INFECTION CONTROL MEASURES TO PREVENT BLOOD BORNE PATHOGENS (BBP)

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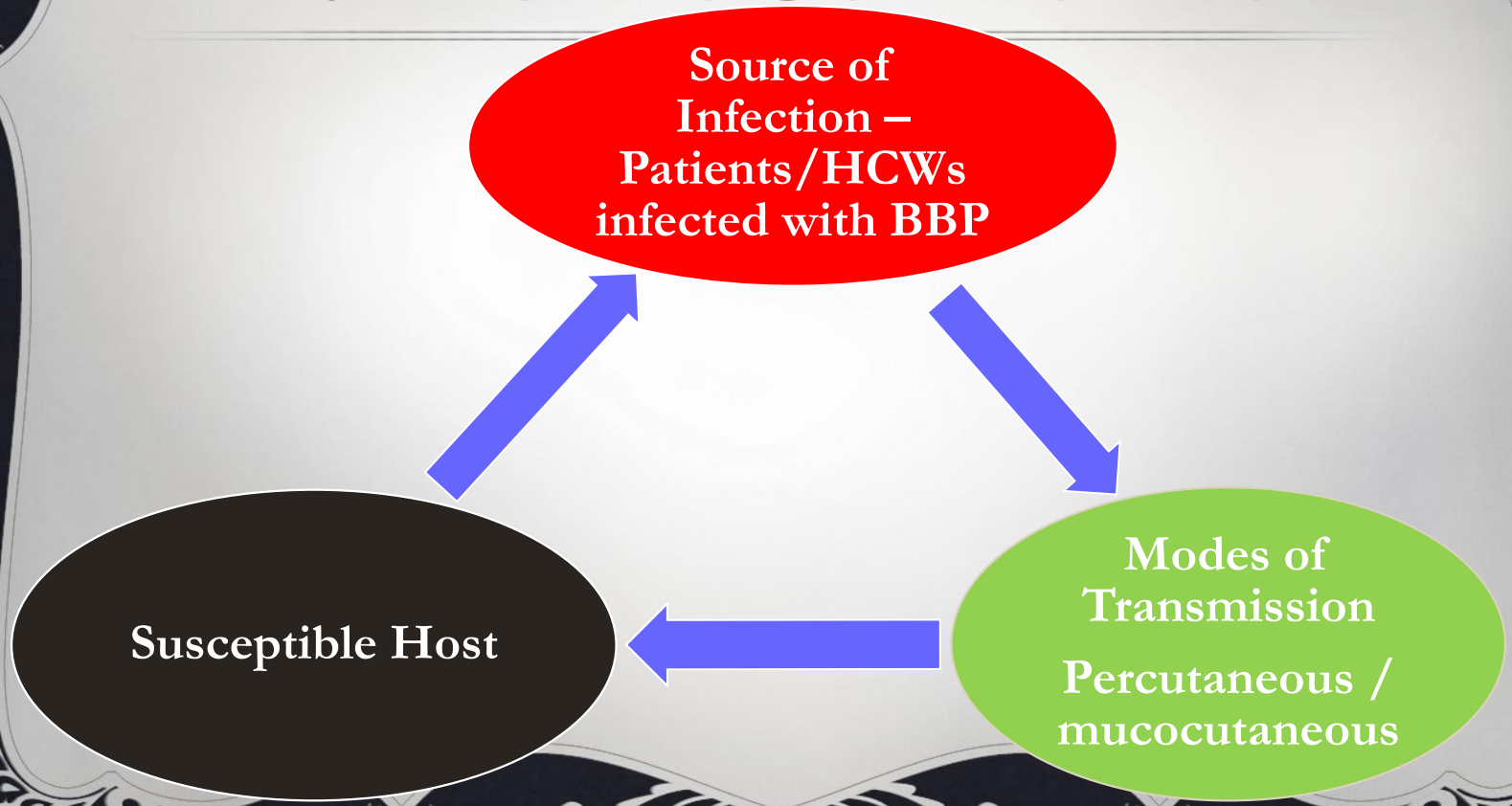
TRANSMISSION OF INFECTIOUS DISEASE



