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**HETA 98-0061-2687**  
**Yerkes Primate Research Center**  
**Lawrenceville, Georgia**

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**Max Kiefer, MS, CIH**  
**Scott Deitchman, MPH, MD**

## PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

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## ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Max Kiefer, of the Hazard Evaluations and Technical Assistance Branch, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS), and Scott Deitchman, of the Office of Extramural Programs. Technical assistance was provided by Tom DeMarcus, Louisa Chapman, and Stephanie Ostrowski of the Centers for Disease Control and Prevention, National Center for Infectious Diseases, and the CDC and NIOSH Offices of General Counsel. Desktop publishing was performed by Pat Lovell. Review and preparation for printing was performed by Penny Arthur.

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**Technical Assistance Report 98-0061-2687  
Yerkes Primate Center  
Lawrenceville, Georgia  
April 1998**

**Max Kiefer, MS, CIH  
Scott Deitchman, MPH, MD**

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## **SUMMARY**

On December 16, 1997, The National Institute for Occupational Safety and Health (NIOSH) received a request for technical assistance from the Atlanta East Area Office of the Occupational Safety and Health Administration (OSHA). The request asked NIOSH to assist OSHA during an investigation of an incident involving an employee of the Yerkes Regional Primate Research Center (Yerkes PRC) Field Station, in Lawrenceville, Georgia. The employee contracted *Cercopithecine herpesvirus 1* (*Herpesvirus simiae*, or B virus) from an ocular exposure to primate body fluids that occurred on October 29, 1997, while working with Rhesus Macaque monkeys at the Field Station and subsequently died on December 10, 1997.

On December 12, 1997, an animal technician working at the Yerkes PRC Main Station was splashed in the eye with an unknown fluid while moving a macaque from a cage to a transfer box. The worker was wearing a combination surgical mask/face shield at the time of the exposure. The employee reported the incident 14 days later after her eye became bloodshot and began to hurt. She was subsequently evaluated for B virus infection, but no evidence of infection was found.

On December 17, 1997, a NIOSH investigator accompanied OSHA compliance officers during their program review investigation at the Yerkes PRC Field Station. During this site visit, NIOSH conducted a limited review of policies and procedures pertaining to working with nonhuman primates (NHP) and B virus, discussed training and work practices with the Yerkes PRC Associate Director for Scientific Programs, and inspected specific areas of the facility where NHPs are handled and captured. On February 11-12, 1998, NIOSH and NCID investigators conducted a site visit to the University of California at Davis Regional Primate Center to learn about the relevant practices and policies at other primate facilities.

Follow-up site visits to the Yerkes PRC Field and Main station were not conducted because Emory University (which operates the Yerkes PRC) declined to allow NIOSH investigators access to their facility, records, and personnel. Additional information necessary to complete the NIOSH investigation was obtained by reviewing information obtained from OSHA compliance officers.

A review of Yerkes PRC animal handling procedures and health and safety guidelines provided to NIOSH indicate that the policy on eye protection was not clear. Some Yerkes PRC policies require eye protection for all personnel in direct contact with animals or animal wastes, while others specify tasks requiring eye protection, or include no eye protection requirement. A consistent program to ensure that exposures (e.g., mucosal membrane contact with

primate body fluids) are systematically recorded, tracked, and investigated did not appear to have been implemented at the time of the fatal exposure.

Existing Emory-wide safety and health training programs may not provide sufficient specific information to employees that addresses the unique safety and health concerns associated with NHPs in general and B virus specifically. The apparent contradictions in policies and unclear definition of when they apply likely resulted in inconsistent application of precautions.

Actions taken after the exposure were not consistent with the 1995 B virus working group guidelines for workers handling NHPs potentially infected with B virus. After the exposure, immediate irrigation of the eyes and consultation with medical personnel knowledgeable about the hazards of B virus and the symptoms of B virus infection did not occur. Although knowledgeable medical personnel had been previously identified by Yerkes PRC, the need to consult or notify these medical experts for occurrences of ocular exposures to primate body fluids had not been effectively communicated to all personnel. As a result, there were delays between the exposure and the employee's first time seeking medical care.

This incident is the first report of B virus infection and death resulting from an ocular exposure to macaque body fluids. The employee was not wearing protective eye wear at the time of the exposure because the activities conducted were considered to carry a low risk of exposure to B virus-containing body fluids. As such, precautions regarding eye protection were not emphasized or enforced despite published information indicating that mucous membrane exposure was a potential route of infection. Treatment immediately after the exposure, and subsequent follow-up, were not consistent with existing B virus safety guidelines.

The death of this worker from B virus contracted from an ocular splash exposure to nonhuman primate body fluid, and the subsequent ocular exposure at the PRC Main Station despite the use of a face shield, indicate that protective eye wear conforming to established standards for eye and splash protection should be part of the protective equipment ensemble worn by all personnel who come in contact with nonhuman primates.

Keywords: SIC 8733 (Noncommercial Research Organizations). Nonhuman primate, rhesus macaque, herpes B virus, Cercopithecine herpesvirus 1, Herpesvirus simiae, infection, ocular exposure.

