Infection Control in the Dialysis Setting: What the Dialysis Techs Need to Know

Matthew J. Arduino, MS, Dr.P.H.
CDC/NCEZID/DHQPP
Email: Marduino@cdc.gov

The findings and conclusions in this presentation are those of the author(s) and do not necessarily represent official position of the Centers for Disease Control and Prevention
Important Trends (1979-2007)

- Growing dialysis population; 341,264
- Mortality, increasing morbidity from infections
- Antimicrobial resistant infections, other new forms of resistance

USRDS 2009 Annual Data Report
Cause Specific Hospitalization Rates (USRDS 2009)

- All
  - Infection (2007: 25.8%)
  - CV (4.6%)
  - All-cause (-2.7%)

- Hemodialysis
  - Infection (37.5%)
  - Cardiovascular (8.2%)
  - All-cause (-0.6%)
  - Vascular access (-41.2%)

- Peritoneal dialysis
  - All-cause (-10.7%)
  - Cardiovascular (-15.4%)
  - Infection (4.7%)
  - Dialysis access (since 1999: -21.5%)

- Transplant
  - All-cause (-14.6%)
  - Cardiovascular (-31.8%)
  - Infection (-10.7%)

Percent change from 1993
Adjusted admissions for principal diagnoses, by modality (USRDS 2009)

Period prevalent ESRD patients; adjusted for age, gender, race, & primary diagnosis. ESRD patients, 2005, used as reference cohort.
Overview

- Important trends
- Introduction: understanding the chain of infection some general epidemiology
- Important pathogens
- Interrupting transmission
Adjusted five-year survival, by modality & primary diagnosis:

1993-1997: All pts, by modality
- Dial. (0.31)
- HD (0.31)
- PD (0.30)
- Tx (0.71)
- All (0.35)

1998-2002:
- Dial. (0.34)
- HD (0.34)
- PD (0.34)
- Tx (0.75)
- All (0.38)

HD pts, by primary diagnosis:
- DM (0.25)
- HTN (0.36)
- GN (0.42)
- Other (0.34)
- All (0.31)

Annual death rate: 23%

~36% alive at 5 years

USRDS 2009
Chain of Infection

To cause an infection, an infectious agent must

1. Leave original host
2. Survive in transit (air, water, surfaces, biofilms, or other reservoir)
3. Be delivered to a susceptible host
4. Reach a portal of entry into the host
5. Escape host defenses
6. Multiply and cause infection

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direct/indirect
Most Common Route of Spread

Bacteria

Workers’ Hands

Infected or colonized Patients

Becomes colonized
Infections are the 2nd leading cause of death (15% of deaths)

Site of infection

- 57% vascular access
- 23% wound
- 15% lung
- 5% urinary tract

USRDS 2009
Tokars, Miller, Stein. AJIC 2002;30:288-295
Bloodborne Pathogens

- Hepatitis B, C, and D Viruses
- Human Immunodeficiency Virus (HIV/AIDS)
<table>
<thead>
<tr>
<th>Exposure</th>
<th>HBV</th>
<th>HCV</th>
<th>HIV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transfusion</td>
<td>++++</td>
<td>++++</td>
<td>++++</td>
</tr>
<tr>
<td>IVDU</td>
<td>++++</td>
<td>++++</td>
<td>++++</td>
</tr>
<tr>
<td>Perinatal</td>
<td>++++</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td>Sexual</td>
<td>+++</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Needle Stick</td>
<td>+++</td>
<td>+</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Non-intact skin</td>
<td>++</td>
<td>+/-</td>
<td>+/-</td>
</tr>
<tr>
<td>Intact Skin</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
# Relative Infectivity of HBV, HCV, and HIV

<table>
<thead>
<tr>
<th>Titer/ml</th>
<th>HBV $10^{8-11}$</th>
<th>HCV $10^5$</th>
<th>HIV $10^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Stability</td>
<td>++++*</td>
<td>+**</td>
<td>-</td>
</tr>
</tbody>
</table>

