Recommendations for Sterilization of Prion-Contaminated Surgical Instruments

William A. Rutala, Ph.D., M.P.H.

University of North Carolina (UNC) Health Care System and UNC School of Medicine, Chapel Hill, NC, USA

Disclosure: Clorox

SHEA Guideline

Infect Control Hosp Epidemiol 2010;31:107

INFECTION CONTROL AND HOSPITAL EPIDEMIOLOGY FEBRUARY 2010, VOL. 31, NO. 2

SHEA GUIDELINE

Guideline for Disinfection and Sterilization of Prion-Contaminated Medical Instruments

William A. Rutala, PhD, MPH; David J. Weber, MD, MPH

EPIDEMIOLOGY OF THE CREUTZFELDT-JAKOB DISEASE PRION

Creutzfeldt-Jakob disease (CJD) is a degenerative neurologic disorder of humans with an incidence in the United States of approximately 1 case per million population per year.[1-3]

tains. To date, no evidence for transmission of chronic wasting disease of deer and elk to humans has been identified.[7-10]

TRANSMISSION OF CJD VIA MEDICAL DEVICES

Prion Diseases: Current and Future Challenges

Topics

- Learning Objectives
  - Define the etiology, epidemiology, and clinical features of prion transmission
  - Review iatrogenic transmission of prion diseases
  - Examine the infectivity of human tissues
  - Review the prion inactivation studies
  - Provide the recommendations to prevent cross-transmission from medical devices contaminated with prions
  - Discuss future challenges

Prion Diseases: Current and Future Challenges

Topics

- Learning Objectives
  - Define the etiology, epidemiology, and clinical features of prion transmission
  - Review iatrogenic transmission of prion diseases
  - Examine the infectivity of human tissues
  - Review the prion inactivation studies
  - Provide the recommendations to prevent cross-transmission from medical devices contaminated with prions
  - Discuss future challenges

Transmissible Spongiform Encephalopathies (TSEs) of Humans

- Kuru-now eradicated
- Gertsmann-Straussler-Scheinker (GSS)-1/40M
- Fatal Familial Insomnia (FFI)-<1/40M
- Creutzfeldt-Jakob Disease (CJD)-1/1M
- Variant CJD (vCJD), (221 cases, August 2011)
  Acquired from cattle with BSE.1995: 172 UK, 25 France, 4 Ireland, 2 Italy, 3 USA, 2 Canada,1 Saudi Arabia, 1 Japan, 3 Netherlands, 2 Portugal, 5 Spain, 1 Taiwan

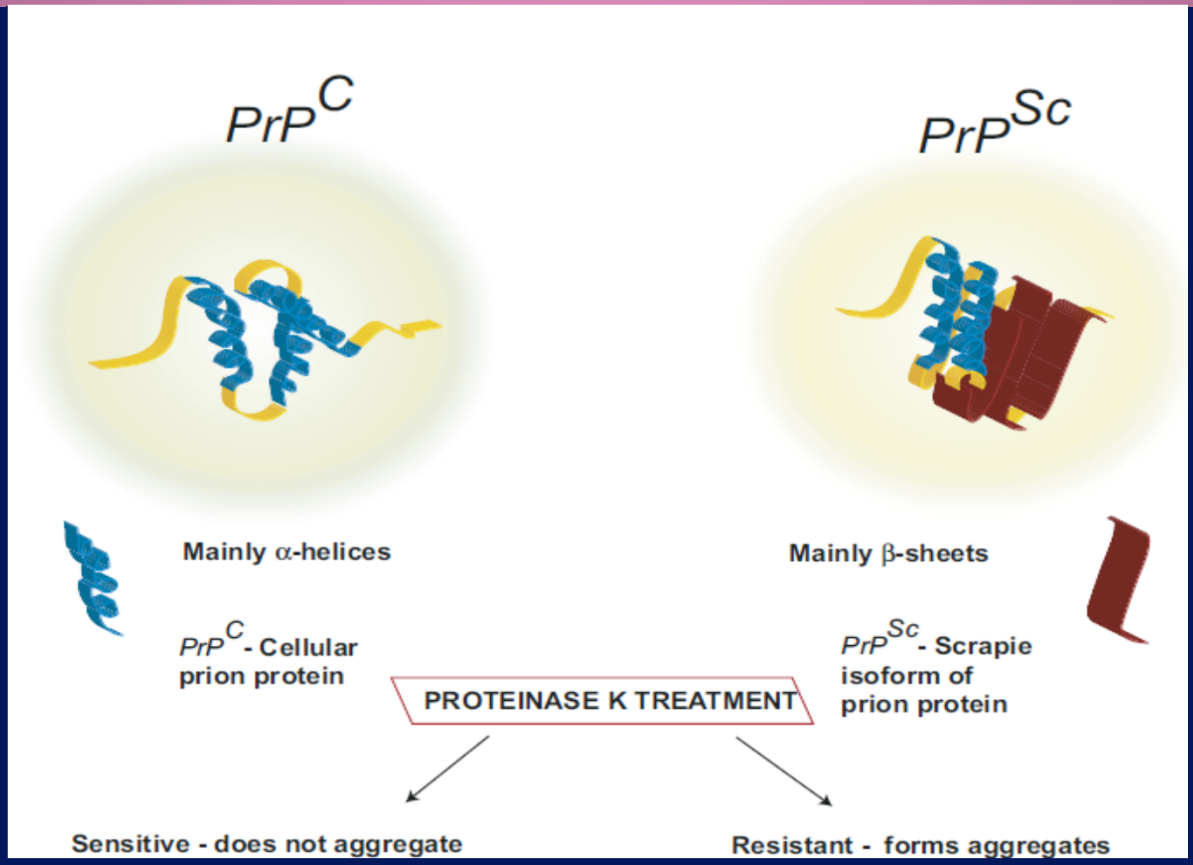
Epidemiology of CJD in the US

- Degenerative neurologic disorder with progressive dementia
- Incidence
  - One death/million population
  - No seasonal distribution, no geographic aggregation
  - Both genders equally affected
  - Age range 50-80+ years, average 67
- Long incubation disease (months-years)
- Rapid disease progression after onset (death within 6 mo)

