Neurodiagn J.
53:271–288, 2013

Infection Prevention: 2013 Review and Update for Neurodiagnostic Technologists*

Nancy Kriso Scott, R. EEG/EP T., R.NCS.T., CNCT, RPSGT, RST, CNIM, BS

Clinical Coordinator/Preceptor
Electroneurodiagnostics Program
Cuyahoga Community College
Parma, Ohio

ABSTRACT. *Since 1995 ASET has published recommendations for infection prevention (Altman 1995, Altman 2000, Sullivan and Altman 2008). In keeping with the desire of providing current updates every five years, this article reviews the aforementioned past publications and incorporates new information from books and Occupational Safety and Health Administration (OSHA) regulations. Knowledge of current infection control practices and recommendations is essential for every neurodiagnostic technologist, no matter if employed in a hospital, an ambulatory setting, an intensive care unit, or the operating room. All technologists who have direct patient contact are responsible for ensuring best practices for infection prevention.*

KEY WORDS. *Blood borne pathogens (BBP), clinical contact environmental surfaces, hand hygiene, health care-associated infection (HAI), high level disinfection, infection prevention, non-intact skin, Occupational Safety and Health Administration (OSHA), personal protective equipment (PPE), semi-critical patient care equipment, standard precautions, sterilization.*

INTRODUCTION AND EDUCATIONAL OBJECTIVES

Neurodiagnostic technologists need to understand and implement effective infection prevention practices, discern between the various levels of disinfection, and

Author's Email: nancy.scott@tri-c.edu
Received: August 28, 2013. Accepted for publication: September 9, 2013.
*Endorsed by the Board of Trustees of ASET – The Neurodiagnostic Society.

know how to achieve such levels in the Neurodiagnostic laboratory. Neurodiagnostic departments should have infection control policies and procedures that not only reflect individual needs and clinical situations but are also in compliance with Occupational Safety and Health Administration (OSHA) regulations. The recommendations in this document are based on current infection control practices and knowledge. Since infection prevention is an active process, technologists need to incorporate new information as it becomes available. There are many organizations devoted to infection prevention and safety issues that are valuable resources for technologists. Most can be accessed through the Internet. The following list is by no means comprehensive but provides a good starting point for current information: Association for Professionals in Infection Control and Epidemiology (APIC), www.apic.org; Society for Healthcare Epidemiology for America (SHEA), www.shea_online.org; Association of periOperative Registered Nurses (AORN), www.aom.org; Centers for Disease Control and Prevention (CDC), www.cdc.gov; Occupational Safety and Health Administration (OSHA), www.osha.gov; the Environmental Protection Agency (EPA), www.epa.gov; The Joint Commission [formerly known as the Joint Commission for Accreditation of Healthcare Organizations (JCAHO)], www.jointcommission.org; and the World Health Organization (WHO), www.who.int.

The educational objectives of this article are:

1. Review the use of personal protective equipment (PPE) and hand hygiene to prevent health care-associated infection (HAI).
2. Educate regarding risk of bloodborne pathogens (BBP) in the outpatient neurodiagnostic lab.
3. Educate managers and staff regarding necessity for compliance to OSHA regulations.
4. Review the concept of Universal Precautions versus Standard Precautions and body substance isolation (BSI).
5. Review the disinfection level necessary for surface EEG electrodes and methods to achieve adequate disinfection.

THE BURDEN OF HEALTH CARE-ASSOCIATED INFECTION

Health care-associated infections (HAI) are illnesses acquired or transmitted within a health care facility including: hospitals, outpatient clinics and laboratories, doctor offices, dental clinics, and nursing homes. A report by the World Health Organization (2011) summarizes HAI to be the most frequent adverse event in health care delivery, and further states that between 7 and 10 of every 100 of the world's hospitalized patients will acquire at least one HAI.

HAI affect not only patients but also health care workers; between 20% and 60% of health care workers become infected with viruses during routine patient care (WHO 2011). The majority of occupational health-related cases are due to one of

three viruses: hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV). Within the past 40 years more than 30 new diseases have been characterized having either viral or bacterial etiologies. Some of these have caused epidemics and pandemics including the West Nile Virus encephalitis outbreaks, H1N1 influenza, and community associated methicillin-resistant staphylococcus aureus (MRSA). Even with the superior health technology of recent years, tuberculosis (TB) is still the most common infectious disease worldwide. It affects one-third of the global population and remains the leading cause of death from a potentially curable infectious disease. Although the Society for Healthcare Epidemiology of America (SHEA) acknowledges the emergence of methicillin drug resistant (MDR) organisms to be a contributing factor, they still cite the major reasons for HAI as inadequate hand hygiene and aseptic or sterile technique, or ineffective cleaning and disinfection of patient care environment or medical equipment (SHEA 2008).

INFECTION TRANSMISSION

Transmission pathways allow for the spread and redeposit of infectious organisms. Infection may be transmitted directly, or indirectly by means of an inanimate object such as a patient care or environmental item. There are five main routes of transmission: contact, droplet, airborne, common vehicle, and vectorborne (CDC 2007).

Contact transmission is direct or indirect, and is the most frequent mode of infection transmission. Direct contact transmission occurs when microorganisms are transferred from one person to another person. Indirect contact transmission occurs when the infecting agent is transferred through a contaminated environmental item or person (CDC 2007).