*Can persist on environmental surfaces for at least 7 days

** Can persist for <24 hrs (CDC unpublished data)
Sources for Bloodborne Virus Infections in Hemodialysis Patients

- **External to the dialysis unit**
  - Transfusion from unscreened blood or infected donor in the window where testing fails to detect the agent
  - Non-dialysis related healthcare procedures
  - Household/sex with infected contact
  - Illegal injection drug use (more common in western countries)

- **Internal to the dialysis unit**
  - Patient-equipment-patient (HBV contamination on devices, tubing, supplies, surfaces)
  - Patient-equipment-staff-patient (HBV contaminated surfaces touched by staff and transmitted with contaminated gloves or hands)
  - Patient-staff-patient (direct contamination of staff members’ hands/gloves with blood)
Infection Control Practices
Environmental Stability of HBV

- High titer of HBV: Blood can be diluted to below visible levels and still contain enough infectious particles that indirect transmission can still occur.
- 3.3% of centers reported ≥1 patients with newly acquired (incident) HBV infection.
- 24.1% of centers reported ≥1 patients with chronic (prevalent) HBV infection.
- 25.5% of centers reported ≥1 patients with either acute or chronic HBV infection.
Identified Breaks in Infection Control Practices

- Failure to review lab results; HBsAg+ patients treated with susceptible patients
- Failure to isolate HBsAg+ patients
- Sharing of staff, equipment, and supplies among patients
- Failure to vaccinate susceptible patients against hepatitis B
Preparation of Injectable Medications

- In 2002, 52.8% of centers reported that medications from multi-dose vials were prepared for patient administration in a dedicated medication room or an area separate from the treatment area.
- 24.6% reported that medications were prepared on a medication cart or a medication area within the treatment area, 3.7% at the dialysis station, and 18.9% in other areas.
- The incidence of HBV infection was significantly higher among patients in centers where injectable medications were prepared on a medication cart or medication area located in the treatment area.
8 hepatitis cases linked to clinic

Hepatitis C outbreak among clinic patients

Brooklyn Bug

Clinic linked to 8 cases of hepatitis C; 2,200 at risk

Medical Mystery

Hepatitis C outbreak

 Strikes 8 endoscopy patients of B’klyn clinic
2001 HEPATITIS OUTBREAK

DOCTOR DID IT

State: Anesthesiologist Contaminated Vial of Medication With Dirty Needle

Page A3

At least 19 people were infected at this Brooklyn clinic.

THE SYRINGE MESS

8,500 More At Risk

Every patient doc treated for 5 years should be tested, health officials say
Private Medical Practice: New York City, 2001

Injection Preparation and Disposal

Don Weiss / NYCDOHMH
Storage of multidose vials and preparation of injections in same area that used needles and syringes were dismantled and discarded

Ref: Sameandi et al. JCHE 2005; 30: 745-750
Injection Preparation Table, Pakistan
Hepatitis C Virus Infections in Dialysis

- Prevalence: 8-10%
  - (1.6% in general popn)
- Majority of infections are asymptomatic; majority develop chronic infection
- Isolation is not recommended, no vaccine
- Prevention requires strict attention to infection control practices
Hepatitis C Virus

- Most efficiently transmitted by direct percutaneous exposure to infectious blood
- Risk factors associated with HCV: history of blood transfusions, volume of blood transfused, and years on dialysis (≥5 years)
- There were no significant differences in HCV incidence or prevalence in centers that reused dialyzers compared to those who did not reuse dialyzers
- the decline in prevalence may be attributable in part to a decline in new infections among patients as a result of increased awareness of the potential for HCV transmission in this setting.
<table>
<thead>
<tr>
<th>Place Where Medication is Drawn up in a Syringe</th>
<th>Anti-HCV Prevalence, No (%) Patients</th>
<th>Had Patients Who Became anti-HCV + in 1999, No (%) Centers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Separate medication room or area</td>
<td>6,898 (8.6)</td>
<td>145 (10.3)</td>
</tr>
<tr>
<td>Dialysis Station</td>
<td>1,178 (9.1)</td>
<td>23 (11.2)</td>
</tr>
<tr>
<td>Medication Cart</td>
<td>2,623 (9.7)&lt;sup&gt;†&lt;/sup&gt;</td>
<td>56 (15.8)&lt;sup&gt;†&lt;/sup&gt;</td>
</tr>
</tbody>
</table>
## HCV Outbreaks, 1998-2006