Prion Diseases

- Etiology
  - Prions (proteinaceous infectious agent)
    - No agent-specific nucleic acid
    - Host protein (PrP^{c}) converts to pathologic isoform (PrP^{sc}); PrP gene resides on chromosome 20
    - The function of the normal prion protein is unknown
    - Mutation in this gene may trigger transformation
    - Accumulates in neural cells, disrupts function
    - Resistant to conventional D/S procedures

NORMAL AND DISEASE-RELATED ISOFORMS OF THE PRION PROTEIN



Venneti S. Clin Lab Med 2010;30:293-309

PRION DISEASE IN HUMANS

Year of Description	Clinical Illness	Mode of Disease
1920	Creutzfeldt-Jakob disease	Familial, sporadic, and transmitted (mainly iatrogenic)
1928	Gerstmann-Straussler-Scheinker	Familial, genetic
1941	Kuru	Transmitted
1986	Fatal familial insomnia	Familial, genetic
1995	New variant of Creutzfeldt-Jakob disease	Transmitted

Venneti S. Clin Lab Med 2010;30:293-309

PRION DISEASES IN ANIMALS

Year of Description	Animal	Disease	Known Transmission to Humans
1732	Sheep and goats	Scrapie	No
1947	Mink	Transmissible mink encephalopathy	No
1967	Elk and deer	Chronic wasting disease	No
1986	Cattle	Bovine spongiform encephalopathy	Yes
1986	Antelopes, bison	Exotic ungulate spongiform encephalopathy	No
1990	Domestic cats and captive large cats	Feline spongiform encephalopathy	No
1996	Captive nonhuman primates	Zoo primate spongiform encephalopathy	No

Clinical Features of CJD

- Degenerative neurological disorder with progressive dementia (memory, intellect, personality)
- Progressive motor deterioration
  - Unsteadiness, clumsiness, incoordination (ataxia)
  - Visual deterioration
  - Muscle twitching (myoclonus)
  - Severe dementia, mute, immobile
- Death (< 1 year)

CLINICAL PHENOTYPES OF PRION DISEASES

Disease	Primary features	Age at Onset (Range)	Duration	Pathology
Kuru	Ataxia, then dementia	40 years (29-60)	3 months–1 year	Kuru plaques
sCJD	Dementia, ataxia, myoclonus	61 years (17-83) rare <40	<1 year	Generalized grey matter vacuolation and gliosis
fCJD	Dementia, ataxia, myoclonus	Typically <55 years (20s to 80s)[a]	1–5 years	Generalized grey matter vacuolation and gliosis
GSS	Ataxia, then dementia	Typically <55 years (20s to 60s)[a]	2–6 years	PrP-plaques, gliosis, less vacuolation
FFI	Insomnia, dysautonomia, ataxia, dementia	45 ± 10	~1 year	Focal thalamic and olivary gliosis, neuronal dropout
vCJD	Behavioral changes, later dementia	Teens/young adults	~1.5 years	Florid plaques and diffuse spongiosis

Abbreviations: fCJD, familial Creutzfeldt-Jakob disease; FFI, familial fatal insomnia; GSS, Gerstmann-Sträussler-Scheinker syndrome; sCJD, Creutzfeldt-Jakob disease; vCJD, variant Creutzfeldt-Jakob disease.

Brown K, Mastrianni JA. J Geriat Psychiat Neurol 2010;23:277-298

DIAGNOSIS OF CJD

Features	Clinical Features and Laboratory Test Result
Possible CJD	Rapidly progressive dementia Myoclonus (may first present as exaggerated startle response) Ataxia and other motor abnormalities MRI with characteristic cortical rimming (sCJD) or pulvinar sign (vCJD) Increased cerebrospinal fluid levels of 14-3-3 protein Triphasic electroencephalogram complexes Family history (fCJD) or documented exposure (iCJD and vCJD)
Confirmed CJD	Mutations detected in PRNP gene (fCJD) Detectable PrP^{Sc} in brain biopsies or autopsy Detectable PrP^{Sc} in tonsillar biopsy (vCJD)

Transmissibility of Prions

- Transmission
  - Not spread by contact (direct, indirect, droplet) or airborne
  - Not spread by the environment
  - Experimentally-all TSEs are transmissible to animals, including the inherited forms
  - Epidemiology of CJD: sporadic-~85%; familial-~15%; iatrogenic-<1% (majority after implant of contaminated grafts [dura mater] or receive hormone therapy, ~400 cases worldwide; contaminated medical equipment [6 cases])

CLINICAL FEATURES OF SPORADIC VERSUS VARIANT CJD

Characteristic	Main Feature	sCJD	vCJD
Clinical features	Median age	68 y	28 y
	Median duration of illness	4 mo	13 mo
	Symptoms and signs	Dementia; early neurologic signs	Behavioral abnormalities, sensory symptoms and delayed neurologic signs
Clinical tests	Periodic triphasic sharp waves on electroencephalogram	Often present	Often absent
	Hyperintensity in posterior thalamus (pulvinar) in relation to the anterior putamen on brain imaging: called the "pulvinar sign"	Often absent	Present in >75% of cases
Laboratory tests	Presence of florid plaques on brain tissues including biopsy	Rare or absent	Present
	Immunohistochemistry for PrP^{Sc} in brain tissues	Variable accumulation	Marked accumulation of PrP^{Sc}
	Detectable PrP^{Sc} in lymphoid tissue including tonisllar biopsy	Not readily detected	Readily detected
	Codon 129 geneotype	Usually Met/Met	Polymorphism may be absent