Chain of Infection

Table 1. Viruses that have caused documented occupational infection following exposure to BBF in HCW or laboratory personnel

Pathogen	Exposure	Setting	Source
Argentinian VHF (Junin virus)	Nonintact skin	Contact with rodents' blood	73
Bolivian VHF (Machupo virus)	Needlestick, nonintact skin	Health care	74,75
Brazilian VHF (Sabia virus)	Needlestick	Research laboratory	18
Crimean Congo VHF	Nonintact skin	Health care	14
Dengue	Needlestick	Health care	1
Ebola VHF	Nonintact skin	Health care	76
Hendra virus	Nonintact skin	Veterinary care	77
Hepatitis B virus	Needlestick, nonintact skin	Health care	78
Hepatitis C virus	Needlestick, nonintact skin	Health care	2
Hepatitis D virus	Needlestick	Health care	8
Hepatitis G virus	Needlestick	Health care	10
Herpes simplex I	Needlestick, nonintact skin	Health care	23,24
Human immunodeficiency virus I (HIV I)	Needlestick, nonintact skin	Health care	11,79
Kyasanur virus	Needlestick	Research laboratory	80
Lassa VHF	Nonintact skin	Health care	15
Marburg VHF	Needlestick, nonintact skin	Health care	81,82
Rift Valley Fever virus	Nonintact skin	Veterinary care	82
Simian Foamy virus	Nonintact skin	Animal handling	83
Simian immunodeficiency virus (SIV)	Splash to eyes	Research laboratory	84
Epizootic vesicular stomatitis	Nonintact skin	Veterinary care laboratory	85
Vaccine virus (recombinant)	Needlestick	Research laboratory	30
Varicella zoster virus (VZV)	Needlestick	Health care	25
Venezuelan VHF (Guanarito virus)	Nonintact skin (suspected)	Health care	86
Virus B (Herpes I)	Splash to eyes	Research laboratory	26,28
West Nile virus	Scalpel cut, needlestick	Research laboratory	22
Yellow Fever virus	Nonintact skin (suspected)	Hospital laboratory	87

VHF, viral hemorrhagic fever.

Table 2. Bacteria and rickettsia that have caused documented occupational infection following exposure to BBF in HCW or laboratory personnel

Pathogen	Exposure	Setting	Source
Brucella abortus	Needlestick	Research laboratory Veterinary care	88 89
Burkholderia mallei	Nonintact skin	Research laboratory	90
Corynebacterium diphtheriae	Needlestick	Hospital laboratorys	91
Corynebacterium striatum	Scalpel cut	Health care	92
Leptospira icterohaemorragiae	Needlestick	Research laboratory	93
Mycobacterium leprae	Needlestick	Health care	94
Mycobacterium marinum	Needlestick	Hospital laboratory	95
Mycobacterium tuberculosis	Needlestick	Health care	96
Mycoplasma caviae	Needlestick	Research laboratory	97
Neisseria gonorrhoeae	Cut	Research laboratory	98
Orientia (or Rickettsia) tsutsugamuchi	Cut	Research laboratory	99
Pasteurella multocida	Needlestick	Veterinary care	100
Rickettsia rickettsii (Rocky Mountain Spotted Fever)	Needlestick	Health care	101
Rickettsia typhi (typhus)	Needlestick	Research laboratory	102
Staphylococcus aureus	Needlestick	Housekeeping	103
β-hemolytic streptococcus (*S pyogenes*)	Scalpel cut	Autopsy	104
Streptococcus A (necrotizing fasciitis)	Nonintact skin	Health care	105
Treponema pallidum	Needlestick	Research	

Table 3. Parasites that have caused documented occupational infection following exposure to BBF in HCW or laboratory personnel

Pathogen	Exposure	Setting	Source
Leishmania species (6 species)	Needlestick, nonintact skin	Hospital laboratory	39,108
Plasmodium cynomolgi	Needlestick	Research laboratory	109
Plasmodium falciparum	Nonintact skin	Health care	3
Plasmodium malariae	Needlestick, nonintact skin	Health care	110,111
Plasmodium vivax	Needlestick	Health care	109
	Undetermined	Autopsy	112
Toxoplasma gondii	Splash to eyes, needlestick	Research laboratory	39,113
Trypanosoma brucei	Needlestick	Hospital laboratory	39
Trypanosoma cruzi	Projection	Hospital laboratory	39

