire recorded basic demographic information, history of recent travel, recalled recent contact with livestock, domestic and wild animals, recent diagnoses and symptoms of various infections, and recalled current vaccination status for tuberculosis, influenza, hepatitis A and B, rabies, polio, measles, and chickenpox. Questionnaires were distributed to adults (≥18 years) in English and Malay only, participation was voluntary and anonymous, and no compensation was provided. This protocol was approved by the Human Subjects Committee at the University of Wisconsin–Milwaukee. Permission to conduct this project was granted by the Sabah Wildlife Department.

Statistical analyses were performed in SAS version 8.1 and included univariate and multivariable analyses using logistic regression models. The odds of reported vaccination for each of the eight diseases of interest were obtained for each demographic variable relative to its reference category; 95% confidence intervals (CI) were estimated to show the range of values consistent with reported odds ratio (OR) point estimates.

Results

During our 9-day observation, 1503 tourists viewed the animal feedings at Sepilok (mean of 167 visitors per day; range 91–205). Surveys were originally obtained from 773 of these individuals. However, 140 of these individuals did not report information regarding vaccination status (on the reverse side of the questionnaire). Thus, for presentation here, 633 surveys were utilized, representing 42.1% of all visitors during this observation. Mean age of the surveyed population was 38 years (range 18–84 years) (Table 1). The majority of participants were under the age of 50 (76.6%), and were female (55.1%). Over half of the sample listed Europe as their region of origin. The regions with the next highest representation were Australia and New Zealand (22.5%), followed by Malaysia (11.6%). Compared to travelers originating from Europe, visitors from Asia and Malaysia were less likely to report vaccination against TB, hepatitis A and B, polio, and measles. Travelers from North America compared to Europe were more likely to report influenza and hepatitis B vaccinations (Table 2).

Over half of the sample reported that they were currently vaccinated against tuberculosis, hepatitis A, hepatitis B, polio, and measles. Fewer participants reported a current vaccination status for influenza, rabies, and chickenpox. Males and females reported similar vaccination rates for all diseases except influenza, for which more males reported a current vaccination status. This is different from previous reports in which women are more likely to be vaccinated for influenza than men (Tacken et al., 2002). It is unknown why this is not the case in the present sample.

Age groups were classified by 10-year intervals. Compared to younger individuals, members of older age groups were less likely to be vaccinated against most infections. Older individuals were more likely to report being vaccinated against influenza, which is quite typical (Tacken et al., 2002).

Participants were asked to report their occupation, which was later categorized into medical or nonmedical groups for analysis. The medical category included such occupations as veterinarians, physicians, and nurses, as well as students preparing to enter these fields; 12.7% of participants were categorized as having a medical-related occupation. Those participants with a medical-related occupation were more likely to report vaccination for hepatitis A and B, and polio, compared to those with nonmedical-related occupations.

Table 1. Characteristics of survey participants

	N (%)
Number of completed surveys	633
Age, mean (range), years	38 (18–84)
Gender	
Male	284 (44.9)
Female	349 (55.1)
Occupation	
Medical	76 (12.7)
Nonmedical	524 (87.3)
Region of residence	
Africa	4 (<0.1)
Asia	38 (6.0)
Australia; New Zealand	142 (22.5)
Europe	323 (51.3)
Malaysia	73 (11.6)
Middle East	8 (1.3)
North America	42 (6.7)
Reported current vaccination status	
Tuberculosis	382 (60.5)
Influenza	173 (27.4)
Hepatitis A	442 (69.8)
Hepatitis B	400 (63.2)
Rabies	139 (22.1)
Polio	457 (72.2)
Measles	338 (53.6)
Chickenpox	252 (39.9)

Discussion

The present study demonstrates that, despite their recognized travel itinerary to view endangered animals, a significant proportion of visitors at Sepilok are not adequately protected against a number of vaccine-preventable infections. These results are consistent with the low vaccination rates found among other international travelers (Table 3). Therefore, visitors to other wildlife sanctuaries are likely under-vaccinated as well. Participants in nature-based tourism are generally concerned about environmental protection, although they appear to be largely unaware of the impacts they may directly have on animal health.

The majority of travelers are likely unaware of their true vaccination status. Frequent travelers too often perceive their vaccination status to be current, when in reality this is not the case (Hamer and Connor, 2004). Perceived immune status, as reported in surveys such as ours, is usually found to be very significantly higher than actual current immune status, as verified by reference to vaccination certificates (Toovey et al., 2004; Van Herck et al., 2004) or serological testing (Hilton et al., 1991). Whether or not travelers choose to seek and utilize pretravel health measures is determined by their personal risk assessment, including age, gender, current health, past infection exposure and perceived vaccination status, and travel specifics (location, purpose, length of stay, time of year, etc.) (Crockett and Keystone, 2005; Lopez-Velez and Bayas, 2007).