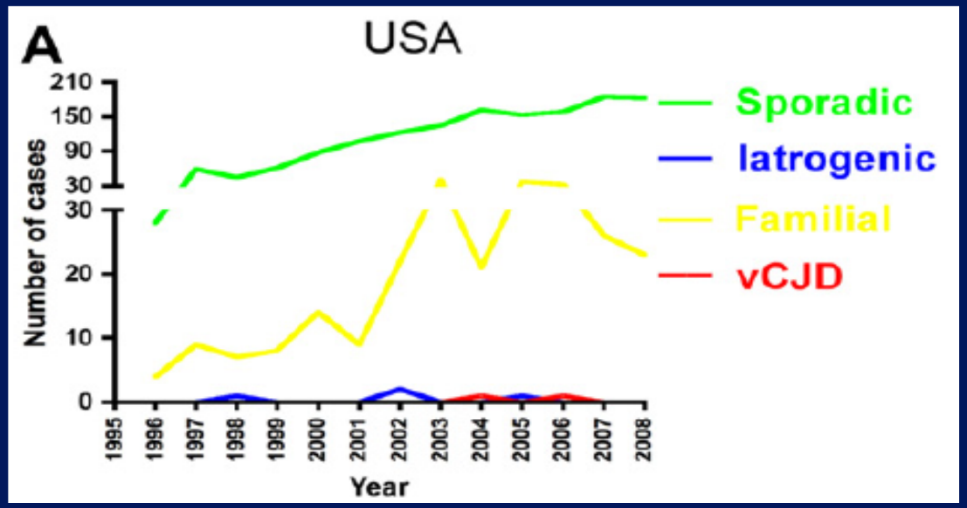
Venneti S. Clin Lab Med 2010;30:293-309

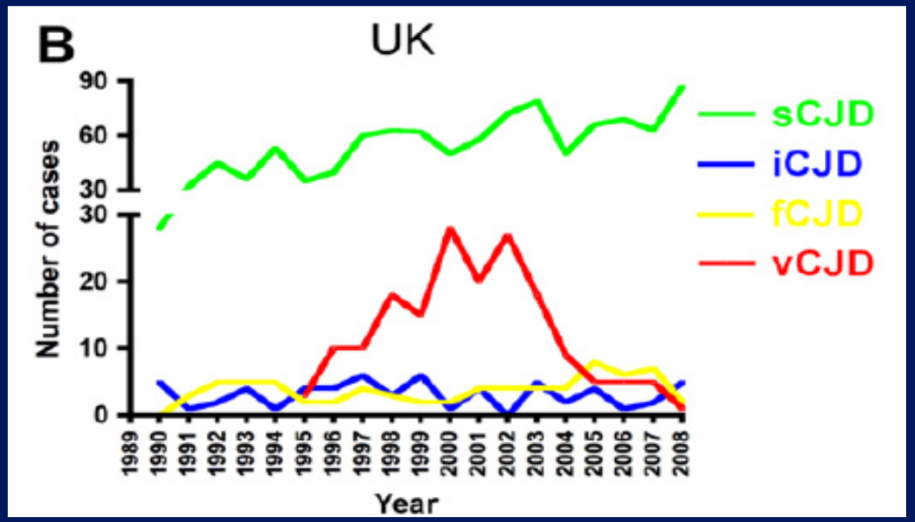
Prion Diseases: Current and Future Challenges

Topics

- Learning Objectives
  - Define the etiology, epidemiology, and clinical features of prion transmission
  - Review iatrogenic transmission of prion diseases
  - Examine the infectivity of human tissues
  - Review the prion inactivation studies
  - Provide the recommendations to prevent cross-transmission from medical devices contaminated with prions
  - Discuss future challenges

PRION DISEASES IN THE US (1996-2008) AND UK (1989-2008)





US - Green (sporadic, 85%), yellow (familial, 14.7%), blue (iatrogenic, 0.2%), red (vCJD, 0.1%)
UK – Green (sporadic, 78%), blue (iatrogenic, 4%), yellow (familial, 5%), red (vCJD, 13%)
Venneti S. Clin Lab Med 2010;30:293-309

Iatrogenic Transmission of CJD

- Contaminated medical instruments
  - Electrodes in brain (2)
  - Neurosurgical instruments in brain (4 suspected cases)
- Implantation of contaminated grafts
  - Dura mater grafts (>190)
  - Corneal grafts (3)
- After patients received hormone therapy
  - Use of human growth hormone and gonadotropin (>190 cases)

CJD and Medical Devices

- Six cases of CJD associated with medical devices
  - 2 confirmed cases-depth electrodes; reprocessed by benzene, 70% alcohol and formaldehyde vapor
  - 4 unconfirmed cases-CJD following brain surgery, suspect neurosurgical instruments; index CJD identified-1
- Cases occurred from 1953-1980 in UK, France and Switzerland
- No cases since 1980 and no known failure of steam sterilization

Prion Diseases: Current and Future Challenges

Topics

- Learning Objectives
  - Define the etiology, epidemiology, and clinical features of prion transmission
  - Review iatrogenic transmission of prion diseases
  - Examine the infectivity of human tissues
  - Review the prion inactivation studies
  - Provide the recommendations to prevent cross-transmission from medical devices contaminated with prions
  - Discuss future challenges