Table 4. Yeasts that have caused documented occupational infection following exposure to BBF in HCW or laboratory personnel

Pathogen	Exposure	Setting	Source
Blastomyces dermatitidis	Scalpel	Autopsy	114
Cryptococcus neoformans	Needlestick	Health care	5
Sporotrichum schenkii	Needlestick	Research laboratory	115

BBV TRANSMITTED IN HEALTHCARE SETTINGS

- 2 million HCV infections each year
- 21 million HBV infection each year
- 37.6% HBV, 39% HCV, 4.9% HIV in HCW due to needlestick injuries (NSI)
- No. of sharp injuries annually 0.18/HCW to 4.28/HCW (questionnaire by surgeons)

Occup Environ Med 2008;65:446-451

Table 3

Health Care Workers with Documented and Possible Occupationally Acquired AIDS/HIV Infection by Occupation in the United States Reported through June 30, 2001

Occupation	*Documented*	*Possible*	*Total*
Dental worker	—	6	6
Embalmer or morgue technician	1	2	3
Emergency medical technician or paramedic	—	12	12
Health aide or attendant	1	15	16
Housekeeper or maintenance worker	2	13	15
Lab technician, clinical	16	17	33
Lab technician, nonclinical	3	—	3
Nurse	24	34	58
Physician, nonsurgical	6	12	18
Physician, surgical	—	6	6
Respiratory therapist	1	2	3
Technician, dialysis	1	3	4
Technician, surgical	2	2	4
Technician, therapist (other than listed)	—	9	9
Other health occupations	—	4	4
Totals	**57***	**137†**	**194**

(CDC, 2002)

**Of the 57 health care workers with documented seroconversion 48 had percutaneous exposures, five had mucous membrane or skin exposure, two had both percutaneous and mucous membrane or skin exposures and two had an unknown route of exposure.*

†Possible occupational exposures include those health care workers who have had a seroconversion to HIV, who did not have any other reported risk factors for HIV but for whom HIV seroconversion from an occupational exposure was not documented.

AAOHN Journal; Jan 2003; 51, 1

BBV TRANSMISSION INCIDENTS FROM HCW

	Details of transmission	Was a lookback undertaken?	Was phylogenetic analysis performed?	Additional comments
Dentist (Florida)	Six patients infected between 1987 and 1989. Exact mode of transmission not identified. Epidemiological data supported direct dentist to patient transmission rather than patient to patient transmission.	After the first transmission was identified, former patients of the dentist were publicly requested to have an HIV test. 1100 patients were tested.	Infected patients had DNA sequencing analysis, showing a high degree of similarity among their strains and that of the dentist. This was supported by evidence from phylogenetic trees.	All infected patients had undergone invasive procedures after the dentist had had his AIDS diagnosis.
Orthopaedic surgeon (France)	One patient infected in 1992 during a hip operation (category 3 EPP). The operation was described as lengthy and difficult.	Infected patient was identified during a lookback, initiated after the surgeon was diagnosed with AIDS. No additional transmissions identified after testing 983 of 3004 (33%) at risk patients.	Molecular analysis indicated that the viral sequences obtained from the surgeon and the patient were closely related. The patient had tested negative for HIV shortly before the operation.	CD4 count of the surgeon at diagnosis was 46 cells/ml (in 1994). The surgeon reported frequent percutaneous injuries, and was suspected to have been infected by a patient in 1983.
Nurse (France)	One patient infected in 1996, exact mode of transmission unclear. The nurse had an unclear history of having performed EPPs.	No further transmissions identified following testing of 2294 of 7508 (31%) at risk patients.	Extensive phylogenetic analysis undertaken. Results strongly supported HCW to patient transmission. Patient was HIV negative on pre-op screening.	HCW had advanced stage HIV infection and was co-infected with HCV.
Gynaecologist (Spain)	One patient infected during a caesarean section (category 3 EPP) in 2001.	Additional testing of 250 of 275 (91%) at risk patients did not reveal additional transmissions.	Phylogenetic analysis revealed genetic similarity of the HCW and patient viruses. The average nucleotide variation was 3%.	Patient was HIV negative during a pregnancy screen, and developed HIV symptoms shortly after the operation.

