Potential Threats Through Infectious Diseases: Hepatitis B, Hepatitis C, HIV

(Unrecognized Threats from “Old” Diseases)

Miriam J. Alter, Ph.D.
Institute for Human Infections and Immunity
University of Texas Medical Branch at Galveston
Galveston, Texas

Global and US Disease Burden from Bloodborne Viral Infections

<table>
<thead>
<tr>
<th></th>
<th>Estimated No. Chronic Infections</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Global</td>
</tr>
<tr>
<td>HBV</td>
<td>370 million</td>
</tr>
<tr>
<td>HCV</td>
<td>130 million</td>
</tr>
<tr>
<td>HIV</td>
<td>40 million</td>
</tr>
<tr>
<td>HIV / HBV</td>
<td>(3–4 million)</td>
</tr>
<tr>
<td>HIV / HCV</td>
<td>(4–5 million)</td>
</tr>
</tbody>
</table>

Sources: WHO and CDC, unpublished data.
## Relative Efficiency of HBV, HCV, HIV Transmission by Type of Exposure

<table>
<thead>
<tr>
<th>Type of exposure</th>
<th>Transmission efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HBV</td>
</tr>
<tr>
<td>Transfusion</td>
<td>++++</td>
</tr>
<tr>
<td>Injecting drug use</td>
<td>++++</td>
</tr>
<tr>
<td>Unsafe therapeutic injections</td>
<td>+++</td>
</tr>
<tr>
<td>Needlestick</td>
<td>+++</td>
</tr>
<tr>
<td>Sexual</td>
<td>+++</td>
</tr>
<tr>
<td>Perinatal</td>
<td>++++</td>
</tr>
<tr>
<td>Non-intact skin</td>
<td>++</td>
</tr>
<tr>
<td>Intact skin</td>
<td>-</td>
</tr>
</tbody>
</table>

## HBV & HCV Transmission in Health Care Settings

- **Patient to patient**
- **Healthcare worker to patient**
- **Patient to healthcare worker**

Clinical Infectious Diseases 2004; 38:1592–8
Recognition of Healthcare-related Viral Hepatitis Transmission, United States

- Decreased transfusion, dialysis, and occupational risks
- Increasing recognition of outbreaks involving patient-to-patient spread
  - Detection is haphazard
    - Asymptomatic infections
    - Long incubation periods / low index of suspicion
  - Various settings, primarily those providing outpatient (ambulatory) or long-term care

Relative Infectivity of HBV, HCV, HIV

<table>
<thead>
<tr>
<th></th>
<th>HBV</th>
<th>HCV</th>
<th>HIV</th>
</tr>
</thead>
<tbody>
<tr>
<td>IU/mL</td>
<td>$10^{8-9}$</td>
<td>$10^5$</td>
<td>$10^3$</td>
</tr>
<tr>
<td>Environmental stability</td>
<td>++++</td>
<td>++</td>
<td>-</td>
</tr>
<tr>
<td>Remains infectious after drying at room temp</td>
<td>$\geq 7$ d</td>
<td>$\geq 16$ h</td>
<td>0</td>
</tr>
</tbody>
</table>

HBV and HCV Related to Health-Care in Inpatient and Outpatient Settings, U.S.

**HBV**
- Contaminated equipment
  - Hemodialysis
  - EEG electrodes
- Unsafe injection practices
  - Finger stick devices
  - Multi-dose medication vials
  - Jet injector
  - Dermatology practice
  - Acupuncture
  - Therapeutic injections

**HCV**
- Contaminated equipment
  - Hemodialysis
- Unsafe injection practices
  - Plasmapheresis
  - Multi-dose medication vials
  - Reuse of contaminated needles and syringes
  - Home infusion therapy

Transmission of Hepatitis B and C Viruses in Outpatient Settings – MMWR 2003 52:901-6

- **Private Medical Practice: New York City, 2001**
  - 38 HBV infections associated with unsafe injection practices

- **Endoscopy Clinic: New York City, 2001**
  - 19 HCV infections likely due to contamination of multiple-dose anesthetic vials

- **Oncology Clinic: Nebraska, 2002**
  - 99 HCV infections associated with syringe reuse leading to contamination of common saline bag