Risk of CJD Transmission

- Epidemiologic evidence (eye, brain) linking specific body tissue or fluids to CJD transmission
- Experimental evidence in animals demonstrating that body tissues or fluids transmit CJD
  - Infectivity assays a function of the relative concentration of CJD tissue or fluid

COMPARATIVE FREQUENCY OF INFECTIVITY IN ORGANS, TISSUE, AND BODY FLUIDS OF HUMANS WITH PRIONS (CJD)

Rutala, Weber. Infect Control Hosp Epidemiol 2010;31:107

Infectious risk[a]	Tissue
High	Brain (including dura mater), spinal cord, posterior eye, pituitary tissue
Low	Cerebrospinal fluid, liver, lymph node, kidney, lung, spleen, placenta, olfactory epithelium
No risk	Peripheral nerve, intestine, bone marrow, whole blood, leukocytes, serum, thyroid gland, adrenal gland, heart, skeletal muscle, adipose tissue, gingiva, prostate, testis, tears, saliva, sputum, urine, feces, semen, vaginal secretions, milk, sweat

NOTE. Modified from Brown[14] and Brown et al,[15] with information from other studies.[16-20]

[a] High risk indicates a rate of transmission to inoculated animals of >50%; low risk indicates a rate of transmission to inoculated animals of ⩾10%–20% (except for lung tissue, for which transmission is 50%); no risk indicates a rate of transmission to inoculated animals of 0% (several tissues in this category had few tested specimens).

Prion Diseases: Current and Future Challenges

Topics

- Learning Objectives
  - Define the etiology, epidemiology, and clinical features of prion transmission
  - Review iatrogenic transmission of prion diseases
  - Examine the infectivity of human tissues
  - Review the prion inactivation studies
  - Provide the recommendations to prevent cross-transmission from medical devices contaminated with prions
  - Discuss future challenges

Decreasing Order of Resistance of Microorganisms to Disinfectants/Sterilants

Most Resistant

Prions (CJD)

Spores (*C. difficile*)

Mycobacteria (TB)

Non-Enveloped Viruses (norovirus)

Fungi (*Aspergillus*)

Bacteria (MRSA, VRE, *Acinetobacter*)

Enveloped Viruses (HIV)

Most Susceptible

CJD: DISINFECTION AND STERILIZATION

- Effectiveness must consider both removal by cleaning and disinfection/sterilization
  - Probability of a device remaining capable of transmitting disease depends on the initial contamination and effectiveness of cleaning and disinfection/sterilization.
  - Device with 100µg of protein (median protein contamination from 8-91µg per instrument) and CJD brain tissue has a titer of 5 $\log_{10}$ LD_{50}IC/g (mean infectivity calculated from group of 27), an instrument would have 10 potentially infectious units without considering prionicidal activity of process.

EFFICACY OF CHEMICALS IN INACTIVATING PRIONS Rutala, Weber.

Rutala, Weber. Infect Control Hosp Epidemiol 2010;31:107

Ineffective ($\leqslant 3$ $\log_{10}$ reduction within 1 hour)	Effective (>3 $\log_{10}$ reduction within 1 hour at temperatures of 20°C–55°C)
Acetone	Alkaline detergent (specific formulations)
Alcohol, 50%–100%	Chlorine, >1,000 ppm
Alkaline detergent (specific formulations)	Copper, 0.5 mmol/L, and hydrogen peroxide, 100 mmol/L
Ammonia, 1.0 M	Enzymatic detergent (specific formulations)
Chlorine dioxide, 50 ppm	Guanidine thiocyanate, >3 M
Enzymatic detergent (specific formulations)	Hydrogen peroxide, 59%
Formaldehyde, 3.7%	Peracetic acid, 0.2%
Glutaraldehyde, 5%	Phenolic disinfectant (specific formulation), >0.9%
Hydrochloric acid, 1.0 N	Quaternary ammonium compound (specific formulation)
Hydrogen peroxide, 0.2%, 3%, 6%, 30%, 60%	Sodium dodecyl sulfate, 2%, and acetic acid, 1%
Iodine, 2%	Sodium hydroxide, $\geqslant 1$ N
Ortho-phthalaldehyde, 0.55%	Sodium metaperiodate, 0.01 M
Peracetic acid, 0.2%–19%	
Phenol/phenolics (concentration variable)	
Potassium permanganate, 0.1%–0.8%	
Quaternary ammonium compound (specific formulation)	
Sodium dodecyl sulfate, 1%–5%	
Sodium deoxycholate 5%	
Tego (dodecyl-di[aminoethyl]-glycine), 5%	
Triton X-100, 1%	
Urea, 4–8 M	

NOTE. The same process may be listed as both effective and ineffective because of differences in chemical concentration, exposure time, temperature, pH, etc, or differences in testing methods. All of these experiments were done without cleaning. Modified from Rutala and Weber,[16] with information from other studies.[27-30,32-35,37-39,42,44-49,60,61,64,66,78-88]

Effective Disinfectants

($\geq$3 $\log_{10}$ decrease in LD_{50} within 1 hour)

- Sodium hydroxide
  - 1 N for 1h (variable results)
- Sodium hypochorite
  - 5000 ppm for 15m
- Guanidine thiocyanate
  - >3M
- Phenolic (LpH)
  - 0.9% for 30m
- Some alkaline and enzymatic detergents