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## INTRODUCTION

On December 16, 1997, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Atlanta East Area Office of the Occupational Safety and Health Administration (OSHA) for technical assistance during the investigation of a worker fatality at the Yerkes Regional Primate Research Center (PRC) Field Station in Lawrenceville, Georgia. The worker had sustained a splash to the eye of body fluid from an unidentified monkey on October 29, 1997, while participating in a group capture of Rhesus Macaque monkeys, and was subsequently infected with *Cercopithecine herpesvirus 1* (*Herpesvirus simiae*, or B virus). B virus is endemic in the macaque species. The worker, who was not wearing eye protection at the time of the exposure, died as a result of this infection on December 10, 1997. On December 12, 1997, an animal technician at the Yerkes PRC main station at Emory University was splashed in the eye during the transfer of a monkey; the incident was reported on December 26. The employee was wearing a combination surgical mask/face shield at the time of the incident. This worker did not become infected with B virus. The Yerkes PRC is administered by Emory University.

On December 17, 1997, a NIOSH investigator accompanied OSHA compliance officers during a site visit to the Yerkes PRC Field Station. During the site visit, information about the activities of the worker who died was obtained from Yerkes PRC personnel, a limited review of existing procedures was conducted, and the area where the exposure occurred was inspected. Emory University declined to allow NIOSH to conduct additional data gathering activities (interview workers, obtain copies of procedures, observe work practices) at the Yerkes PRC during this site visit. Emory also declined to allow NIOSH to conduct additional site visits.

On February 11-12, 1998, NIOSH investigators and a representative from the Centers for Disease Control and Prevention, National Center for Infectious Diseases (CDC-NCID), Division of Quarantine,

visited a Regional Primate Center funded by the National Institutes of Health (NIH) and operated by the University of California at Davis. The purpose of this site visit was to learn about the relevant practices and policies at other primate facilities.

## BACKGROUND

### Yerkes Regional Primate Research Center

The Yerkes Regional Primate Research Center (PRC) is part of a national network of seven primate centers funded by the National Institutes of Health (NIH); it is administered by the Emory University Woodruff Health Sciences Center, Atlanta, Georgia. There are two Yerkes PRC facilities: the Main Station, located on the Emory Campus, and the Field Station, located in Lawrenceville, Georgia. The Yerkes PRC was accredited by the American Association for the Accreditation of Laboratory Animal Care (AAALAC) in 1985. AAALAC accreditation indicates the facility adheres to the highest standards of animal care. The Institutional Animal Care and Use Committee (IACUC), required by the United States Department of Agriculture (USDA) for all institutions performing animal research, approves research protocols and inspects the facility. Health and Safety Support for the Yerkes PRC is provided by the Emory University Environmental Health and Safety Office.

### Yerkes Field Station

The Yerkes PRC Field Station was established in 1965 and is located on 117 acres of wooded and open land. Approximately 35-40 full-time employees work at the Field Station, including four veterinarians. The mission of the Field station is to provide a facility for breeding and study of large social living groups of nonhuman primates (NHP). A primary function of the Field Station is to provide a domestic supply of NHPs, and this facility allows the primate center to be self-sufficient in its primate resources. Only behavior-related research is

conducted at the Field Station, including studies of social organization, aggression, social dominance, maternal-infant relationships, and reproductive behavior. No infectious disease studies are conducted at the Field Station.

Approximately 1800 NHPs are housed at the Field Station, including 3 great ape species, 1 lesser ape species, and 5 monkey species. There are about 600 rhesus macaques, 250 pigtail macaques, and 30 stump-tail macaques at the Field Station. All of these animals were born and raised at the Field Station. The facilities at the Field Station are designed for housing and socializing, and consist of 25 outdoor compounds, the largest of which are about 15,600 ft<sup>2</sup> in size, where the colonies live. A typical macaque colony will consist of 80-100 animals. Each compound is surrounded by a 10 ft high chain link fence, with an additional solid wall extending upward approximately 10 ft above that, to prevent the animals from escaping. In addition to the animal compounds, the Field Station also has an administrative and data processing office, a veterinary hospital, isolation and quarantine facilities, food preparation and storage facilities, and a cage washing facility.

Adjacent to every compound are indoor corridors that are accessible to the NHPs. These corridors are climate conditioned and serve to provide shelter and, because the animals are nocturnal prey species, a night sleeping area. The corridors also serve as a capture and handling facility.

### **Yerkes PRC Main Station**

The Yerkes PRC Main Station is located approximately 5 miles from downtown Atlanta on 25 acres on the Emory University campus. Approximately 120 employees work at the Main Station. The Main Station consists of administrative offices, research laboratories, and medical support for research activities. Approximately 1100 monkeys and 160 great apes are housed at the Main Station.