Droplet transmission occurs primarily through coughing, sneezing, talking, or during certain procedures such as suctioning and bronchoscopy. Spewed droplets are heavier than air and as they fall are deposited on conjunctivae, nasal mucosa, or the mouth of a host, as well as on inanimate and environmental objects (CDC 2007).

Airborne transmission occurs by dissemination of particles through the air or dust. The particles remain suspended in the air for long periods of time (CDC 2007).

Common vehicle transmission refers to infection transmitted by items such as food, water, medications, and equipment. Many common vehicle transmissions occur from improper hand hygiene and/or equipment disinfection (CDC 2007).

Vectorborne transmission occurs through animals and insects such as rats and mosquitoes (CDC 2007).

THE OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION AND THE BLOODBORNE STANDARD

The Occupational Safety and Health Administration (OSHA) was established by the United States Department of Labor in 1971 for the purpose of ensuring safe work

environments for all workers in every industry and service in the United States. OSHA creates and enforces federal laws, known as Codes of Federal Regulations (CFR) for every workplace. OSHA provides inspections and has the ability to cite violations and assign fines for non-compliance to CFR. Fines range from $250.00 to $70,000.00 per single violation. Although OSHA was established in 1971, it studied the recommendations and knowledge of the Center for Disease Control (CDC) and other infection control experts for 20 years before publishing the Bloodborne Pathogen (BBP) Standard. Published in December 1991, the Standard quickly became effective in March 1992, addressing a wide scope of safety and health standards. The BBP Standard is found in 29 CFR 1910.1030 OSHA General Industry Regulations. The regulations are federal laws that apply to: industry, manufacturing, service, and all healthcare workplaces including hospitals (public, private, and community), nursing homes, all laboratories, clinics and doctor offices whether inpatient, outpatient, dental, research, public, or private. No employer or employee is exempt from OSHA regulations as they are federal laws. In the CFR Standard OSHA defines bloodborne pathogens to include any pathogenic microorganism present in human blood or other potentially infectious material (OPIM) that can infect and cause disease in persons who are exposed to blood containing the pathogen. Engineering controls in the form of actions or measures that isolate or remove the BBP hazard from the workplace are mandated.

OSHA REGULATIONS ON HAND HYGIENE

Hand hygiene is necessary before and after situations in which hands are likely to become contaminated with blood, body fluid, secretions, excretions, or any items soiled with these. Hands should be cleaned before and after wearing gloves; gloves are not a substitute for hand hygiene. By federal law employers must provide sinks with soap and running water which are readily accessible to employees. When the above is not feasible, an appropriate antiseptic hand cleanser and paper towels or antiseptic towelettes must be provided. *When these are used, hands must still be washed with soap and running water as soon as feasible.* Employers shall ensure that employees wash their hands immediately or as soon as feasible after removal of gloves or other personal protective equipment.

According to the CDC hand friction to create lather is the most important aspect of handwashing. The contact time should be at least 20 seconds with attention to lather between fingers and around the nails and wrists (CDC 2013). Hands should be rinsed in a flowing stream of water with no contact of water valves until hands are dried and a proactive barrier (paper towel) is used to turn off the water and exit the room. Although easily found in healthcare settings, OSHA law makes it clear that handrubs are not a substitute for hand washing. Handrubs may only be used in the absence of water and must be a minimum of 60% alcohol based. Handrubs or gels

may not be used if hands are visibly soiled and the hands must still be washed as soon as possible even after using a handrub.

OSHA REGULATIONS ON PERSONAL PROTECTIVE EQUIPMENT

Employers must provide appropriate personal protective equipment in the appropriate sizes that is readily accessible at the worksite. Hypoallergenic gloves, glove liners, powderless gloves, or other similar alternatives shall be readily accessible to those employees who are allergic to the gloves normally provided. Furthermore, it is the responsibility of the employer to ensure that the employee uses appropriate PPE, and does so correctly. All personal protective equipment shall be removed prior to leaving the work area. This means removing gloves (followed by handwashing) and protective gowns and/or masks (if used) before leaving the room. Gloves must be worn when it can be reasonably anticipated that the employee may have hand contact with blood, other potentially infectious materials (OPIM), mucous membranes, non-intact skin, and when handling or touching contaminated items or surfaces. Gloves used during patient preparation or electrode removal must be removed followed by hand hygiene before touching anything including bedrails, computer keys, light switches, etc.

CLEANING, DISINFECTION, AND STERILIZATION

Cleaning merely removes soil which may or may not be visible. Cleaning is usually done with water and detergent or soap and removes material such as dust or soil which microorganisms might find favorable for continued life and growth. Cleaning does not affect or remove the microorganism. Disinfection is a step beyond cleaning. There are three levels of disinfection: low level, intermediate level and high level (Figure 1). The item to be disinfected and the manner in which it is to be used dictate the level of disinfection necessary. Sterilization is a step beyond disinfection. In a class by itself, sterilization is a process that destroys all microorganisms including bacterial spores. While neurodiagnostic personnel can easily accomplish cleaning and the various levels of disinfection, sterilization is generally accomplished in the hospital setting by the Central Sterile Supply department or Surgical Processing Department using steam, gas, chemicals, or plasma techniques (STERRAD®, Advanced Sterilization Products, Irvine, California, USA).