EFFICACY OF STERILIZATION PROCESSES IN INACTIVATING PRIONS

Rutala, Weber. Infect Control Hosp Epidemiol 2010;31:107

Ineffective (≤ 3 $\log_{10}$ reduction within 1 hour)	Effective (>3 $\log_{10}$ reduction from 18 minutes to 3 hours)
Autoclave at standard exposure conditions (121°C for 15 minutes)	Autoclave at 121°C–132°C for 1 hour (gravity displacement sterilizer) or 121°C for 30 minutes (prevacuum sterilizer)
Boiling	Autoclave at 134°C for 18 minutes (prevacuum sterilizer)
Dry heat	Autoclave at 134°C for 18 minutes immersed in water
Ethylene oxide	Hydrogen peroxide gas plasma (Sterrad NX)
Formaldehyde	Radiofrequency gas plasma
Hydrogen peroxide gas plasma, Sterrad 100S (ASP)	Sodium dodecyl sulfate, 2%, plus acetic acid, 1%, plus autoclave at 121°C for 15–30 minutes
Ionizing radiation	Sodium hydroxide (NaOH), 0.09 N or 0.9 N, for 2 hours plus autoclave at 121°C for 1 hour (gravity displacement sterilizer)
Microwave	Vaporized hydrogen peroxide, 1.5–2 mg/L
UV light	

NOTE. The same process may be listed as both effective and ineffective because of differences in sterilant concentration, exposure time, temperature, etc, or differences in testing methods. All of these experiments were performed without cleaning. Modified from Rutala and Weber,[16] with information from other studies.[27-52]

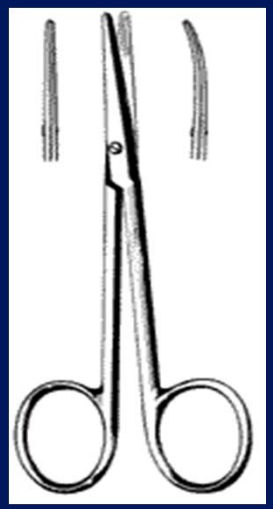
Effective Processes: CJD

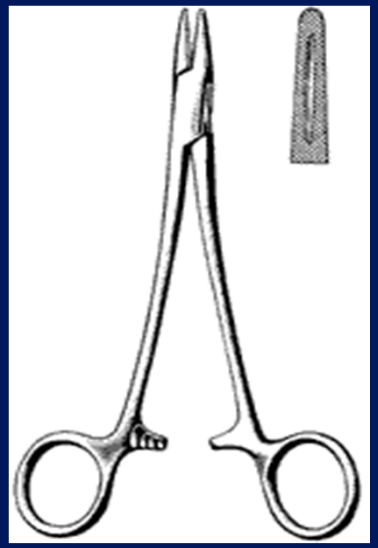
- Autoclave
  - 134°C for 18m (prevacuum)
  - 132°C for 60m (gravity)
- Combination (chemical exposure then steam autoclave, potentially deleterious to staff, instruments, sterilizer)
  - Soak in 1N NaOH for 1 hour, remove and rinse in water, then autoclave 121°C for 60m

Prion Diseases: Current and Future Challenges

Topics

- Learning Objectives
  - Define the etiology, epidemiology, and clinical features of prion transmission
  - Review iatrogenic transmission of prion diseases
  - Examine the infectivity of human tissues
  - Review the prion inactivation studies
  - Provide the recommendations to prevent cross-transmission from medical devices contaminated with prions
  - Discuss future challenges





CJD : potential for secondary spread through contaminated surgical instruments

Disinfection and Sterilization

- EH Spaulding believed how an object will be D/S depended on the objects intended use
  - CRITICAL-objects that enter normally sterile tissue or the vascular system should be sterile
  - SEMICRITICAL-objects that touch mucous membranes or skin that is not intact requires a disinfection process (high level disinfection) that kills all but bacterial spores (prions?)
  - NONCRITICAL-objects that touch only intact skin require low-level disinfection

Risk Assessment for Special Prion Reprocessing: Patient, Tissue, Device

- High-Risk Patient
  - Known or suspected CJD or other TSEs
  - Rapidly progressive dementia
  - Familial history of CJD, GSS, FFI
  - History of dura mater transplant, cadaver-derived pituitary hormone injection
- High-Risk Tissue
  - Brain, spinal cord, eyes
- High-Risk Device
  - Critical or semicritical

STERILIZATION OPTIONS FOR PROCESSING CJD CONTAMINATED PATIENT-CARE EQUIPMENT

1. Autoclave at 134 °C for ≥18 minutes in a prevacuum sterilizer
2. Autoclave at 132 °C for 1 hour in a gravity displacement sterilizer
3. Immerse in 1 N NaOH for 1 hour; remove and rinse in water, then transfer to an open pan and autoclave (121 °C for 1 hour in a gravity displacement sterilizer or 134 °C in a porous or prevacuum sterilizer) for 1 hour
4. Immerse in 1 N NaOH for 1 hour and heat in a gravity displacement sterilizer 121 °C for 30 minutes (to minimize autoclave and operator exposure to gaseous NaOH when immersing instruments and autoclaving in NaOH, the use of containers with a rim and lid designed for condensation to collect and drip back into the pan is recommended); then rinse and subject to routine sterilization

Examples: CJD D/S

- High risk patient, high risk tissue, critical/semicritical device-special prion reprocessing
- High risk patient, **low risk tissue** (defined as CSF, kidney, liver, spleen, lung, etc) critical/semicritical device-no recommendation, use either conventional D/S or special prion reprocessing
- High risk patient, **no risk tissue**, C/SC device-conventional D/S
- **Low risk patient**, high risk tissue, critical/semicritical device-conventional D/S
- High risk patient, high risk tissue, **noncritical device**-conventional disinfection