## **B Virus Exposure at Yerkes**

On October 29, 1997, a 22 year old female researcher at the Yerkes PRC Field Station was assisting with a routine group capture of rhesus macaques in compound A-4. Personnel conducting the capture wore uniforms, disposable latex gloves, and surgical masks. Eye protection was not required by Yerkes PRC for this activity, and employees participating in this capture did not wear eye protection. During the transfer of a macaque from a transfer (or capture) cage into a squeeze cage, the worker sustained a splash to the right eye. The worker reported the onset of a foreign body sensation in her eye as she looked down at the caged macaque. The worker suspected the substance that entered her eye was monkey feces, although this could not be confirmed. The worker wiped the exposed eye and, approximately 45 minutes later, flushed the eye with tap water for two to three minutes. The incident was not formally reported, and there was no medical consultation at the time of the exposure. The cage had been used to transport many monkeys that day and the monkey in the cage at the time of exposure was returned to a larger group and was not identified. The researcher subsequently developed a B virus infection and died from associated complications on December 10, 1997.

Compound A-4 is one of the largest (15,600 ft<sup>2</sup>) compounds at the Field Station and houses approximately 90 adult and 15-20 young macaques. In addition to the worker who sustained the eye splash, 4 other persons (including a veterinarian) participated in the capture, which was conducted over a period of two days. The purpose of the capture was to conduct routine health examinations and tuberculosis tests on all animals.

According to a Yerkes PRC representative, the procedures for conducting a group capture of macaques at the Field Station have been well established and in place for approximately 25 years. When an animal handler enters the compound, the macaques are conditioned to enter the indoor corridor through small doors (approximately 2ft x 2ft) leading into an area that has been sectioned off

by a floor-to-ceiling chain link fence. When the animals are inside the corridor, a transfer cage is placed by a floor level guillotine door in the chain link fence. When the doors are opened, the animal exits the chain link compound into the transfer cage. The animals are individually captured and identified by tattoos. After capture, the transfer cage is hand carried to a squeeze cage mounted on a table 3-4 feet above the floor. The transfer cage is married to the squeeze cage, and the animal exits into the squeeze cage for the health examination. After the examination, the process is reversed and the animals exit into the compound. The animals are not sedated during this activity.

On December 12, 1997, an animal technician working at the Yerkes PRC Main Station was moving a monkey from a cage to a transfer box when she was splashed in the eye with an unknown fluid. At the time of the incident, the employee was wearing a combination surgical mask/face shield. The technician reported the incident on December 26, 1997, after her eye became bloodshot and began to hurt. Follow-up tests reportedly did not indicate a B virus infection. Specific medical information was not available to the NIOSH investigators.

## METHODS

On December 17, 1997, a NIOSH investigator accompanied OSHA during a visit to the Yerkes PRC Field Station. During this site visit, descriptive information about the Yerkes PRC Field Station was obtained, and procedures for handling NHPs, B virus specific precautions, and employee safety training were discussed with Yerkes PRC officials. A limited review of procedures and policies was conducted. The facility where the exposure resulting in the B virus infection occurred was inspected, and procedures for conducting group captures of macaques were reviewed with the Yerkes PRC Associate Director. Emory University declined to allow NIOSH to participate in employee interviews, obtain copies of pertinent procedures and policies, or observe a live group capture during this visit.

Following the initial site visit, a meeting was held on January 7, 1998, with scientists from the Centers for Disease Control and Prevention (CDC) National Center for Infectious Disease (NCID) and the CDC Office of Health and Safety (OHS), and OSHA Area and Regional Office representatives. The purpose of this meeting was to review both incidents, identify information still needed, and determine what revisions to existing guidelines might be necessary given the recent Yerkes PRC exposure(s).

On February 11-12, 1998, NIOSH investigators and a representative from the CDC-NCID, Division of Quarantine, visited an NIH-funded Regional Primate Center operated by the University of California at Davis. The purpose of this site visit was to learn about the relevant practices and policies at other primate facilities. At the request of the CDC visitors, the staff reviewed existing policies and procedures for handling macaques at these facilities, and in particular those associated with captures and those intended to protect worker from exposure to B virus and other zoonoses. The physical facility where the monkeys are housed and captured was inspected. The employee training program, and provisions for providing medical support for suspected exposures, were also reviewed.

Subsequent visits to the Yerkes PRC Field and Main station were not conducted because Emory declined to allow NIOSH investigators access to their facilities, records, or personnel. Additional information necessary to complete the NIOSH investigation was obtained by reviewing information obtained from OSHA compliance officers.

## EVALUATION CRITERIA

### General

When assessing workplace conditions where environmental evaluation criteria has not been developed or is not applicable, NIOSH field staff may utilize guidelines and recommendations developed by public health agencies or professional associations, accepted industry practice, or criteria



for safe work practices published by standard setting organizations. In some situations, workplace evaluations and recommendations may be based on “state of the art” industrial hygiene and occupational medicine concepts, principles, and practices, or by analogy to other industrial settings. Note that evaluation criteria may change over the years as new information on the toxic effects of an agent, efficacy of control systems, or safe work practices become available.