Although there are three levels for disinfection: low, intermediate, and high (Figure 1), in the typical neurodiagnostic lab one encounters the need for either the low or high level. There are environmental surfaces such as floors, doors, sinks that are maintained by housekeeping. Generally, environmental surfaces undergo cleaning or low level disinfection by facilities engineering or housekeeping unless BBP

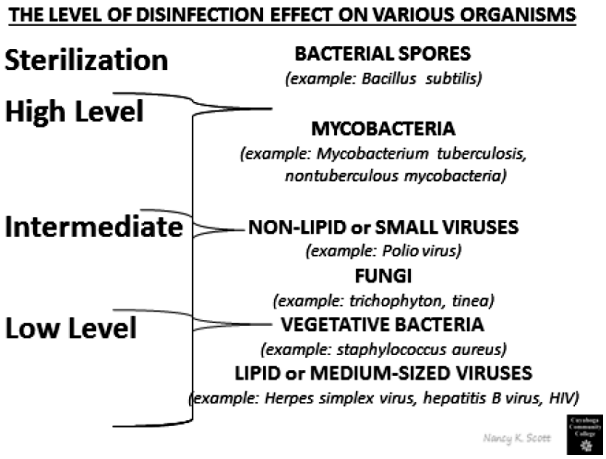

FIG. 1. Federal law requires high-level disinfection for semi-critical patient care items. When performed correctly this level kills only a few bacterial spores but all mycobacteria and organisms weaker than mycobacteria.

are present. There are also clinical contact environmental surfaces such as computer keyboards, patient tables, light switches, sink faucets, bedrails, etc. which may become contaminated during or between patients.

In patient care settings there are also items that come into direct contact with the patient. These patient care items fall into one of three categories: non-critical, semicritical, and critical. Non-critical are those which come in contact with intact skin (e.g., blood pressure cuff, comb, tape measure, finger pulse oximeter). Semi-critical items typically contact mucous membranes or non-intact skin (e.g., oral/nasal airflow sensors, EEG disk electrodes). Critical patient care items penetrate or contact soft tissue, bone, bloodstream or normally sterile tissue (e.g., surgical, dental practice instruments, subdermal or subdural electrodes).

The non-critical items encountered in the laboratory call for low level disinfection, however OSHA classifies disk electrodes as applied for routine EEG procedure as semicritical, requiring high level disinfection. Why are electrodes considered semi-critical when they are merely placed on scalp or skin? The caveat is that intact skin is considered a natural barrier. A reusable patient care item that comes into contact with intact skin is a non-critical item and needs low level disinfection. However, a reusable item contacting non-intact skin or mucous membranes (nose, mouth, eyes, etc.) is a semi-critical item and needs high level disinfection. OSHA defines non-intact skin as skin with dermatitis, hangnails, cuts, abrasions, chafing, acne, etc. By this legal definition, skin preparation with any abrasive to lower impedance creates non-intact skin on the patient.

MYTH OR FACT

In a study by Bild (1997), forensic testing proved the presence of occult blood on surface EEG electrodes. Occult blood was found to be present on gold disk electrodes even when blunt tips were not used for skin prep. This important study was followed by the settlement of a class action lawsuit (Anderson et al. v. Wilson et al. 1998) involving an epidemic outbreak of hepatitis B (HBV) attributed to six outpatient EEG clinics all owned and operated by the same physician and chief technician. The largest outbreak of hepatitis B in history was due to an outpatient EEG lab where both subdermal and gold disk electrodes were used. 14,000 cases of HBV were acquired from 1991 to 1996, one resulting in death within that time period. According to the CDC the hepatitis B virus can live for one week on an inanimate surface.

OSHA demands the use of Universal Precautions within the workplace. Under Universal Precautions all human and OPIM must be treated as if known to be infectious for human immunodeficiency virus (HIV), HBV, hepatitis C (HCV), or other pathogens regardless of perceived "low risk" status of the patient. Many health care institutions practice Standard Precautions and Body Substance Isolation (BSI) which expands this coverage to include all body fluids and substances, not just blood. As this is federal law, a neurodiagnostic technologist may not elect to provide a lower level of disinfection for electrodes; regardless if they were removed from a seemingly healthy outpatient, an ICU patient, or an outpatient with a known disease such as neurosyphilis, AIDS, hepatitis, etc. Electrodes from all patients must be treated in the same manner.

ENGINEERING CONTROLS IN THE NEURODIAGNOSTIC LABORATORY

The understanding of a concept is paramount in order to properly perform a task. Neurodiagnostic technologists must understand the need for disinfection, know the various levels of disinfection, and the appropriate disinfection level for equipment as well as how to perform the process correctly. Correct disinfection removes or destroys some pathogens that remain on the item but are not visible to the eye, and is accomplished by exposure to a chemical for a required amount of time. The duration of exposure is generally determined by the type and number of pathogens that are to be affected. Exposure to a liquid chemical disinfectant means keeping the item wet for a specified length of time. The chemical used must be hospital grade and registered with the Environmental Protection Agency (EPA) as a disinfectant and have a label claim to be tuberculocidal.

Re-usable patient care items that come in contact with intact skin (including blood pressure cuffs, bedside tables, combs, hair clips, etc.) with no visible blood on them are non-critical items and require low level disinfection. Low level disinfection

destroys vegetative bacteria, some fungi and viruses but not mycobacteria or bacterial spores. It is accomplished by liquid contact with an EPA registered hospital grade disinfectant (can be a spray or wipe) with the proper contact time (30 to 60 seconds) according to product label.