RECOMMENDATIONS FOR PROCESSING CJD-CONTAMINATED PATIENT-CARE EQUIPMENT

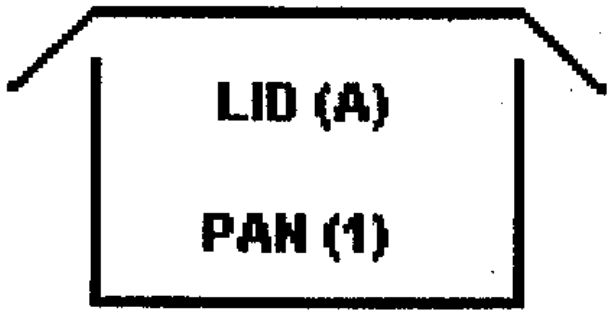
- Discard devices that are impossible to clean (II)
- Do not use flash sterilization for reprocessing instruments (IB)
- Discard items that permit only low-temperature sterilization (e.g., ethylene oxide) (IB)
- No recommendation can be made regarding the use of low-temperature technologies that have shown prionicidal activity, such as specific type of hydrogen gas plasma, and vaporized hydrogen peroxide as data are limited and require corroboration (unresolved)
- Recall contaminated items (e.g., medical devices used for brain biopsy before diagnosis) that have not been processed according to there recommendations and appropriately reprocess them (II)

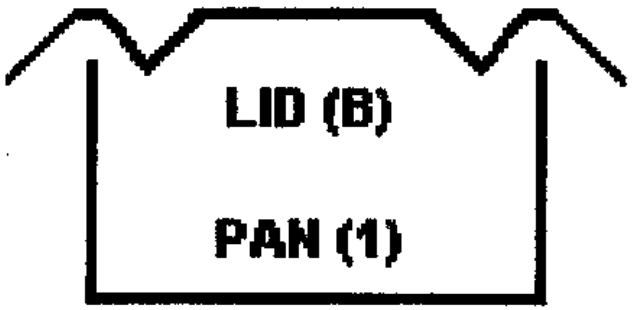
D/S of Medical Devices

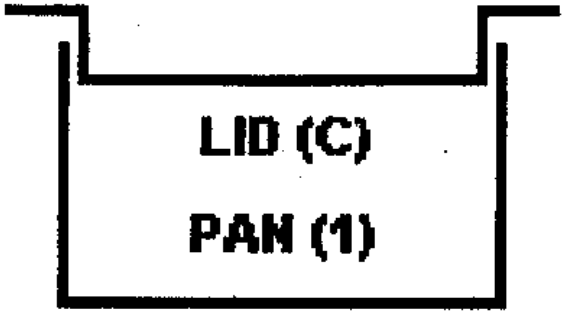
- Issues
  - Do not allow tissue/body fluids to dry on instruments (e.g., place in liquid)
  - Some decontamination procedures (e.g., aldehydes) fix protein and this may impede effectiveness of processes
  - Clean instruments but prevent exposure
  - Assess risk of patient, tissue, device
  - Choose effective process

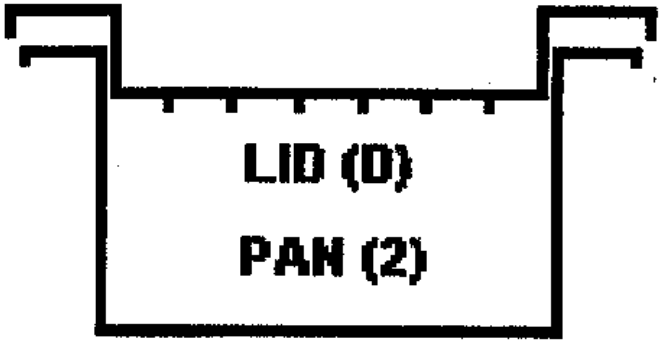
CJD: Instrument Reprocessing

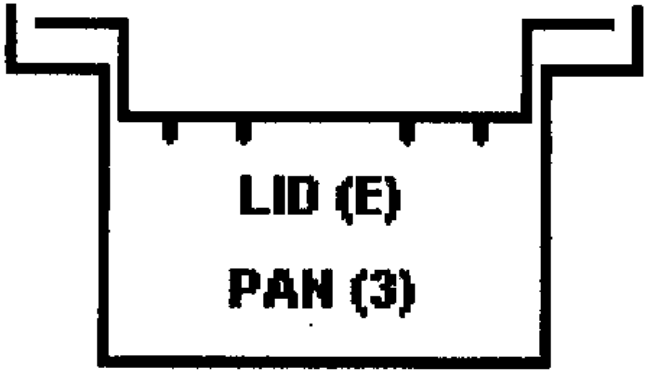
- Special prion reprocessing by combination of NaOH and steam sterilization
  - Immerse in 1N NaOH for 1 hour; remove and rinse in water, then transfer to an open pan and autoclave at 121^{o}C for 1 hour
  - Immerse in 1N NaOH for 1 hour and heat in a gravity displacement sterilizer at 121^{o}C for 30 minutes
- Combined use of autoclaving in sodium hydroxide has raised concerns of possible damage to autoclaves, and hazards to operators due to the caustic fumes.
- Risk can be minimized by the use of polypropylene containment pans and lids (AJIC 2003; 31:257-60).