## ***Cercopithecine herpesvirus 1*** **(B virus)**

*Cercopithecine herpesvirus 1*, also known as B virus or *Herpesvirus simiae*, is a member of the herpes group of viruses. B virus frequently infects Old World primates of the genus *Macaca*, including those used in research such as rhesus, Japanese, cynomolgus, pig-tailed, and stump-tailed macaques. B virus infection in captive adult macaque populations apparently is quite common, as the seroprevalence of neutralizing antibodies to B-virus is 73% to 100%.<sup>1</sup> Like *Herpes simplex* virus infection in humans, B-virus infection in monkeys is characterized by lifelong infection with intermittent reactivation and shedding of the virus in saliva or genital secretions, particularly during periods of stress or immunosuppression.<sup>2</sup> B virus infection is transmitted among monkeys primarily through sexual activity or bites. Antibody titer to B virus indicates infection in the animal but can neither confirm nor rule out actual viral shedding at the time a human is exposed through a bite or other exposure.<sup>2</sup>

There are approximately 40 known cases of human B virus infection.<sup>2</sup> B-virus disease in humans usually results from macaque bites or scratches, contaminated needle sticks, or contact with infectious products from the macaques. Incubation periods may be as short as 2 days, but more commonly are 2 to 5 weeks. Most documented infections have occurred among biomedical research employees who had occupational exposure to macaques, although laboratory workers handling

only infected central nervous system or primary monkey kidney cell lines have been exposed and, in at least one instance, infected.<sup>3</sup> One case of person-to-person transmission has been reported. The source case was a monkey handler who apparently became infected through a bite or scratch; his wife, who applied hydrocortisone cream to his wound before his infection with B virus was recognized, was apparently infected while applying the same cream to a rash on one of her own fingers.<sup>4</sup>

## **Prevention of B virus and Other Zoonotic Infections When Working with Nonhuman Primates**

The occurrence of four cases of B virus infection in 1987 in Pensacola, Florida, resulted in the development of guidelines for preventing B virus infections in monkey handlers.<sup>5,6</sup> These guidelines, published by the CDC, provide specific information and recommendations regarding the handling of macaques, including personal protective equipment such as gloves and eye protection.<sup>6</sup> In 1990, a group of experts (B virus Working Group) was convened by the Robert W. Woodruff Health Sciences Center of Emory University and the CDC to develop guidelines for the detection and medical management of B virus infection in humans.<sup>2</sup> The recommendations from this effort were published in 1995.<sup>2</sup>

Item 3 of the CDC guidelines recommends that “all macaque monkeys not known to be free of B virus infection should be regarded as infected.” Item 4 of these guidelines recommends that macaque handlers be protected with a “face shield (or surgical mask and goggles or glasses) to prevent exposure of eyes and mucous membranes to macaque secretions.” Both the CDC and B virus Working Group guidelines also recommend that primate facilities identify a local physician, or group of physicians, knowledgeable about the infectious risks of exposure to nonhuman primates to serve on an on-call basis in the event of an exposure.<sup>2,6</sup>

In addition to B virus specific recommendations, guidelines addressing safety precautions for working with NHPs to prevent worker infection with NHP-borne viruses, tuberculosis, and other agents have been developed by the CDC.<sup>7,8,9,10</sup> Criteria for eye protection and information regarding eye and mucosal contact as potential routes of exposure are addressed in several of these published guidelines. A worker protection checklist developed in June 1990, to comply with CDC Special Permit Requirements for NHPs provides a description of the necessary elements of a program for infection-prevention, worker communication, worker training, and medical surveillance.<sup>10</sup> This guideline, provided to all NHP importers, specifies that a written infection control plan should stipulate that workers entering NHP rooms with potential exposures wear appropriate protective clothing, including face shields or other eye protection. In July 1993, CDC published interim guidelines for NHPs during quarantine.<sup>7</sup> These guidelines recommend that because of the potential for aerosol transmission of certain pathogenic bacteria and viruses, face shields or eye protection should be worn by workers whose faces may come within 5 feet of the NHPs.<sup>7</sup>

## Health and Safety in Animal Research

Although specific regulatory criteria have not been established, guidelines and recommendations for occupational safety and health programs associated with the care and use of research animals are available from a number of sources. The National Research Council has published a report prepared by the Committee on Occupational Safety and Health in Research Animal Facilities, under the auspices of the Institute of Laboratory Animal Resources.<sup>11</sup> This report provides recommendations for implementing a safety and health program in animal research facilities, includes information about B virus and NHPs, and recommends that personnel working with NHPs wear face shields and other protective garments.<sup>11</sup> The report also recommends that sharp edges on cages and ancillary equipment should be identified and eliminated.