<table>
<thead>
<tr>
<th>Location</th>
<th>Year</th>
<th>% of Patients with Chronic HCV Infection</th>
<th>% of Susceptible Patients that Became Newly Infected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maryland</td>
<td>1998</td>
<td>22%</td>
<td>17.5%</td>
</tr>
<tr>
<td>Ohio</td>
<td>2000</td>
<td>36%</td>
<td>8.2%</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>2000</td>
<td>4%</td>
<td>13%</td>
</tr>
<tr>
<td>Virginia</td>
<td>2006</td>
<td>19%</td>
<td>13%</td>
</tr>
</tbody>
</table>

*Thompson N, et al. ICHE 2009;30(9):900-3*
Breaks in Infection Control

- Not cleaning blood spills or splatters; including prime buckets on side of machine
- Not cleaning or disinfecting commonly touched environmental surfaces between patients (e.g. machine, chair or station)
- Sharing equipment and supplies that were not disinfected; shared multidose vials placed on the top of the machines
- Sharing a common medication cart
Hepatitis D (Delta) Virus

Δ antigen
HBsAg
RNA
Human Immunodeficiency Virus (HIV)
Hemodialysis-Associated Transmission of HIV

- In the U.S. there have been no patient infections, however there has been patient to healthcare worker transmission (1 definite, 3 possible) due to needlestick injuries (CDC. U.S. HIV and AIDS cases reported through June 2000. *HIV/AIDS Surveillance Report* 2001;12 (1))

- Outside U.S., transmission has occurred associated with reuse of vascular access needles, syringes, and injection practices (Argentina, Columbia, Ecuador, Egypt)
Bacterial/Fungal Infections

- Vascular access related
- Contaminated machines
- Reuse related
- Contaminated IV medications
### Number Of Events And Event Rate By Type Of Vascular Access, Dialysis Surveillance, 1999 -2005

<table>
<thead>
<tr>
<th>Event</th>
<th>Fistula Rate</th>
<th>Graft Rate</th>
<th>Cuffed Catheter Rate</th>
<th>Non-cuffed Catheter Rate</th>
<th>Port Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospitalization</td>
<td>8.7</td>
<td>12</td>
<td>18.6</td>
<td>26.6</td>
<td>17.7</td>
</tr>
<tr>
<td>IV Abx</td>
<td>2.3</td>
<td>3.2</td>
<td>9.4</td>
<td>9.3</td>
<td>12.6</td>
</tr>
<tr>
<td>+ Blood Culture</td>
<td>0.6</td>
<td>1.1</td>
<td>5.6</td>
<td>8.4</td>
<td>12.4</td>
</tr>
<tr>
<td>Access infection</td>
<td>0.6</td>
<td>1.6</td>
<td>7.6</td>
<td>10.1</td>
<td>13.7</td>
</tr>
<tr>
<td>Access related BSI</td>
<td>0.3</td>
<td>0.7</td>
<td>4.6</td>
<td>7.3</td>
<td>11.4</td>
</tr>
<tr>
<td>Outpatient Vanco Starts</td>
<td>1.2</td>
<td>1.9</td>
<td>6.4</td>
<td>6.7</td>
<td>10</td>
</tr>
<tr>
<td>Total Incidents</td>
<td>12,143</td>
<td>16,301</td>
<td>22,925</td>
<td>2,239</td>
<td>205</td>
</tr>
</tbody>
</table>

Rate=number of events/100 patient-months
Non-Cuffed Catheter
Contaminated Machines: Waste Handling Option

- Several outbreaks since 1995 (U.S., Canada, and Israel)
- *Enterobacter cloacae, Pseudomonas aeruginosa, Escherichia coli, Candida parapsilosis*
- Recent cluster in Chicago *Phialemonium curvatum* (two patients sequentially on the same machine became fungemic, WHO port was removed prior to the investigation); *Phialemonium* was isolated in the water feeding the machine
Reuse Related Bacteremia/Fungemia