Management of HIV-infected healthcare workers - a paper for consultation. The Report of the Tripartite Working Group. DoH 2011. Accessed at: http://www.dh.gov.uk/en/Consultations/Liveconsultations/DH_131532.

HBV	**Technician (Canada)**	**75 patients infected by an HBeAg positive technician who was implanting subdermal electrodes**
HCV	CTS surgeon (USA)	14 patients infected (10000 operations over a 10 yr period)

RISK OF BLOOD CONTACT & SHARPS INJURY

TABLE 1. Prospective observational studies of blood contact among HCWs

Specialty and authors (reference)	Yr	Location(s)	No. of procedures observed	No. of procedures with ≥1 blood contact	% Procedures with ≥1 sharps injury
Surgery					
Tokars et al. (256)	1990	New York, N.Y.; Chicago, Ill.	1,382	46.6	6.9
Popejoy et al. (220)	1988	Albuquerque, N.Mex.	684	27.8	3.1
Quebbeman et al. (224)	1990	Milwaukee, Wisc.	234	50.4	15.4
Gerberding et al. (116)	1988	San Francisco, Calif.	1,307	6.4	1.3
Panlilio et al. (208)	1988–1989	Atlanta, Ga.	206	30.1	4.9
Obstetrics					
Panlilio et al. (210)	1989	Atlanta, Ga.	230	32.2	1.7
Invasive radiology					
Hansen et al. (130)	1992	Dallas, Tex.	501	3.0	0.6
Emergency room					
Marcus et al. (178)	1989	New York, N.Y.; Chicago, Ill.; Baltimore, Md.	9,793	3.9	0.1
Dentistry					
Cleveland et al. (77)	1993	New York, N.Y.	16,340	NA[a]	0.1

[a] NA, not available.

73% suturing, >50% when fingers were used

Source of Infection
- Pathogens

1. Disinfection to kill the infective agents
2. Early diagnosis and treatment of infected person

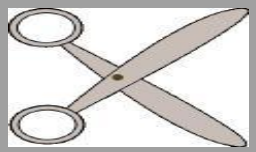
22-gauge needle 1 μl of blood inoculated