Items that contact mucous membranes or non-intact skin are semi-critical and require high level disinfection. This destroys all microorganisms and low numbers (but not all) of bacterial spores (Figure 1). High level disinfection is accomplished by wet heat automated techniques such as pasteurization (autoclave) or by liquid immersion in a chemical sterilant EPA approved as a high level disinfectant. The proper contact time for high level disinfection is 10 to 30 minutes, according to product label. Because every facet, crevice, and curve of the item must maintain contact with the sterilant for the proper contact time, *when a liquid is used for disinfection the item must be immersed.* High-level disinfection of semi-critical patient care items cannot be achieved by a spray or wipe method.

Clinical contact environmental surfaces in the treatment area contaminated during patient care by bare or gloved hands, saliva, or body fluids should also be disinfected. This includes the bedrails, prep table or patient table, light switch, door knob, computer and mouse, drawer pulls, etc. If a disinfectant wipe is used it must be hospital grade, EPA registered, and have a label claim to be tuberculocidal. Neurodiagnostic staff must know the steps to disinfect their work areas, and these steps should be written in the department's procedure manual.

1. Isolate contamination, especially if moving items to a different area for cleaning. Sheathe electrodes in a paper towel and then remove your gloves. You cannot wear gloves in the hallway, so must remove your used gloves before leaving the work area. However, if carrying used electrodes to another area for disinfection you may wear clean gloves. The contaminated electrodes must be contained in a manner so they are not in contact with the air and not directly visible.
2. Once in the cleaning area, wear gloves throughout the cleaning and disinfecting process.
3. Clean the items before disinfection. All traces of collodion, paste, or other soil must be removed.
4. Disinfect for the proper contact time. This means all facets of the item must stay wet for that length of time. This can only be accomplished by immersion. Remember to include any brushes used for cleaning.
5. After the initial cleaning and during the disinfection soak, wipe down wires and jackbox with a hospital grade low level disinfectant or wipe.
6. Wipe any reusable prep tools (tape measure, marker, combs, hair clips), prep cart (including drawer pull), and anything that may have been touched during patient prep.

7. Remove gloves and wash hands.
8. After the disinfection time has been met rinse electrodes with water. Dry, or allow to air dry.
9. Remove electrodes from dirty utility area (clean items cannot be stored in the area used to clean).
10. Some busy labs have employees initial and date the electrode sets they have disinfected for quality assurance measures.

KNOW YOUR DISINFECTANTS

Many commercial chemical disinfectants are available from suppliers (i.e., Cidex®, CaviCide®, Control III® Elite, etc.) Some of these require special care; they may or may not need mixing or activation: read the label or call the manufacturer. Bleach (sodium hypochlorite) solutions require measured dose mixing and it is required that employees can do this correctly and follow through consistently; a commercial product that requires no mixing can take this responsibility off of the staff and laboratory should there ever be a problem. Commercially prepared products are expensive but generally have a longer shelf life and potency, require a shorter contact time, and may be less corrosive to electrodes than sodium hypochlorite. Replacing electrodes less frequently may offset the cost of a commercial product. One should always read the label for level of disinfection and required contact time. If a quick turn-around time for equipment is necessary in the lab some commercial products provide appropriate disinfection in half the time of a sodium hypochlorite solution (10 minutes versus 20 minutes).

Other concerns in choosing a disinfectant are to know if it will harm you, your staff or your equipment; read the material data safety sheet (MSDS) (formaldehyde is banned due to carcinogenesis, gluteraldehyde can only be used with strict ventilation requirements). Some products need to be mixed or activated. If so, the recommended ratio must be strictly followed; measure when mixing. You must know if the concentration needs to be tested before use, some preparations demand the use of test strips. You must also know the shelf life and expiration date before and after uncapping. Mark the bottle with dates of shelf expiration (if unopened), date of uncapping, and date for discard. Generally, commercial products have a three year shelf life if unopened and remain potent for one year after uncapping.

In an effort to conserve money, many labs use sodium hypochlorite (i.e., bleach). Mixing different amounts of bleach with water can produce a high, intermediate-high, intermediate, or low level disinfectant (Table 1). Sodium hypochlorite may be used for high level disinfection, however the employee is responsible for understanding how to prepare and use it correctly. The label must state 5.25% sodium hypochlorite. The shelf life of bleach, unopened, is one year. However, the potency (useful life) of uncapped bleach in its white opaque bottle is full strength stable for only four

Table 1. *Household bleach (5.25%) dilutions for disinfection.*

Disinfectant Level	Final Dilution Sodium Hypochlorite %	Bleach Solution Ratio	Bleach Dilution	ppm (available chlorine)	Comments **Always Use on Cleaned Surfaces
Low	0.025%	1:200	1.5 Tbsp (0.6 oz) bleach to 1 gallon water	250 ppm	Common household use. Can be sprayed or wiped.
Intermediate to High	0.1%	1:50	5 Tbsp (1/3 C) bleach to 1 gallon water	1000 ppm	Commonly used. For high level disinfection: provide 20 minute contact time. Must use immersion; cannot be sprayed or wiped.
	0.16%	1:32	1/2 C (4.0 oz) bleach to 4 C (1 quart) water	1562.5 ppm	
High	0.5%	1:10	1 C (8.0 oz) bleach to 9 C water	5000 ppm	This is a very strong solution. Use on a limited basis. May be corrosive to equipment. Must use immersion; cannot be sprayed or wiped.