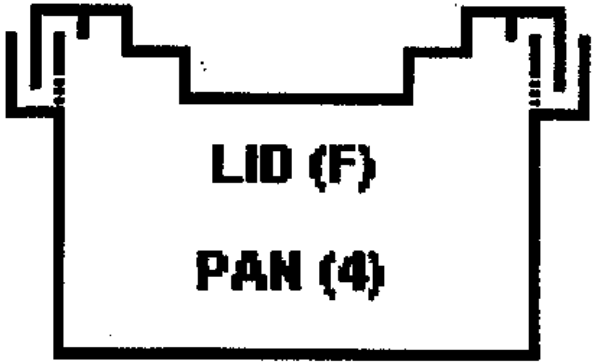

LID (A)
PAN (1)


LID (B)
PAN (1)


LID (C)
PAN (1)


LID (D)
PAN (2)


LID (E)
PAN (3)


LID (F)
PAN (4)

CJD: Disinfection and Sterilization
Conclusions

- Critical/Semicritical-devices contaminated with high-risk tissue from high-risk patients requires special prion reprocessing
  - 134°C for 18m (prevacuum)
  - 132°C for 60m (gravity)
  - NaOH and steam sterilization (e.g., 1N NaOH 1h, then 121°C 1h)
- Discard instruments that are impossible to clean
- No low temperature sterilization technology currently recommended*
- Noncritical-four disinfectants (e.g., chlorine, Environ LpH) effective (4 log decrease in LD_{50} within 1h)

*VHP and HP gas plasma (Sterrad NX) reduced prion infectivity but not cleared by FDA

Prevent Patient Exposure to CJD Contaminated Instruments

How do you prevent patient exposure to neurosurgical instruments from a patient who is latter given a diagnosis of CJD?

Hospitals should use the special prion reprocessing precautions for instruments from patients undergoing brain biopsy when a specific lesion (e.g., suspected tumor, abscess) has not been demonstrated by CT or MRI. Alternatively, neurosurgical instruments used in such cases could be disposable.

RECOMMENDATIONS FOR CLEANING ENVIRONMENTAL SURFACES AND NONCRITICAL DEVICES

- Clean noncritical environmental surfaces contaminated with high-risk tissues (e.g., a lab surface in contact with brain of a CJD-infected person) with a detergent and then spot decontaminate these surfaces with 1:5 to 1:10 dilution of sodium hypochlorite (i.e., bleach; a 1:5 dilution of 5.25-6.15% sodium hypochlorite provides 10,500-12,300 ppm chlorine), ideally for a contact time of at least 15 minutes. To minimize environmental contamination, use disposable plastic-backed cover sheets on work surfaces (IB)
- Clean and then disinfect noncritical equipment that has been decontaminated with high-risk tissue using a 1:5 to 1:10 dilution of sodium hypochlorite or 1 N NaOH, depending on material compatibility. Ensure that all contaminated surfaces are exposed to the disinfectant (IB)

General Infection Prevention Precautions

- Standard Precautions should be used for patients with CJD. Gloves worn for handling blood and body fluids.
- Masks, gowns, and eyewear if exposure is anticipated.
- No additional precautions for laundry or handling food utensils.
- Patients with prion diseases should not serve as organ donors
- No special precautions for disposal of body fluids or regulated medical waste.
- No excess precautions needed for burial.

Prion Diseases: Current and Future Challenges

Topics

- Learning Objectives
  - Define the etiology, epidemiology, and clinical features of prion transmission
  - Review iatrogenic transmission of prion diseases
  - Examine the infectivity of human tissues
  - Review the prion inactivation studies
  - Provide the recommendations to prevent cross-transmission from medical devices contaminated with prions
  - Discuss future challenges and changes

Critical/semicritical instruments contaminated with high-risk tissue from a high-risk patient require “special prion reprocessing”. New technologies may alter the need for “special prion reprocessing” in the future.

Inactivation of Prions

Newer Studies

- Yan et al. Infect Control Hosp Epidemiol 2004;25:280. Enzymatic cleaner (EC)-no effect
- Fichet et al. Lancet 2004;364:521. Phenolic (Environ LpH), alkaline cleaner (AC), EC+VHP-effective
- Baier et al. J Hosp Infect 2004;57:80. AC-effective
- Lemmer et al. J Gen Virol 2004;85:3805. SDS/NaOH, AC, 0.2% PA, 5% SDS-effective (in vitro)
- Jackson et al. J Gen Virol 2005;86:869. E (Pronase, PK)-effective
- Race R and Raymond G. J Virol 2004;78:2164. Environ LpH-effective
- Peretz et al. J Virol 2006;80:1. Acidic SDS and SDS+SS-effective
- Fichet et al. JHI 2007;67:278. Gaseous HP-effective
- Yan et al. Zentr Steril 2008;16:26-34. HP Gas Plasma effective (Sterrad NX)
- Rogez-Kreuz C. ICHE 2009;30:769. HP Gas Plasma effective (Sterrad NX)

Variant CJD

- Strongly associated with epidemiology of BSE (1983) in UK
- BSE amplified by feeding cattle meat and bone meal infected with BSE (bovine spongiform encephalopathy)
- August 2011 (221 cases: 172 UK, 25 France, 4 Ireland, 2 Italy, 3 USA, 2 Canada,1 Saudi Arabia, 1 Japan, 3 Netherlands, 2 Portugal, 5 Spain, 1 Taiwan)
- Affects young persons (range 13-48y, median 28y)
- Clinical course is longer (14 mo vs <6 mo)
- BSE not reported in the United States
- vCJD and BSE are believed caused by the same prion agent

vCJD: Disinfection and Sterilization

- To date no reports of human-to-human transmission of vCJD by tissue but 4 possible cases by blood transfusion reported
- Unlike CJD, vCJD detectable in lymphoid tissues (e.g., spleen, tonsils, thymus, appendix) and prior to onset of clinical illness
- Special prion reprocessing (or single use instruments) proposed in the UK in dental, eye, or tonsillar surgery on high risk patients for CJD or vCJD
- If epidemiological and infectivity data show these tissues represent a transmission risk then special prion reprocessing could be extended to these procedures