Criteria for activities involving infectious disease work with experimental animals is described in a joint CDC-National Institutes of Health publication, *Biosafety in Microbiological and Biomedical Laboratories* (BMBL).<sup>12</sup> Recommendations in this guide include four combinations of work practices, safety equipment, and facilities, that are based on the hazard presented by the infectious agent under study. The four animal biosafety levels (ABSL 1-4) described in this document provide for increasing protections, based on the level assigned.<sup>12</sup> According to the BMBL, Biosafety Level 2 practices are recommended for tasks entailing the manipulation of tissues, body fluids, or primary tissue culture materials from macaques. More stringent Biosafety Level 3 practices are recommended when the use or manipulation of material known to contain B virus is conducted. Biosafety Level 4 criteria applies to the propagation and manipulation of production quantities of the virus.<sup>12</sup>

Most of the regulatory effort and recommendations regarding laboratory animal research address the care and well-being of the animals and research protocols.<sup>11</sup> Regulatory or research funding agencies (USDA, NIH) may not include detailed occupational safety and health criteria as part of their oversight activities.

## Personal Protective Equipment

Protective clothing and equipment is designed to shield or isolate individuals from the chemical, physical, or biological hazards that may be encountered during their work.<sup>13</sup> Personal protective equipment (PPE) is generally considered the last line of defense, and is utilized after every effort to eliminate the hazard through feasible engineering or administrative controls has been implemented. PPE places the burden of protection on the employee, and if the equipment fails, exposure could occur. PPE can be an effective control technique for occupational hazards; however, PPE effectiveness depends on proper use by the wearer.<sup>14</sup> PPE is also

appropriate in some situations as a backup in the event of an engineering control failure or for jobs of short duration. Selection of PPE appropriate for a given task should be made from assessments of the worksite hazards, which includes an evaluation of each activity. Hazard assessments require a good understanding of the work tasks, knowledge of the potential routes of exposure, the opportunities for exposure in the task assessed (nature and extent of worker contact), and the potential for adverse health outcomes if exposure were to occur. Accident and incident reports should be reviewed to identify those injuries or exposure incidents (whether or not infection occurred) that could have been prevented by the proper use of PPE. Most approaches for selecting the appropriate PPE incorporate the following process:<sup>14</sup>

1. Determination of the hazards most likely to occur
2. Assessment of the adverse effects of unprotected exposure
3. Identifying other control options that can be used instead of protective clothing
4. Determining the performance characteristics needed for protection
5. Evaluating the need for decontamination
6. Assessing any constraints that may hinder the use of PPE (ergonomics, safety, vision, dexterity)

Once it is determined that PPE is required for a task, its use should be mandatory. PPE should be individually assigned whenever possible. Written procedures should be in-place to ensure consistent selection and use of PPE. Affected users must be informed of the need for PPE, consequences of not wearing the appropriate PPE, and how to properly inspect, wear, maintain, and store the PPE. Users must also be informed of all limitations associated with the use of PPE and must be aware that the equipment does not eliminate the hazard. Finally, periodic inspections and evaluations of the PPE program should be conducted to ensure that procedures are consistently followed, to identify any process changes that may have occurred, and that the selected PPE is still appropriate for the given task.

## **Protective Eyewear**

There is a wide variety in the types of protective eyewear, and appropriate selection should be based on a number of factors, the most important of which is the nature and extent of the hazard. For example, protection against eye impact hazards generated during chipping, grinding, or masonry work may dictate a specific type of protection. For splash hazards, goggles and face shields should be used. Face shields are considered a secondary protector and are only designed to provide limited protection to the face and front part of the neck.<sup>15</sup> Face shields should always be used with suitable primary eye protection such as safety glasses or goggles. Most protective goggles and eyewear are available with an anti-fog lens option to prevent clouding in humid environments. Lens cleaning supplies and anti-fog materials should be available for employee use. Eye protection must be comfortable, allow for sufficient peripheral vision, and be adjustable to ensure a secure fit. It may be necessary to provide several different types, styles, and sizes. Protective eyewear should meet or exceed the criteria established by the American National Standard Institute (ANSI) *Standard Practice for Occupational and Educational Eye and Face Protection* (ANSI Z87.1-1989).<sup>15</sup>

## **FINDINGS**

Yerkes representatives indicated that prior to the B virus death that occurred on December 10, 1997, personal protective equipment required for conducting routine captures of NHPs included a complete uniform, disposable gloves, and a surgical mask. A “dual-focus” approach was utilized because of the concern that workers may carry infections that could harm the animals; thus, for example, surgical masks served to protect the animals from possible respiratory infections of the personnel. In the event that handling of the animal was required, heavy gloves were worn.

Yerkes PRC representatives indicated that eye protection was not required for group captures because the risks were considered to be low, the

humid environment created eye wear fogging problems, and there was concern that eye protection may impair vision and create animal handling difficulties. Yerkes PRC representatives indicated that many of the policies and procedures at the other six regional primate centers were the same. Although a comprehensive review of eye-protection policies and B virus precautions at all primate centers was not conducted, discussions with representatives at two other regional primate centers suggest that eye protection during the capture and transport of NHPs in other centers may not have been routinely required until the death of the Yerkes PRC employee. Information about this incident was apparently widely circulated throughout the primate research industry and increased awareness of the risk of infection from this route of exposure.