Table 2. Logistic regression analysis of demographic characteristics associated with reported vaccination status

Characteristic	Odds ratio (95% CI) of participant reporting vaccination for disease							
	Tuberculosis	Influenza	Hepatitis A	Hepatitis B	Rabies	Polio	Measles	Chickenpox
Sex: female (reference group: male)	1.10 (0.76–1.60)	0.61 (0.41–0.91)*	0.98 (0.64–1.49)	0.74 (0.51–1.07)	0.88 (0.59–1.32)	1.35 (0.88–2.05)	1.00 (0.70–1.43)	0.88 (−0.62–1.24)
Age group (10-year intervals)								
18–29 (reference group)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
30–39	1.09 (0.67–1.76)	0.75 (0.45–1.27)	0.52 (0.29–0.92)*	1.93 (0.58–1.48)	1.73 (0.46–1.16)	0.85 (0.49–1.48)	0.98 (0.63–1.53)	0.88 (0.58–1.34)
40–49	0.71 (0.39–1.29)	0.93 (0.49–1.79)	0.32 (0.16–0.64)**	0.73 (0.40–1.32)	0.26 (0.12–0.57)***	0.95 (0.46–1.94)	0.53 (0.30–0.93)*	0.61 (0.35–1.06)
50–59	0.61 (0.32–1.16)	0.78 (0.38–1.58)	0.23 (0.11–0.48)***	0.62 (0.32–1.18)	0.27 (0.12–0.64)**	0.67 (0.32–1.43)	0.35 (0.19–0.65)**	0.49 (0.26–0.92)*
60–69	0.37 (0.19–0.71)**	3.24 (1.67–6.31)***	0.25 (0.12–0.52)***	0.47 (0.25–0.89)*	0.24 (0.10–0.62)**	0.48 (0.24–0.99)*	0.23 (0.12–0.45)***	0.31 (0.15–0.62)**
≥70	0.24 (0.09–0.65)**	3.19 (1.19–8.57)*	0.13 (0.05–0.37)***	0.31 (0.12–0.80)*	[a]	0.32 (0.12–0.88)*	0.14 (0.05–0.42)***	0.31 (0.11–0.92)*
Medical-related occupation (reference group: nonmedical-related occupation)	1.46 (0.80–2.66)	1.76 (0.99–3.14)	2.93 (1.23–6.74)*	3.42 (1.70–6.88)***	1.30 (0.72–2.34)	3.67 (1.45–9.26)**	1.37 (0.79–2.38)	1.33 (0.79–2.22)
Country of residence								
Europe (reference group)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Africa	0.46 (0.05–3.94)	0.58 (0.04–7.88)	[a]	0.36 (0.04–2.96)	[a]	[a]	0.40 (0.04–4.60)	[a]
Asia	0.17 (0.08–0.36)***	1.55 (0.67–3.56)	0.16 (0.08–0.34)***	0.46 (0.23–0.95)*	0.77 (0.33–1.80)	0.15 (0.07–0.32)***	0.35 (0.17–0.74)**	0.88 (0.43–1.83)
Australia; New Zealand	0.43 (0.27–0.67)***	3.20 (1.98–5.17)***	0.55 (0.33–0.93)*	0.89 (0.56–1.42)	0.78 (0.45–1.36)	0.42 (0.25–0.70)***	1.10 (0.70–1.74)	1.32 (0.84–2.07)
Malaysia	0.12 (0.06–0.21)***	0.70 (0.31–1.56)	0.05 (0.02–0.09)***	0.20 (0.11–0.36)***	0.39 (0.18–0.83)*	0.08 (0.04–0.14)***	0.24 (0.13–0.44)***	1.10 (0.64–1.91)
Middle East	2.01 (0.24–16.74)	3.41 (0.77–15.05)	1.33 (0.15–11.43)	3.33 (0.40–27.77)	0.89 (0.17–4.67)	[a]	0.98 (0.23–4.26)	2.55 (0.59–11.03)
North America	0.55 (0.27–1.12)	3.71 (1.81–7.61)***	0.55 (0.25–1.23)	2.71 (1.08–6.80)*	1.18 (0.54–2.55)	3.66 (0.84–16.00)	1.64 (0.78–3.44)	1.55 (0.79–3.07)

[a] Category sample size not sufficient for odds ratio calculations.