CJD: Disinfection and Sterilization
Conclusions

- Epidemiologic evidence suggests nosocomial CJD transmission via medical devices is very rare
- Guidelines based on epidemiologic evidence, tissue infectivity, risk of disease via medical devices, and inactivation data
- Risk assessment based on patient, tissue and device
- Only critical/semicritical devices contacting high risk tissue from high risk patients require special prion reprocessing

CJD: Disinfection and Sterilization
Conclusions

- Critical/Semicritical-devices contaminated with high-risk tissue from high-risk patients requires special prion reprocessing
  - 134^{0}C for 18m (prevacuum)
  - 132^{0}C for 60m (gravity)
  - NaOH and steam sterilization (e.g., 1N NaOH 1h, then 121^{0}C 1h)

Prion Diseases: Current and Future Challenges

Topics

- Learning Objectives
  - Define the etiology, epidemiology, and clinical features of prion transmission
  - Review iatrogenic transmission of prion diseases
  - Examine the infectivity of human tissues
  - Review the prion inactivation studies
  - Provide the recommendations to prevent cross-transmission from medical devices contaminated with prions
  - Discuss future challenges

THANK YOU!

disinfectionandsterilization.org

CJD and Medical Devices

- World Health Organization, 2000
  - When instruments contact high infectivity tissue, single-use instruments recommended.
  - If single-use instruments not available, maximum safety attained by destruction of re-usable instruments.
  - Where destruction is not practical, reusable instruments must be decontaminated by immerse in 1N NaOH and autoclaved (121^{0}C/30m), cleaned, rinsed and steam sterilized.
  - After decontamination by steam and NaOH, instruments can be cleaned in automated mechanical reprocessor.

CAVEATS ON INTERPRETING PRION STERLIZATION DATA

- In general, studies have not incorporated a cleaning procedure prior to sterilization (cleaning reduces protein contamination)
- Prion studies have been performed with tissue homogenates, and the protective effect of tissue may explain, in part, why the CJD agent is difficult to inactivate
- Results of inactivation studies of prions have been variable because of the use of differing methods, which may have varied according to prion strain, prion concentration, prion detection, tissue or composition of the brain material tested, animals tested, surfaces tested, testing method, duration of follow-up of inoculated animals, exposure container, method of calculating log10 reductions in infectivity, concentration of the disinfectant at the beginning and end of the experiment, cycle parameters of the sterilizer, type of sterilizer, and exposure conditions.

RECOMMENDATIONS FOR PROCESSING CJD-CONTAMINATED PATIENT-CARE EQUIPMENT

- To minimize patient exposure to neurosurgical instruments later determined to have been used on a patient with CJD, use the sterilization guidelines above for neurosurgical instruments used on patients undergoing brain biopsy when a specific lesion (e.g., a suspected tumor or abscess) has not been demonstrated by CT or MRI. Alternatively use disposable neurosurgical instruments on such patients (IB)

RECOMMENDATIONS FOR REPROCESSING DEVICES OR SURFACES CONTAMINATED WITH LOW-RISK TISSUES

- No recommendation can be made regarding the use of the procedures listed for reprocessing of critical or semicritical medical devices that that been contaminated with low-risk tissues (unsolved)
- Use only standard disinfection to process environmental surfaces contaminated with low-risk tissues (IB)

RECOMMENDATIONS FOR REPROCESSING DEVICES OR SURFACES CONTAMINATED WITH NO-RISK TISSUES

- Use the following recommended procedures to reprocess critical or semicritical medical devices that have been contaminated with no-risk tissue:
- Clean and either disinfect or sterilize these devices using conventional protocols of heat or chemical sterilization or high-level disinfection (IB)
- Use standard cleaning and high-level disinfection protocols for reprocessing endoscopes (except neurosurgical endoscopes with central nervous system contact) because these devices can become contaminated only with no-risk tissues (IB)
- Use standard disinfection to process noncritical equipment and noncritical environmental surfaces that have been contaminated with no-risk tissues or fluids (use disinfectants recommended by OSHA for decontaminating blood-contaminated surfaces)(IB)

OTHER RECOMMENDATIONS

- If the operating surgeon believes that the patient is at risk for a TSE such as CJD, he or she should communicate that information to the operating room charge nurse, the anesthesiology staff, the neuropathology or clinical pathology laboratory staff, the risk manager, and the infection preventionist. Train clinicians and reprocessing technicians on how to properly tag the equipment and train them in the special prion reprocessing protocols. Because standard decontamination of tissue sample (e.g., with formalin) or specimens may not inactivate CJD, all tissue samples should be handled with the use of standard precautions (i.e., gloves). Tag equipment that requires special prion reprocessing after use. The tissue samples and specimens should be labeled as a “biohazard” and as “suspected CJD” before being sent to the laboratory (IB)

Disinfection and Sterilization for Prion Diseases

References

- Rutala WA, Weber DJ. Creutzfeldt-Jakob Disease: Recommendations for Disinfection and Sterilization. Clin Infect Dis 2001;32:1348-1356.
- Rutala WA, Weber DJ, and HICPAC. CDC Guideline for Disinfection and Sterilization (draft). www.cdc.gov/ncidod/hip/dsguide.htm
- Prusiner SB. Prion Biology and Diseases. 1999. Cold Spring Harbor Laboratory Press, New York.
- Rutala WA, Weber DJ. Guideline for disinfection and sterilization of prion-contaminated medical instruments. ICHE; 2010; 31:107-117
- Weber DJ, Rutala WA. 2002. Managing the risks of nosocomial transmission of prion diseases. Current Opinions in Infectious Diseases. 15:421-426.