## Employee Training

Training and safety requirements for Yerkes personnel were developed using a “universal precautions” approach, which presumes that all macaques are infected with B virus. According to Yerkes PRC representatives, employees receive 4-5 levels of training. At the pre-employment stage, personnel are made aware of the risks associated with working with NHPs, including B virus. During orientation, Yerkes PRC employees are shown a biosafety video, which includes a discussion of B virus. A review of the orientation slide narratives shows that standard operating procedures (SOPs) regarding safety and health when working with NHPs are discussed. This orientation also includes a section on personal protective clothing requirements for anyone who has contact with animals. The orientation narrative states that eye protection is required if an aerosol is created or when working with bodily fluids. Prior to commencement of employment, workers are required to sign a form indicating that they have received information on a Yerkes PRC policies and procedures, including B virus precautions. Employees are also required to sign a “Release and Assumption of Risk for Participation in Research Programs” form acknowledging awareness of the risks of working with laboratory animals.

Additional employee training includes sections on animal welfare and biosafety, in addition to on-the-job training. Periodically, Emory safety and health personnel provide seminars on various safety and health topics to Yerkes PRC employees.

## Policies and Procedures

Several of the Yerkes PRC written policies and procedures that were available for review contained information and precautions regarding B virus and NHP safety. In September 1996, the Center distributed a one-page “Guidelines for Working in Animal Areas” signed by the Yerkes PRC Director and the Associate Director for Research Resources. This directive states that “all personnel in direct contact with animals or animal waste, and in situations where aerosols may be created will... wear proper eye protection (safety glasses, goggles, or face shield).” Although “direct contact” is not defined, this appears to conflict with the policy of not requiring eye protection when conducting captures.

Yerkes PRC has developed written procedures for management of bites or scratches. These procedures include wound treatment, isolation of the animal, and drawing blood to determine the animal’s B virus status. These procedures call for reporting any injury that breaks the skin, identifying the animal in the event of a bite or scratch, immediate cleansing of the wound, and referral to a physician. The procedures indicate that medical personnel with expertise in B virus should be consulted to determine the need for further treatment.

## Safety and Health Program

Emory University safety and health staff support the Yerkes PRC, and Yerkes PRC personnel are included in existing campus-wide safety and health programs and training. According to Emory representatives, walk-through inspections of the primate center are conducted annually, and refresher training is provided on an as-needed basis. The content of these walk-through inspections was not provided to NIOSH. At the time of the NIOSH

investigation, no safety and health personnel were specifically assigned to provide support solely to the PRC. An internal Emory safety and health committee has been established, which includes a Yerkes PRC Field Station representative. One memorandum from the Yerkes PRC Employee Health and Safety Committee was available for review. This May 23, 1997, document included a reminder to all personnel to use universal precautions when handling all animal or human specimens. No other meeting minutes or reports from this safety committee were available for review.

A review of the Emory incident logs for 1997 showed that out of a total of 86 reported incidents (combined Field and Main Station), 20 (23%) were categorized as "eye exposures." Eight (9%) needle sticks, 20 (23%) scratches, cuts, lacerations, and 11 (13%) monkey bites were reported in this same time period. Details regarding the circumstances associated with these eye exposures, or whether Emory investigated these incidents and implemented changes (procedural, engineering control, training, strengthened eye protection requirements) to prevent recurrence were not available. No information was provided to allow NIOSH to determine whether Yerkes PRC conducts systematic hazard assessments or detailed job safety analyses to assess risks and determine appropriate precautions for the various tasks at the primate center.

## Facility Inspection

Emory officials declined to allow NIOSH investigators access to the Yerkes PRC Field and Main Station after the initial site visit on December 17, 1997. As such, only limited information regarding the facility, work practices, etc., was gathered. Information on protective equipment availability at various work stations, access to emergency eyewash stations, or signage describing the required safety precautions, etc. was not obtained.

A transfer cage reportedly similar to the one used during the exposure incident on October 29, 1997,

was briefly examined on December 17, 1997. This transfer cage was approximately 2 ft x 1 ft x 1 ft, and constructed of metal. The top and bottom of the cage were solid, with a guillotine-style door at the front. Numerous holes, about 0.5" in diameter covered the sides of the transfer cage.

## Post Exposure Actions

Following the death of the infected employee on December 10, 1997, the Yerkes PRC Associate Director for Research Resources issued an internal memorandum on December 12, 1997, to all employees reiterating the statement noted in the September 1996 directive: "when in direct contact with nonhuman primates or animal waste, or in situations where aerosols or droplet splashes may be created, appropriate eye protection is required (safety glasses, goggles, or face shield)." Additionally, each employee was provided a laminated card with B virus exposure information to give to a health care provider if medical attention was necessary. However, specific eye wear designed for splash protection was not specified or required after the incident. For example, the technician who experienced the second eye exposure to primate body fluids that occurred on December 12 at the Yerkes PRC Main Station was wearing a combination surgical mask/face shield at the time of the exposure. Although she was wearing this combination mask, she sustained the exposure in the right eye while moving a monkey from a cage into a transfer cage. As previously noted, face shields are considered secondary protectors and are not appropriate for primary splash protection.