- Organisms: *Burkholderia cepacia* complex, *Ralstonia pickettii*, *Ralstonia mannitolytica*, *Stenotrophomonas maltophilia*, *Candida parapsilosis*

- Today most reuse related infections are associated with header removal “Header-sepsis”

- In the past, most were associated with wither poor water quality, or manual reuse
Contamination of Multidose Medications

- **Serratia liquefaciens** infections associated with pooling of single-dose vials of EPO.
- Contamination of heparin lock solutions (*Pseudomonas fluorescens, Enterobacter cloacae, Klebsiella pneumoniae*)
- Transmission of HBV and HCV
Antimicrobial Resistance (An Emerging Problem)
MRSA = Methicillin-Resistant S. aureus

- Dialysis patients:
  0.1% of the U.S. population
  15% of all invasive MRSA infections
- Rate of invasive MRSA is 100x greater than in general population

CDC. MMWR 2007; 56(09):197-9
VISA AND VRSA in the United States, 2004

- As of July, 2004, there have been a total of 12 documented vancomycin-intermediate S. aureus (VISA) cases in the United States (changes to cell wall). Five of these were in patients who were treated with PD or hemodialysis.
- Since 2002, there have been 10 instances of patients infected with vancomycin-resistant S. aureus (6 due to genetic exchange with VRE).

Vancomycin Resistant S. aureus (VRSA) -- Case #1

- First case of *S. aureus* fully vancomycin resistant
- Michigan, June 2002
- 40 year old with diabetes mellitus, peripheral vascular disease, hemodialysis
- VRSA from foot ulcer and catheter exit site

MMWR July 5, 2002/51 (26) 565-566
But what can I do?
Comprehensive Infection Control Program For Dialysis Units

- Infection control practices for hemodialysis units
  - infection control precautions specifically designed to prevent transmission of bloodborne viruses and pathogenic bacteria among patients;
  - hand hygiene and appropriate glove use
  - routine serologic testing for hepatitis B virus and hepatitis C virus infection;
  - vaccination of susceptible patients against hepatitis B;
  - isolation of hepatitis B surface antigen positive patients.
- Surveillance for infections and other adverse events.
- Infection control training and education.
Published CDC Recommendations

- CDC. Recommendations for preventing transmission of infections among chronic hemodialysis patients. *MMWR* 2001; 50(RR05):1-43
Recommended Infection Control Practices for Hemodialysis Units at a Glance

Infection Control Precautions for All Patients

* Wear disposable gloves when caring for the patient or touching the patient’s equipment at the dialysis station; remove gloves and wash hands between each patient or station.

* Items taken into the dialysis station should either be disposed of, dedicated for use only on a single patient, or cleaned and disinfected before being taken to a common clean area or used on another patient.
  - Nondisposable items that cannot be cleaned and disinfected (e.g., adhesive tape, cloth-covered blood pressure cuffs) should be dedicated for use only on a single patient.
  - Unused medications (including multiple dose vials containing diluents) or supplies (e.g., syringes, alcohol swabs) taken to the patient’s station should be used only for that patient and should not be returned to a common clean area or used on other patients.

* When multiple dose medication vials are used (including vials containing diluents), prepare individual patient doses in a clean (centralized) area away from dialysis stations and deliver separately to each patient. Do not carry multiple dose medication vials from station to station.

* Do not use common medication carts to deliver medications to patients. Do not carry medication vials, syringes, alcohol swabs, or supplies in pockets. If trays are used to deliver medications to individual patients, they must be cleaned between patients.

**Schedule for Routine Testing for Hepatitis B Virus (HBV) and Hepatitis C Virus (HCV) Infections**

<table>
<thead>
<tr>
<th>Patient Status</th>
<th>On Admission</th>
<th>Monthly</th>
<th>Semiannual</th>
<th>Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>All patients</td>
<td>HBsAg, Anti-HBc (total), Anti-HBs, Anti-HCV, ALT†</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HBV-susceptible, including nonresponders to vaccine</td>
<td>HBsAg</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anti-HBs positive &gt;16 IU/mL, anti-HBc negative</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anti-HBs and anti-HBc positive</td>
<td>No additional HBV testing needed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anti-HCV negative</td>
<td>ALT Anti-HCV</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Results of HBV testing should be known before the patient begins dialysis.
† HBsAg=hepatitis B surface antigen; Anti-HBc=antibody to hepatitis B core antigen; Anti-HBs=antibody to hepatitis B surface antigen; Anti-HCV=antibody to hepatitis C virus; ALT=alanine aminotransferase.