Susceptible Host

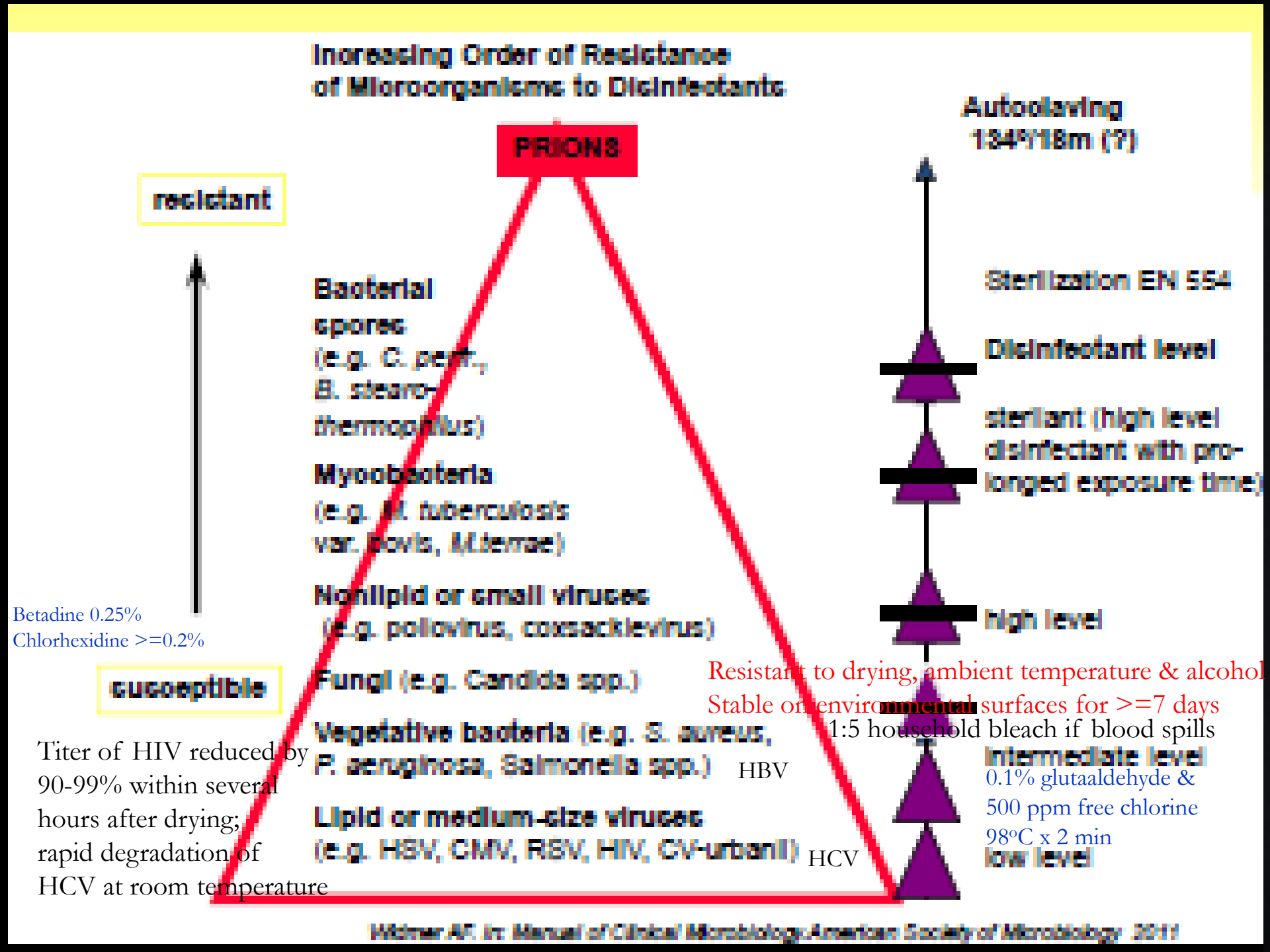
Modes of Transmission

HBV immunization

1. Standard Precautions
2. Safety devices
3. Double gloving/frequent glove change?



Prevention of Infection – Breakdown the Chain of Infection


Increasing Order of Resistance of Microorganisms to Disinfectants
PRIONS
resistant
Bacterial spores (e.g. C. perf., B. stearo-thermophilus)
Mycobacteria (e.g. M. tuberculosis var. bovis, M.terrae)
Nonlipid or small viruses (e.g. poliovirus, coxsackievirus)
Fungi (e.g. Candida spp.)
Vegetative bacteria (e.g. S. aureus, P. aeruginosa, Salmonella spp.)
Lipid or medium-size viruses (e.g. HSV, CMV, RSV, HIV, CV-urbanii)
susceptible
Autoclaving 134°/18m (?)
Sterilization EN 554
Disinfectant level
sterilant (high level disinfectant with pro-longed exposure time)
high level
intermediate level
low level
Betadine 0.25%
Chlorhexidine >=0.2%
Resistant to drying, ambient temperature & alcohol
Stable on environmental surfaces for >=7 days
1:5 household bleach if blood spills
0.1% glutaaldehyde &
500 ppm free chlorine
98°C x 2 min
HBV
HCV
Titer of HIV reduced by 90-99% within several hours after drying; rapid degradation of HCV at room temperature
Widmer AF. In: Manual of Clinical Microbiology. American Society of Microbiology. 2011

EARLY DIAGNOSIS AND TREATMENT

- 70% HBV, 60-80% HCV and 20% HIV acutely infected patients were asymptomatic
- Rely on clinicians' alertness to screen HIV (acute infections, opportunistic infections, TB patients)
- Promote screening in high risk groups (drug users, MSM etc.)
- Promote reporting of NSI (only 43% reported in US)
- Confidentiality issues (Need to know basis)
- Expert Review panel

❖Based on the concepts that all of the following should be treated as potentially infectious:

- ✓Blood
- ✓All body fluids, secretions & excretions (except sweat)
- ✓Non-intact skin
- ✓Mucous Membrane

WHY GLOVE?