## DISCUSSION

Although the risk of acquiring a B virus infection via a mucosal exposure to primate body fluids has been acknowledged and addressed in published guidelines, prior to this incident a B virus infection resulting from an ocular exposure had never been reported. As such, it is likely that exposed workers considered the risk of acquiring an infection from this route of exposure to be remote. Investigators

reporting a 1987 outbreak of four cases of B virus infection among primate handlers in Pensacola, Florida, concluded that because of the time between human infections (at that time it had been 14 years since the previous reported case) many persons who worked with monkeys tended to take fewer precautions.<sup>4</sup> The investigators further concluded that existing guidelines may have been increasingly disregarded because the perceived risks were small and the protective clothing was cumbersome.<sup>4</sup> Maintaining vigilance and avoiding complacency to ensure that precautions and established guidelines are fully met when dealing with a rare outcome requires significant commitment on the part of management. This is especially true if the safety requirements represent a real or perceived burden.

There is evidence suggesting that eye exposures to NHP body fluids are not uncommon occurrences. A review of injury records for 1988-1993 at a regional primate research center found that of the 17 reported mucous membrane exposures to primate body fluids (blood, urine), 16 (94%) involved the eye.<sup>16</sup> A questionnaire survey at two regional primate research centers reported in this same study found that 50% of the mucous membrane exposures went unreported. The investigators concluded that increased training and expansion of existing policies requiring routine use of eye protection could reduce these exposures.<sup>16</sup>

The Yerkes PRC orientation and policy materials on occupational health and safety provided inconsistent direction regarding specific activities requiring eye protection and the specific types of splash protection necessary. Some of the Yerkes PRC policies indicate that eye protection is required for all personnel in direct contact with animals or animal wastes. For example, the Yerkes PRC orientation narrative describes a requirement to utilize universal precautions when working with animals, and the September 1996 Yerkes PRC "Guidelines for Working in Animal Areas" includes cautions that nonhuman primate body fluids should be considered infectious. Other documents (Appendix 20, Yerkes PRC Policy) specify that "procedures resulting in aerosol production (spraying cages, dental work, or opening the skull)" should be done with a face shield

or goggles. One reviewed document (Yerkes PRC Standards for Working with Nonhuman Primates) does not address eye protection, although other types of personal protective clothing is described. Despite cautions in the Yerkes PRC training and published guidelines that mucous membrane contact was a potential route of exposure for infection, Yerkes PRC representatives indicated that conducting a group capture and health examination of monkeys was not an activity requiring the use of eye protection.

It does not appear that Yerkes PRC has a consistent program to ensure that exposures (e.g., mucosal membrane contact with primate body fluids) are systematically recorded, tracked, and investigated. Thorough investigations of all incidents, including "near misses," are necessary to ensure that appropriate actions are taken to prevent future occurrences. Simply tracking incidents without adequate follow-up is insufficient. Twenty eye exposures were reported in 1997, which suggests that a problem exists regarding eye protection. Details about these incidents were not made available to NIOSH, so the extent of investigations, if any, is not known.

Existing Emory-wide safety and health training programs may not provide employees with sufficient specific information that addresses the unique safety and health concerns associated with NHPs in general and B virus in particular. The apparent contradictions in policies and unclear definition of when they apply likely resulted in confusion about which tasks required eye protection.

Actions taken after the exposure were not consistent with the 1995 B virus working group guidelines for workers handling NHPs potentially infected with B virus. After the exposure, immediate irrigation of the eyes and consultation with medical personnel knowledgeable about the hazards of B virus and the symptoms of B virus infection did not occur. Although knowledgeable medical personnel had been previously identified by Yerkes PRC, the need to consult or notify these medical experts for occurrences of ocular exposures to primate body

fluids had not been effectively communicated to all personnel. As a result, there were delays between the exposure and the employee's first time seeking medical care.

Initial medical evaluations, which did not occur until after the exposed worker developed symptoms, did not result in a diagnosis of, and treatment for, B virus infection. The physician conducting the initial examination in the emergency room specifically looked for dendritic lesions characteristic of ocular *Herpes simplex* and *Varicella zoster* infections and did not demonstrate them. Although a previous report describes a dendritic corneal lesion associated with a fatal B virus infection, the present case indicates that the absence of a dendritic lesion can not reliably rule out B virus infection as a cause of conjunctivitis after a possible ocular exposure.<sup>17</sup>

The diagnosis of rare infections is often delayed, especially when there are no unusual signs or symptoms. However, the likelihood of early recognition and appropriate intervention can be maximized if animal facilities identify a local medical consultant who is or can become knowledgeable about B virus infection, symptoms, and treatment. Animal handlers should be instructed to immediately and thoroughly cleanse all bites, scratches, and/or exposures of mucosal surfaces or abraded skin to macaque biologic materials, and to report these immediately.