ppm – parts per million; Tbsp – tablespoon; C – cup; oz – ounce.

weeks from uncapping (up to 50% potency loss, non-linear degradation after four weeks) which impacts correct concentration levels. High level disinfection can be achieved with 1000 parts per million (ppm) of free chlorine, which is a 0.1% sodium hypochlorite solution. This is easily made with 1/3 cup (5 Tablespoons) fresh bleach (the bleach must be less than one month from uncapping) to 1 gallon of water. This mixture must sit undisturbed for 30 minutes prior to using in order for the chlorine to become free. One problem with bleach-water mixtures is that there are no stated contact times on the label to achieve a specific level of disinfection. As a general rule, if exposure times are not documented or unclear, expose items to liquid chemical disinfectants: at least 20 minutes at room temperature for high level disinfection; at least 10 minutes for intermediate level disinfection. In general, the more concentrated the disinfecting product, or the longer the exposure of an item to a disinfectant, the more likely that all contaminating microorganisms will be inactivated. Unfortunately, the longer the exposure or the higher the concentration, the more likely the item will be damaged. For disinfectants that can be used at various concentrations (e.g., sodium hypochlorite), the more concentrated the product the less time required to achieve a specified level of disinfection. The contact time approved by the CDC for high level disinfection using a 1:50 ratio for immersion is 20 minutes, followed by a tap water rinse. The mixed bleach can be re-used for 24 hours but may not be created more than 24 hours in advance.

The selection of disinfectants involves: consideration of the level of disinfection required; the impact of the disinfection process on the instruments or devices, the cost of the disinfection method or product; the turn-around time while waiting for the process to complete; and any occupational health or safety risks. The Association for Professionals in Infection Control and Epidemiology, Inc. (APIC) periodically provides information and updates on infection prevention and control, and has documents that can be viewed or downloaded from the APIC website (www.apic.org). Another good reference, and one well worth obtaining if you have responsibility for selecting or managing disinfection or sterilization products or procedures, is *A Guide to Selection and Use of Disinfectants* (BC Centre for Disease Control 2003). For information regarding specific disinfecting products and manufacturers, the FDA offers a list of sterilants and high-level disinfectants approved for use in reprocessing reusable medical equipment. The list is posted on the FDA website, www.fda.gov. New disinfectant products continue to be introduced into the healthcare market; therefore, selection and use of disinfectants in the healthcare setting is an active process. Healthcare workers should evaluate product claims based on manufacturer information as well as reports in the scientific literature.

ADDITIONAL CONSIDERATIONS IN THE NEURODIAGNOSTIC LABORATORY

The versatility and scope of practice of the neurodiagnostic technologist comprises a wide range of environments and awareness levels for best practice of infection prevention techniques. Besides performing routine and bedside diagnostic testing, neonatal studies, intraoperative neuromonitoring, or long-term monitoring, the neurodiagnostic technologist may be called upon to be the scheduler, patient transporter, housekeeper, front office personnel, or a myriad of other positions. Regardless of job title, it is every employee's responsibility to follow best practice in performing assigned tasks, and the employer's responsibility to teach and ensure that OSHA regulations are followed. Additional engineering controls mandated by OSHA requiring compliance in the laboratory include but are not limited to the following:

- Employees may not have food or beverages in the work area (laboratory), nor may they handle contact lenses or apply cosmetics, including lip balm.
- Eye wash stations must be provided when "the eyes or body of any person may be exposed to injurious corrosive materials" (OSHA 2009). The eye wash station must be tested (documented) at least monthly to insure it works and runs a clear flush stream.
- Employees must use appropriate face and eye protection (safety glasses) when scrubbing electrodes and pouring or emptying disinfectant. Personal eyeglasses and contact lenses are not adequate eye protection. Masks should be worn by

healthcare personnel during procedures requiring sterile technique to protect patients from exposure to infectious agents carried in the healthcare worker's mouth or nose. Masks should be placed on coughing patients to limit the spread of infectious respiratory secretions.

- Gowns must be worn as PPE to protect skin and to prevent soiling of clothing during procedures and patient care activities that are likely to generate splashes or sprays of blood, body fluids, secretions, or excretions. Select a gown that is appropriate for the activity and amount of fluid likely to be encountered. Remove a soiled gown before leaving the patient's room, and perform hand hygiene to avoid transfer of microorganisms to other patients or environments. Clean, non-sterile gowns are adequate. Gowns may not be re-used, even for repeated contacts with the same patient.
- Ensure there are adequate procedures for the routine care, cleaning, and disinfection of clinical contact environmental surfaces, beds, bed rails, bedside equipment, and other frequently touched surfaces.
- No syringes, sharps, or blunt tips may be kept in sight or have ready access in the lab overnight (these must be locked).
- Collodion and acetone must be kept in a safe for flammables and returned to the safe when not immediately in use.
- All items must be used according to package directions and intended use. Two prep gels may not be combined to create a second generation product. All products used in the lab (for any purpose) must be FDA approved and only used per manufacturer's directions. Acetone is neither a cleaning product nor a disinfectant and may only be used to remove electrodes.
- Used patient care equipment and linen soiled with blood, body fluids, secretions, and excretions should be handled in a manner that prevents skin and mucous membrane exposures, contamination of clothing, and transfer of microorganisms to other patients and environments. Ensure that reusable equipment is not used for the care of another patient until it has been cleaned and disinfected appropriately. Ensure that single-use items are discarded properly.
- Take care to prevent injuries when using needles, scalpels, and other sharp instruments or devices; when handling sharp instruments after procedures; when cleaning instruments; and when disposing of used needles. Never recap used needles, or otherwise manipulate them using both hands, or use any other technique that involves directing the point of a needle toward any part of the body. Do not remove used needles from disposable syringes by hand, and do not bend, break, or otherwise manipulate used needles by hand. Place used disposable syringes and needles, scalpel blades, and other sharp items in appropriate puncture-resistant containers, which are located as close as practical to the area in which the items were used. Use mouthpieces, resuscitation bags, or other ventilation devices as an alternative to mouth-to-mouth resuscitation methods.