(Continued on page 21)
One-way Flow of Supplies

- No return of supplies
- No transfer of supplies from one station to another
- No mobile carts

Clean

Dirty

Station A

Station B

Station C

Medication prep area
Supplies

Items taken into a station:

- Dedicated for use on only a single patient at that station
- Disposed of
- Cleaned and disinfected before taken to a common area or used on another patient
Where is this Documented?

Infection Control Requirements for Dialysis Facilities and Clarification Regarding Guidance on Parenteral Medication Vials

http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5732a3.htm
Medication Vials

**Multidose vials**
- Have preservative to prevent bacterial growth

**Single dose vials**
- No preservative
- Pooling of medications caused outbreak of *Serratia* bloodstream infections

Preservative has no impact on HBV, HCV
Medication Options

- Medications in prepackaged, pre-filled syringes
- Single dose vial for single patient
- Multidose vial for single patient
- Multidose vial for > 1 patient
Infection Control Precautions for All Patients

- For dialyzers and blood tubing that will be reprocessed, cap dialyzer ports and clamp tubing. Place all used dialyzers and tubing in leak-proof containers for transport from station to reprocessing or disposal area.
Routine serologic testing for HBV and HCV

<table>
<thead>
<tr>
<th>Patient Status</th>
<th>On-Admission</th>
<th>Monthly</th>
<th>Semi-Annually</th>
<th>Annually</th>
</tr>
</thead>
<tbody>
<tr>
<td>All patients</td>
<td>HBsAg*, Anti-HBc (total)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Anti-HBs, Anti-HCV, ALT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HBV Susceptible including vaccine</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonresponders</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anti-HBs positive (&gt;10 mIU/mL), Anti-HBc negative</td>
<td></td>
<td>HBsAg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anti-HBs and anti-HBc positive</td>
<td></td>
<td></td>
<td>No additional HBV testing needed</td>
<td></td>
</tr>
<tr>
<td>Anti-HCV negative</td>
<td></td>
<td>ALT</td>
<td></td>
<td>Anti-HCV</td>
</tr>
</tbody>
</table>

* Results of HBsAg testing should be known before the patient begins dialysis.
HBV / HCV Testing

- **HBV Testing**
  - Required by CMS
  - Check total anti-HBc on admission

- **HCV Testing**
  - *Not* required or reimbursed by CMS
  - Only realistic way to identify transmission and rectify incorrect practices
  - Consider testing on admission, and annually (or with some regular frequency)

Must review and act upon results in a timely manner
Management of HBsAg-Positive Patients

- Infection control practices for hemodialysis units for all patients.
  - Dialyze HBsAg-positive patients in a separate room using separate machines, equipment, instruments, and supplies.
  - Staff members caring for HBsAg-positive patients should not care for HBV susceptible patients at the same time (e.g., during the same shift or during patient change-over).
Additional Precautions for Individuals Co-infected with HBV and HDV

- Patient needs to be isolated from ALL other dialysis patients
- Staff should not treat any other patients
- Screening for anti-HDV may be warranted
Why?

- Lack of patient-free period between shifts associated with HCV outbreaks
- KDIGO: “Unit should ensure that there is enough time between shifts for effective decontamination of the exterior of the machine and other shared surfaces”
- Patient privacy concerns
- Patient should not be exposed to bleach or other disinfectant solution
Bringing This All Together

- Good Infection Control Can Make a Difference
  - Hand Hygiene
  - Environmental cleaning and disinfection

- Vascular Access Care
  - Fistula First, Catheter Removal
  - Vascular Access Site Care
  - Staff Training & Patient Education
  - Follow recommended practices, ensure policies reflect best practices
    - Chlorhexidine antisepsis

- Monitoring Infections /Active surveillance program
Protect patients,
Protect healthcare personnel,
Protect quality healthcare

Prevention Is Primary!