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

Table 3. Vaccination status of survey respondents from past vaccine research projects

Reference	TB (%)	Influenza (%)	Hepatitis A (%)	Hepatitis B (%)	Rabies (%)	Polio (%)	Measles (%)	Chickenpox (%)
Present study	60.5	27.4	69.8	63.2	22.1	72.2	53.6	39.9
Hamer and Connor (2004)			24.0	29.0		16		
Wilder-Smith et al. (2004)			60.0	74.0				
Van Herck et al. (2004)			31.6	31.4				
Prazuck et al. (1998) (French/Northern European/Southern European)			18.3/32./8.5	31.8/26.7/15.7		64.6/65.2/28.3		
Schunk et al. (2001)			59.0			49.0		
Falvo et al. (1996)		30.1				54.7	26.3	
Kollaritsch and Wiedermann (1992)			81.2			38.7		
Zukerman and Steffen (2000)				16.9				
Toovey et al. (2004) (% presumed/% documented)	19.0/1.0	19.0/6.0	66.0/37.0	56.0/27.0	11.0/2.0	46.0/20.0		
Hilton et al. (1991) (% seronegative)						12.0	4.0	
Adams et al. (2001)	55.0	3.0	58.0			69.0	37.0	

Hamer and Connor (2004): Self-report vaccine and malaria questionnaires given to US international travelers (n = 201 vaccine questionnaires) departing from John F. Kennedy International Airport, New York, going to destinations that were high risk for malaria or hepatitis A in January 2003.

Wilder-Smith et al. (2004): Self-report vaccine or malaria questionnaires given to travelers (n = 1060 vaccine questionnaires) departing from five airports in Australasia whose travel destinations were Asia, Africa, or South America.

Van Herck et al. (2004): Self-report vaccine or malaria questionnaires given to European international travelers (n = 2779 vaccine questionnaires) departing from nine major international airports in Europe, going to destinations in developing countries from September 2002 through September 2003.

Prazuck et al. (1998): Self-report vaccine questionnaires given to French and European travelers (n = 9156) departing from Paris to 12 tropical destinations.

Schunk et al. (2001): Self-report vaccine questionnaires given to German international travelers (n = 3776) departing from Munich International Airport going to tropical or subtropical areas over a 4-month period.

Falvo et al. (1996): Self-report vaccine questionnaires given to US residents (n = 220) visiting a travelers' clinic in NY between July 1992 and March 1993.

Kollaritsch and Wiedermann (1992): Self-report vaccine and prophylactic questionnaires given to Austrian tourists (n = 2627) on their return flight from tropical destinations between November 1988 and March 1989, and between October 1989 and January 1990. Data in table limited to those travelers returning from Thailand (n = 1050).

Zuckerman and Steffen (2000): Self-report hepatitis B vaccination and risk factor surveys administered to randomly selected individuals (n = 9008) in nine European countries.

Toovey et al. (2004): Self-report and documented vaccine or malaria questionnaires given to international travelers (n = 200 vaccine questionnaires) departing from Johannesburg International Airport, going to destinations in developing countries from August through October 2003.

Hilton et al. (1991): Serologic survey of US travelers (n = 233) attending the Long Island Jewish Medical Center Travel and Immunization Center, New York, and the Travel Well Center at Crawford M. Long Hospital in Atlanta, Georgia, from July through September 1988.

Adams et al. (2001): Self-report vaccine and medical history questionnaires given to tourists (n = 62) visiting the Kibale National Park visitors center between July 1998 and November 1999, and to local villagers (n = 50) in July 1999.

Although a large number of statistical tests were performed in the present study, data are consistent with the supposition that younger individuals were more likely to be vaccinated for most infections than older individuals. But most surprising are the proportions of individuals with medical-related occupations who report lack of current vaccinations. Despite the fact that the majority of visitors to Sepilok are from temperate regions where influenza is relatively more prevalent, 67.1% of those with medical-related occupations reported not being currently vaccinated for influenza. Respiratory infections, like influenza, would arguably be the easiest to transmit while visiting these semi-wild primates at Sepilok.