- Prep materials should be removed from the container immediately before use and the excess must be discarded after each patient. Electrodes should never be dipped into the paste jar during application.
- Dirty electrodes must be contained (covered) and go directly to the dirty utility area for processing.
- The sink used to disinfect cannot be in the patient testing area.
- The sink used to disinfect cannot be in a clean storage area.
- Clean areas must be kept clean and only dirty areas are permitted to be dirty.
- Containers used to clean before disinfection must be labeled for cleaning use only.
- Containers used to disinfect must be labeled for disinfection use only and also be labeled with the disinfectant's name it contains.
- Items may not be left soaking after shift ends. All items should be cleaned and disinfected and not left soaking overnight.
- Disinfectant may not be left in the container unless container is covered, marked, and tested daily for potency.
- Labs must maintain the material safety and handling sheets (MSDS) on products a minimum of 30 years past the last date used or the last employee terminates.
- MSDS must be readily available to employees; employees must know where to locate and how to read all MSDS.
- Develop good habits; wear gloves for patient preparation, electrode application, maintenance, and removal. Skin preparation agents contain an abrasive element that scrapes the skin and breaks the surface, creating non-intact skin and the risk of BBP. Ungloved hands that also have non-intact skin from chapping, chaffing, or hangnails are a port of entry or exit for microorganisms.
- Remove gloves and perform hand hygiene before touching the neurodiagnostic instrument, computer keyboard, or other clinical contact environmental surface.
- Wear gloves and protective barriers when touching potentially contaminated electrodes, oral/nasal airflow sensors, continuous positive airway pressure (CPAP) masks; when emptying and cleaning bedpans or urinals. Do not touch writing devices, instruments, doors, or other items after handling soiled equipment or when moving from one area to another, until hand hygiene is performed. Used electrodes must be sheathed or otherwise contained before transport to the dirty utility area. Dirty gloves must be removed and hands washed prior to leaving the work area (whether it is the patient's bedside or the neurodiagnostic laboratory). Generally, gloves may not be worn in the hallway unless during the transport of contained dirty equipment. "Contained" is defined as neither directly visible to the eye nor open to the air. In this instance, the gloves must be fresh.

- Wear gloves and protective barriers when entering surgical suites, handling babies in the nursery or neonatal intensive care area, when entering an isolation area, or when there is anticipated exposure to blood, body fluids, or specific microorganisms.
- Wear gloves and protective barriers when using or handling disinfectants.
- Products and equipment labeled as "single use" may not be re-used on another patient regardless if disinfection has been attempted. Single use devices have not been FDA approved to successfully be disinfected by any means. A syringe is a single use, disposable item and should be discarded after its use. A syringe may be used to insert the electrolyte paste or gel via a blunt tip but must be discarded after patient use. It is unacceptable to change only the tip and reuse the syringe with the electrolyte paste or gel on another patient. The recapping of needles and allowing needle electrodes to dangle is forbidden.
- Report any needle-stick incident, including EEG subdermal needle electrodes, according to the hospital/facility policy. EEG subdermal needle electrodes are solid, not hollow bore needles like injection needles, so there is no column for fluid within the needle (Schneider 2006).
- Treat any electrodes or monitors that come in contact with mucous membrane (such as thermistors and airflow monitors, CPAP masks) as semi-critical devices. These require high level disinfection but may be especially sensitive to sodium hypochlorite solutions. Less corrosive commercially prepared chemical high level disinfectants requiring a shorter contact time may be an alternative.
- Provide low-level disinfection for non-critical reusable patient care items including tape measure, china marker and the tip, calipers, hair clips, combs, pulse oximeter probe, nerve conduction electrodes and prong stimulators, earphones, toys, etc. Low-level disinfection may be accomplished by removing all debris from the object and then cleaning with a hospital grade, EPA approved disinfectant wipe or spray.
- The departmental procedure manual should address special issues such as patients that present with lice or scabies. These are insect parasites, lice being common among younger school-aged children and scabies becoming more prevalent in the nursing home community. If the patient is an inpatient, the nursing staff should be alerted. Special care should be taken to carefully clean all electrodes and surfaces of the neurodiagnostic equipment so as not to spread the insects to the next patient. If the patient is an outpatient, you may want to establish a policy to cancel the appointment and reschedule after the lice have been eliminated.

CREUTZFELDT-JAKOB DISEASE (CJD)

The average worldwide incidence of classic Creutzfeldt-Jakob (CJD) is estimated at approximately one in one million habitants (Liras 2008). In about 85% of patients,

CJD occurs as a sporadic disease with no known pattern of transmission. 5% to 15% of patients develop CJD because of inherited mutations of the prion protein gene. These inherited forms include Gerstmann-Straussler-Scheinker syndrome and fatal familial insomnia (CDC 2010).