## CONCLUSIONS

This is the first reported case of B virus infection resulting from an ocular exposure to macaque body fluids. Although the true risk of infection from exposure to NHP body fluids is not known, the report of a second exposure at another station of the same facility within months and other reviews of injuries among workers exposed to nonhuman primates suggest that mucocutaneous exposure to nonhuman primate body fluids may be more common than appreciated among exposed workers.<sup>16,18</sup>

The employee was not wearing protective eye wear at the time of her exposure. Yerkes PRC management did not require eye protection while transporting caged macaques or conducting routine group captures, although the Yerkes PRC written guidelines were inconsistent on this issue. Precautions regarding eye protection were not emphasized or not enforced despite information indicating that mucous membrane exposure was a potential route of infection. The death of this worker from an ocular exposure to B virus and the subsequent ocular exposure at the Main Station despite the use of a face shield indicate that protective eye wear that conforms to established standards for eye and splash protection should be part of the protective equipment ensemble worn by all personnel who come in contact with nonhuman primates.

Opportunities for early intervention were missed. The B virus Working Group Guidelines recommend flushing the eye with water for 15 minutes immediately after an exposure, but among Yerkes PRC staff an eye splash without additional injury was apparently not recognized as an exposure posing a risk of infection. As a result, cleansing did not occur at the time of exposure.

## RECOMMENDATIONS

Recommendations are provided to improve health and safety practices when working with NHPs. Although some of these recommendations specifically apply to the Yerkes PRC facility, many are applicable to all NHP facilities and activities.

1. Develop a comprehensive personal protective equipment (PPE) program. The program should include specific details regarding tasks and areas where PPE is required so there is no room for misinterpretation. Proper eye protection should be part of the mandatory PPE ensemble when working with NHPs, including entering animal areas. The elements of a PPE program include:

- Written procedures and assigned responsibility for the program
- Defining the necessary PPE and ensuring it is properly and consistently selected, used, and maintained
- PPE should be obtained and individually assigned
- Inspection and Maintenance. PPE should be inspected before and after each use, cleaned prior to removal, and discarded frequently. After cleaning, PPE should be stored properly.
- Employee training
- Periodic assessments of the effectiveness of the PPE program.

Protective eyewear should meet or exceed the criteria established by the American National Standard Institute (ANSI).<sup>15</sup>

For splash hazards, goggles and face shields should be used. Face shields are considered to be secondary protectors and are only designed to provide limited protection to the face and front part of the neck. Face shields should always be worn with suitable eye protection such as safety glasses or goggles.

2. Conduct a comprehensive review of all policies and procedures and ensure that they are consistent with the most current recommendations regarding NHP safety.<sup>6,2,7,10,11</sup> A checklist detailing specific safety precautions for working with or around NHPs should be developed and used prior to all NHP handling and capture activities. Periodic program and facility reviews that are specific to NHP safety should be conducted.

3. Ensure that emergency eyewash stations are accessible to employees near primate handling areas and that personnel are trained on proper eye flushing technique. Employee training should include information on the importance of initiating thorough

cleansing within minutes of injury or exposure as described in the 1995 guidelines (e.g., irrigate for at least 15 minutes).<sup>2</sup>

4. Because of the unique activities and hazards present, specific safety and health programs and objectives should be developed for the Yerkes PRC, and safety and health staff with specific expertise in biosafety and primate safety issues should provide dedicated support to the PRC.

5. Conduct comprehensive hazard assessments (e.g., job safety analyses) for all job descriptions and activities involving NHPs. Workers responsible for these tasks should participate in the assessments. The assessments should include a review of all activities where NHP contact occurs, all illness and injury reports, and a detailed determination of the necessary precautions. The assessments should also be used to identify areas or situations where handling or contact with the animals could be reduced or eliminated. Revise procedures accordingly.

6. Ensure all opportunities to minimize contact with NHPs are investigated and implemented where feasible. These may include engineering controls such as improved cage designs (elimination of sharp corners, providing a solid surface on the side of the transfer cage adjacent the side of the worker), and monkey identification (e.g., unique dye markers for remote identification).

7. Ensure required safety precautions are consistent in all facility policies and procedures.

8. Review all employee training materials and revise as necessary to ensure the most current NHP safety guidelines and Yerkes PRC procedures are effectively communicated. The results of the hazard assessments should be included in this training.

9. Tracking incidents (bites, scratches, eye exposures, etc.) is a good method to monitor the effectiveness of a safety program. However, each incident should be thoroughly investigated to ensure that the circumstances are well understood and



appropriate interventions are implemented. Each and every exposure should be reported to the Emory safety and health department for appropriate investigation and follow-up.

10. Employee training should include a discussion of appropriate exposure management. This training should emphasize the need for immediate care of the exposure (wound cleansing, eye irrigation, etc.) followed by medical assessment, and should be reinforced at appropriate intervals. Yerkes PRC administrators should identify medical consultants with appropriate knowledge and skills regarding the care of workers potentially exposed to B virus and other primate zoonoses, and develop a contact system to ensure that an exposed worker is referred directly to these consultants. This system should include provisions for referrals after normal working hours and on weekends.

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