- <10% occupationally HBV infected HCW recalled a specific percutaneous injury. Br Med J 1982; 284:1408-1982.
- 50% reduction in blood volume during simulated needlesticks with hollow bore needles
- 80% reduction in blood transferred with suture needles

J Infect Dis 1993; 168: 1589-1592

WHY HAND HYGIENE AFTER GLOVE REMOVAL

- Leak rate for sterile gloves (2.5%) & exam gloves (4%) : 1989 FDA
- Study reported that leak rates for surgical gloves (up to 8%); latex & vinyl gloves (7-20% & 34-63%)

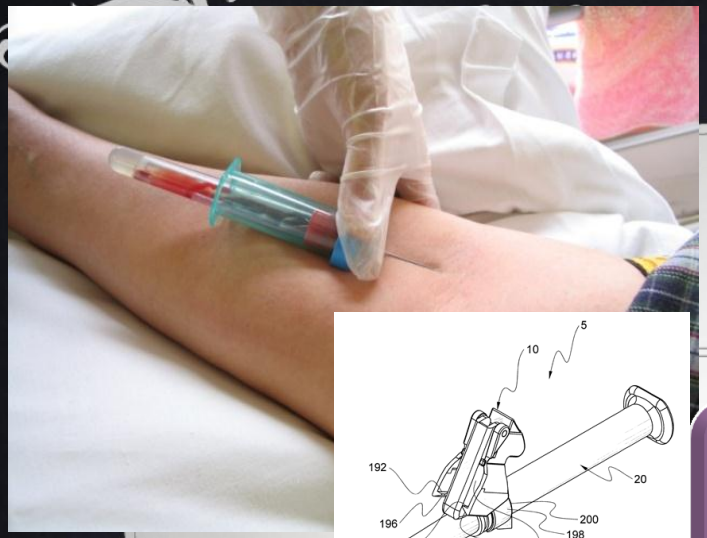
AJIC 1989;17:196-201; J clin Micro 1990; 28: 787-788; Nurs Res 1989;38 : 144-146

- Study reported that there are pits suggesting the viruses can penetrate this barrier gloves

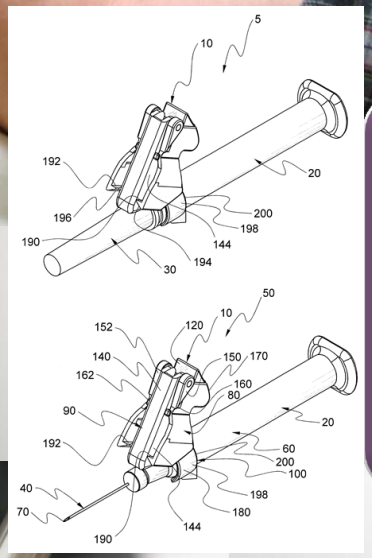
Nature 1988;335-19

Convenient placement of sharps containers decrease needlestick injuries by 60%

Dispose Sharps Immediately & Properly



IV related percutaneous injuries decreased by 72 -100% following the introduction of needleless systems



Use Safety / Needleless Devices

Needle Cap Holder

Resheathable & bluntable needles reduced percutaneous injuries during phlebotomy by 23-76%

Blunt needles

Type of suture needles	Percutaneous injuries
Blunt	No
Curved	1.9/1000 used
Straight	14.2/1000 used

Knitted gloves

Glove liners, knitted gloves and triple gloves all show less perforations to the innermost glove compared with double gloving

Glove liner

DOUBLE GLOVING – EVIDENCE?