CJD is neither bacterial nor viral; it is a transmissible spongiform encephalopathy that is known as a prion-based disease. These diseases are caused by an infectious agent called a prion, which is composed primarily of protein. Protein is composed of amino acids and can occur in both a normal form, such as found in the body's cells, and in an infectious form, which causes disease. Both the harmless and infectious forms of the prion protein have the same sequence of amino acids. The protein of the infectious form mis-folds upon itself, creating an abnormal shape. The replication and collection of this mis-folded form creates amyloid plaques causing neurodegeneration.

There is an inherited form of CJD, which accounts for about 5% to 10% of all known cases. These cases arise from a mutation, or change, in the gene that controls formation of the normal prion protein. While the prions themselves do not contain genetic information and do not require genes to reproduce themselves, infectious prions arise if a mutation occurs in the gene that governs the body's normal prion protein. If the prion protein gene is altered in a person's sperm or egg cells, the mutation can be transmitted to the person's offspring. All mutations in the prion protein gene are inherited as dominant traits. However, not all people with mutations in the prion protein gene develop CJD.

Variant Creutzfeldt-Jakob disease (vCJD) is the term assigned to the form of human transmissible spongiform encephalopathy that was first described in the United Kingdom in 1996 (CDC 2010). vCJD has been found to be associated with consumption of bovine spongiform encephalopathy (BSE) contaminated cattle products (Liras 2008). vCJD has different clinical and pathologic characteristics than classic CJD and the EEG abnormalities typically seen in classic CJD are absent in vCJD (Turner 1999).

There have been no reported cases of direct human-to-human transmission of vCJD by casual or environmental contact, droplet, or airborne routes (CDC 2007, FDA 2012). Bloodborne transmission of vCJD has occurred in the United Kingdom in four patients (Llewelyn et al. 2004, Peden et al. 2004, FDA 2012).

Historically, many EEG labs have taken special precautions against patients with CJD, even to the point of discarding electrodes. Because a prion is protein based, CJD is passed by contact with tissue from certain organs (cornea, brain, kidney, liver, lung, spleen, lymph) or CSF and not through contact with blood (NIH NINDS 2013). Standard Precautions, as mandated by OSHA, are required for all patients including those with known or suspected CJD. Despite the fact that the vehicle of disease is not bloodborne, non-invasive reusable electrodes must still undergo high-level disinfection as semi-critical patient care equipment, which should be standard for all patients.

Disposable, single-use EEG electrodes are an option to use on any patient suspected of having CJD. Isolation of the patient with CJD is not necessary and they can be nursed in the open ward using Standard Precautions (WHO 2003).

CONCLUSION

The rapid growth of the neurodiagnostic field has caused the technologist to perform their jobs in a wide range of work environments. Some, like the operating suite, intensive care, or neonatal unit, have specialized needs for infection prevention. While many technologists set their own laboratory polices and standards, they must be mindful of the higher incidence of acutely and chronically ill, as well as immuno-compromised individuals who enter our workplace as outpatients. It is our responsibility as professionals to develop and adhere to best practice standards, even if they are different from the current established routine in the laboratory. "Do no harm" applies to not only the physician but to every health care professional. Harm can be done via inadequate or lax infection prevention procedures, as evidenced by at least 1 death and 14,000 cases of HPB attributed to a single physician-technician EEG lab practice. Every laboratory, patient care item, and set of electrodes should be looked at critically before use by the technologist. The technologist should ask themselves: "Would I want to be a patient here; and would I want this to be used on me or anyone in my family?" This should be the standard applied to each lab practice and disinfection process. Managers and supervisors are responsible for ensuring that they and their staff know the federal laws and abide by them. Furthermore, OSHA requires that the laboratory document competency and adherence to infection prevention. Just as treatment of infectious diseases have been changed and improved, the practices for infection prevention will likely follow suit.

REFERENCES

Altman CL. Infection control and the electroneurodiagnostic department: 1994 guidelines. Am J EEG Technol 1995; 35:3–36.

Altman CL. Infection control: 2000 review and update for electroneurodiagnostic technologists. Am J Electroneurodiagnostic Technol 2000; 40(2):73–97.

American Dental Assistants Association. How to Clean, Disinfect, and Sterilize a Dental Operatory. The Gale Group; 2004.

Anderson et al. v. Wilson et al. 1998. On the Internet at: http://www.hartelaw.com/hepb/gdcert.htm. Accessed September 2013.

BC Centre for Disease Control. A guide to selection and use of disinfectants. 2003. On the Internet at: http://www.bccdc.ca/NR/rdonlyres/EAA94ACF-02A9-4CF0-BE47-3F5817A25669/0/InfectionControl_GF_DisinfectntSelectnGuidelines_nov0503.pdf Accessed August 2013.

Bild S. Detection of occult blood on EEG surface electrodes. Am J Electroneurodiagnostic Technol 1997; 37(4):251–57.

Center for Disease Control and Prevention (CDC)/Hospital infection Control Practices Advisory Committee (HICPAC). Guidelines for environmental infection control in health-care facilities.