At Sepilok, a multilingual information sign indicates that smoking, eating, and spitting are not allowed; that visitors should keep their distance from the animals; should not bring medications, bags, or insect repellant; and other miscellaneous information. Park rangers are present during animal feedings, and the visitor viewing area is separated from the actual feeding platforms. Despite being directed not to touch any animals, such contact does sometimes occur (Fig. 1), increasing the risks of zoonotic and anthropozoonotic infections alike. Over half of all human infections are zoonotic in origin (Cleaveland et al., 2001; Woolhouse and Gaunt, 2007), and the situation seems to be worsening from the impact of global environmental change (Daszak et al., 2001). Despite these facts, there are no foreseeable reasons to either eliminate tourism in wildlife sanctuaries or alarm tourists about the risks of traveling. Miscommunication about travel health and fear of disease from wildlife could certainly impact ecotourism in a negative manner, and this should obviously be avoided. It is therefore the combined responsibility of the tourism and medical communities to accurately communicate any risks to travelers, particularly the risks they pose to other people and wildlife by traveling while either ill and infectious, or otherwise unvaccinated for diseases they are at risk of acquiring either pretravel or in-country. Wildlife veterinarians familiar with zoonotic infections should play a key role in educating the public in addition to educating other medical professionals on the risks of anthropozoonoses. It is also the responsibility of tourists to respect local guidelines regarding proper behaviors in wildlife sanctuaries.

Figure 1. Tourists can sometimes come into direct contact with the macaques at Sepilok Orangutan Rehabilitation Centre, despite being directed not to touch the animals (see information brochure in man's hand)

Preventative measures are either in effect or have been recommended for various wildlife sanctuaries, particularly those involving apes (Adams et al., 2001; Homsy, 1999; Wallis and Lee, 1999; Woodford et al., 2002). In the Bwindi Impenetrable National Park, Uganda, visitors to the mountain gorillas are asked to follow several guidelines, including keeping a minimum distance from the animals, self-reporting illnesses, avoiding littering, smoking, eating, spitting, and nose-blowing (Homsy, 1999). Other recommendations (not requirements) for this and other sanctuaries include wearing disposable facemasks and gloves, mandatory hand washing and shoe disinfection before and after visiting the animals, medical screening of tourists and refusal of entry to visibly ill people (Adams et al., 2001; Homsy, 1999; Wallis and Lee, 1999; Woodford et al., 2002). Orangutans can be naturally infected by a number of pathogens, including Epstein-Barr virus, mumps, parainfluenza 3, respiratory syncytial virus, dengue, Japanese encephalitis, and various intestinal parasites (Kilbourn et al., 2003; Wolfe et al., 2001). Increased preventive measures may further assist in the conservation of this species, particularly the semi-wild animals at Sepilok which exhibit relatively high levels of human contact compared to their wild counterparts.

One important preventive measure may include required vaccinations. However, routine, required, and recommended vaccines vary between countries and by age and health status of the recipient. For example, the BCG vaccine for tuberculosis is not part of the 2008 recommended adult immunization schedule for the United States (Advisory Committee on Immunization Practices, 2008). Recommended vaccinations for travelers from the United

States to foreign locations vary by international destination. Current recommendations by the Centers for Disease Control and Prevention (http://wwwn.cdc.gov/travel/destinationMalaysia.aspx; accessed August 2, 2008) for healthy, adult U.S. travelers to Malaysia include routine vaccinations (polio, measles/mumps/rubella, etc.), hepatitis A and B, typhoid, and Japanese encephalitis. Specific information on these vaccines is widely available (Jong, 1998; Keystone et al., 2004; Steffen and Connor, 2005), including the internet (http://www.who.int/ith and http://www.cdc.gov/travel/contentYellowBook.aspx; accessed July 1, 2008). Unfortunately, vaccination certifications are not usually standardized between countries. It is therefore difficult to accurately ascertain current immune status for most travelers. The results of this and other surveys lend support for the recommendation of required, standardized vaccination certificates at wildlife tourism locations, particularly those involving nonhuman primates.

Public awareness of the importance of travel health may increase following recent notable emerging infectious diseases like severe acute respiratory syndrome, and the importance of vaccine use in travelers may become more realized following continued development and testing of potential avian and pandemic influenza vaccines (Kaiser, 2006). Policies should be put in place and adopted before, not after, any future outbreaks occur. Polio and measles, both vaccine-preventable diseases, have already caused high mortality in chimpanzee and gorilla populations, respectively (Byers and Hastings, 1991; Kortlandt, 1996). The risks of negatively affecting these and other endangered animal populations, including orangutans, must be better understood and communicated to all concerned parties. This may begin by urging travelers to examine their actual vaccination status, particularly as the ecotourism industry continues its rapid expansion, and is seen increasingly as a possible tool to save great ape populations from extinction.

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