- Single gloving vs Double gloving - perforations to innermost gloves (OR 4.10, 95% CI 3.30 to 5.09 – 14 trials).
- Indicator gloves – more perforations detected (OR 10 – 12.5)

Cochrane Database Syst Rev 2002;3:CD003087

- In a simulation in which the surgeon tied surgical knots continuously for 1 hr, visible skin separations were observed on his index fingers and HBsAg was detected in the saline used to rinse out his gloves

CLINICAL MICROBIOLOGY REVIEWS, July 2000, p. 385–407

Differences between Routine Change every 20min and 3x per Surgery

Study group

	Pairs of gloves	Pairs with perforations (%)
Surgeon	120	5 (4.2)
Assistant	116	4 (3.4)
Nurse	118	6 (6.1)

[a] Calculated using chi-squared test

Control group

Pairs of gloves	Pairs with perforations (%)	p value[a]
94	11 (11.7)	0.04
88	6 (6.8)	0.27
91	15 (16.5)	0.01

Al-Maiyah M et al. J Bone Joint Surg 2005;87-B:550-9

HBV VACCINATION – FREQUENT QUESTIONS

- >90% healthy recipients develop protective antibody response
- 30-50% of individuals will respond to the second 3 dose series
- 21-60% of HCW had non-reactive titers > 7 -8 years after vaccination.
- Immune memories intact for >=12 yrs, even though anti-HBs levels may become low or undetectable. Lancet 1995; 345: 1089-1092

BBV INFECTED HCW

- **Category I: Procedures with minimal risk of BBV transmission**

  e.g. minor surface suturing, elective peripheral phlebotomy, colonoscopy/sigmoidoscopy

- **Category II: Procedures for which bloodborne virus transmission is possible but unlikely**

  e.g. Periodontal scaling, minor local procedures, other endoscopy

- **Category III: Procedures for which there is definite risk of BBV transmission /'exposure-prone'** (digital palpation of a needle tip in a body cavity or the simultaneous presence of the HCWs fingers and a sharp instrument in a poorly visualized or highly confined anatomic site)

  e.g. General surgery, open resuscitation, open surgical procedure > 3 hrs

SHEA GUIDELINE 2010

TABLE 1. Summary Recommendations for Managing Healthcare Providers Infected with Hepatitis B Virus (HBV), Hepatitis C Virus (HCV), and/or Human Immunodeficiency Virus (HIV)

Virus, circulating viral burden	Categories of clinical activities[a]	Recommendation	Testing
HBV			
$<10^4$ GE/mL	Categories I, II, and III	No restrictions[b]	Twice per year
$\geqslant 10^4$ GE/mL	Categories I and II	No restrictions[b]	NA
$\geqslant 10^4$ GE/mL	Category III	Restricted[c]	NA
HCV			
$<10^4$ GE/mL	Categories I, II, and III	No restrictions[b]	Twice per year
$\geqslant 10^4$ GE/mL	Categories I and II	No restrictions[b]	NA
$\geqslant 10^4$ GE/mL	Category III	Restricted[c]	NA
HIV			
$<5 \times 10^2$ GE/mL	Categories I, II, and III	No restrictions[b]	Twice per year
$\geqslant 5 \times 10^2$ GE/mL	Categories I and II	No restrictions[b]	NA
$\geqslant 5 \times 10^2$ GE/mL	Category III	Restricted[d]	NA

FOR
BBV INFECTED HCW

Lower viral load

- Double gloving for Category II & Category III procedures
- Frequent glove changes, particular for tasks known to compromise glove integrity (e.g. placing sternal wires)

High viral load with restrictions in practice

- Double gloving for all invasive procedures and all indications of gloving

UK DH GUIDANCE

- HIV-infected HCWs can perform EPP if they are on cART and have a plasma viral load suppressed consistently to <200 copies/ml (Retest at 3 months)

Management of HIV-infected healthcare workers - a paper for consultation. The Report of the Tripartite Working Group. DoH 2011. Accessed at: http://www.dh.gov.uk/en/Consultations/Liveconsultations/DH_131532.

- HBV infected HCW can perform EPP if HBV DNA $<10^3$ GE/mL (Retest at 12 months)
- HCV infected HCW can perform EPP only if circulating HCV RNA is negative (Retest at 6 months)

EFFICACY OF STANDARD PRECAUTIONS

- Mean no. of blood exposures 35.8 /yr -> 18.1/yr
- No. of occupational HBV infections in HCWs ~10000 in 1983

x3-5 greater risk of contracting HBV Vs 400 (x5 less risk) in 2002 (CDC, unpublished data)

Clinical Microbiology Reviews, July 2000, p. 385–407

The End.