2003. On the Internet at: http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5210a1.htm Accessed August 2013.
Center for Disease Control and Prevention (CDC). Guideline for isolation precautions: preventing transmission of infectious agents in healthcare settings 2007. 2007. On the Internet at: http://stacks.cdc.gov/view/cdc/6878/. Accessed August 2013.
Centers for Disease Control and Prevention (CDC). Questions and answers: Creutzfeldt-Jakob disease infection control practices. 2010. On the Internet at: www.cdc.gov/ncidod/dvrd/cjd/qa_cjd_infection_control.htm Accessed August 2013.
Centers for Disease Control and Prevention (CDC). Infection prevention checklist for outpatient settings: minimum expectations for safe care. 2011. On the Internet at: http://www.cdc.gov/HAI/settings/outpatient/checklist/outpatient-care-checklist.html Accessed February 2012.
Centers for Disease Control and Prevention (CDC). What is the right way to wash your hands. 2013. On the Internet at: http://www.cdc.gov/handwashing/. Accessed September 2013.
CDC-INFO. RE: Disinfecting Reusable EEG Electrodes, Personal email reply, March 20, 2012, cdcinfo@cdc.gov.
Food and Drug Administration (FDA). Guidance for industry: revised preventive measures to reduce the possible risk of transmission of Creutzfeldt-Jakob Disease (CJD) and variant Creutzfeldt-Jakob Disease (vCJD) by blood and blood products. Last updated April 2012. On the Internet at: http://www.fda.gov/biologicsbloodvaccines/guidancecomplianceregulatory information/guidances/blood/ucm074089.htm. Accessed August 2013.
General Industry Regulations 29CFR1910, US Department of Labor Occup Safety and Health Admin, 2008.
Georgia Department of Public Health. Hypochlorite (Bleach) Solution Concentration. On the Internet at: health.state.ga.us. Accessed August 2013.
Grass Technologies, Genuine Grass precious metal electrode care. 2013. On the Internet at: http://www.grasstechnologies.com/knowledgebase/sterile1.html. Accessed August 2013.
Lawriter. Ohio Revised Code 4731-17-04 Disinfection and sterilization. 2007. On the Internet at http://codes.ohio.gov/oac/4731-17-04. Accessed August 2013.
Liras A. The variant Creutzfeldt-Jakob disease: risk, uncertainty or safety in the use of blood and blood derivatives. Int Arch Med 2008; June 23; 1(1):9.
Llewelyn CA, Hewitt PE, Knight RS, Amar K, Cousens S, Mackenzie J, Will RG. Possible transmission of variant Creutzfeldt-Jakob disease by blood transfusion. Lancet 2004; 363(9407):411–12.
Luich R. Letter to the editor: infection control. Am J Electroneurodiagnostic Technol 2000; 40(2):71–72.
Middlesex-London Health Unit. Mixing of chlorine (bleach) solution for disinfecting. On the Internet at https://www.healthunit.com/clean-up. Accessed August 2013.
National Institute of Health (NIH), National Institute of Neurological Disorders and Stroke (NINDS). NINDS Creutzfeldt-Jakob disease information page. Last updated June 2013. On the Internet at http://www.ninds.nih.gov/disorders/cjd. Accessed August 2013.
Occupational Safety and Health Administration (OSHA). Eye wash stations. 1910.151, 1910.151(c). 2009. On the Internet at: https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=27089. Accessed September 2013.
Occupational Safety and Health Administration (OSHA). Bloodborne pathogens — 1910.1030. 2012. On the Internet at: https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10051. Accessed August 2013.
Peden AH, Head MW, Ritchie DL, Bell JE, Ironside JW. Preclinical vCJD after blood transfusion in a PRNP codon 129 heterozygous patient. Lancet 2004; 364(9433):477–79.
Rutala W. APIC guideline for selection and use of disinfectants. Am J Infec Control 1996; 24(4): 313–42.
Schneider AL. Technical tips: subdermal needle electrodes: an option for emergency ("stat") EEGs. Am J Electroneurodiagnostic Technol 2006; 46(4):363–68.
Sheltermedicine. Guidelines for using bleach. 2011. On the Internet at http://sheltermedicine.vetmed.ufl.edu/files/2011/12/guidelines-for-using-bleach-update.pdf. Accessed August 2013.

Society for Healthcare Epidemiology of America (SHEA). Compendium of strategies to prevent healthcare-associated infections in acute care hospitals. 2008. On the Internet at: http://www.shea-online.org/HAITopics/CompendiumofStrategiestoPreventHAIs.aspx. Accessed September 2013.

Soule B, Memish Z, Malani P (Editors). Best Practices in Infection Prevention and Control: Second Edition. Joint Commission International, 2012.

Sullivan LR, Altman CL. Infection control: 2008 review and update for electroneurodiagnostic technologists. Am J Electroneurodiagnostic Technol 2008; 48(3):140–65.

Turner M. The impact of new-variant Creutzfeldt-Jakob disease on blood transfusion practice. Br J Haematol 1999; 106(4):842–50.

World Health Organization. WHO manual for surveillance of human transmissible spongiform encephalopathies including variant Creutzfeldt-Jakob disease. 2003.On the Internet at http://whqlibdoc.who.int/publications/2003/9241545887.pdf. Accessed August 2013.

World Health Organization (WHO). Report on the burden of endemic health care-associated infection worldwide: clean care is safer care. 2011. On the Internet at: http://whqlibdoc.who.int/publications/2011/9789241501507_eng.pdf. Accessed August 2013.