- **Pain Remediation Clinic: Oklahoma, 2002**
  - 71 HCV and 31 HBV infections due to syringe reuse
HBV Transmission
Private Medical Practice, 2001

- Two patients aged >75 yrs with acute hepatitis B
  - Both visited same private practice in incubation period
- Lookback among 1,042 patients seen in last 2 yrs
  - 38 with acute and 4 with chronic infection
    - HBV sequences identical
- Retrospective cohort study (n=275)
  - RR 13.6 (95% CI 2.4-undefined) for receiving injections
    - AR 27% among those who received ≥1 injection versus 0 among those who received no injections

Source: CDC. MMWR 2003;52(38)

Frequency of Injections
HBV Cases vs. Susceptibles, 2001

<table>
<thead>
<tr>
<th>Number of injections</th>
<th>Percentage of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-4</td>
<td>10%</td>
</tr>
<tr>
<td>5-9</td>
<td>20%</td>
</tr>
<tr>
<td>10-14</td>
<td>30%</td>
</tr>
<tr>
<td>15+</td>
<td>40%</td>
</tr>
</tbody>
</table>

Median # injections
- 14 (Case-patient)
- 2 (Susceptible)  (p<.001)
Procedures and Location for Handling Injectable Medications and Supplies

- Injections administered at almost every visit
  - B12, dexamethasone, atropine used to make patients “feel better”
  - Two or three medications drawn from multiple dose vials with the same needle and syringe
- Same workspace was used to prepare, dismantle, and dispose of injection equipment

Injection Preparation and Disposal
HCV Transmission
Private Endoscopy Practice, 2001

- 4 patients hospitalized with acute hepatitis C May 2001
  - All underwent endoscopy at clinic A 3/28-3/30/01
- Lookback investigation for 9-day period
  - Infection attack rate of 44% (12/27) for 3/28-3/30
  - One patient with chronic infection identified
    - All acute HCV patients’ procedures followed
  - All patients’ strains genotype 2c (rarest in world)
- Extended offer of testing back to Jan 2000

Source: CDC. MMWR 2003;52(38)

HCV Infection Rates by Type of Procedure

<table>
<thead>
<tr>
<th>Procedure</th>
<th>HCV Attack Rates</th>
<th>RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exposed</td>
<td>Not Exposed</td>
</tr>
<tr>
<td>EGD</td>
<td>60%</td>
<td>27%</td>
</tr>
<tr>
<td>Colonoscopy*</td>
<td>33%</td>
<td>57%</td>
</tr>
<tr>
<td>Biopsy</td>
<td>45%</td>
<td>29%</td>
</tr>
</tbody>
</table>

* Source patient’s procedure

No association with endoscopy type or biopsy
Purchase Order Amounts for Injection Supplies

<table>
<thead>
<tr>
<th>9/00-4/01</th>
<th>Expected use*</th>
<th># Ordered</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV catheters</td>
<td>1530</td>
<td>1439</td>
</tr>
<tr>
<td>Needles</td>
<td>4590</td>
<td>600</td>
</tr>
</tbody>
</table>

* Based on number of procedures performed

Anesthesiologist admitted to re-inserting used needles into multi dose vials

HCV Transmission
Oncology Clinic, 2002

- Cluster of 6 patients with rare genotype (3a)
  - All attended same oncology clinic
- Lookback conducted for 20 month period
  - 99/486 (20%) HCV positive
  - 95/95 tested genotype 3a (rare in US)
- Retrospective cohort study
  - RR 10.0 (95% CI 5.9-16.8) for implanted central venous line
    - AR 61% among those with CV line versus 6% among those without CV line
HCV Transmission
Oncology Clinic, 2002

- Nurse drew blood from central line, then reused same syringe to perform saline flush
  - Solution from 500cc bag used for multiple patients
  - New syringe was used for each patient
- No transmission occurred after practice was stopped.

Oklahoma Pain Remediation Clinic

- August 2002 – 6 patients with acute hepatitis C who all received treatment at a single pain clinic
- Nurse anesthetist filled single needle and syringe with enough sedation medication to treat up to 24 sequential patients
  - Administered through heparin locks
- Lookback investigation for entire two year time period of clinic operation
  - 71 (9%) clinic-associated HCV infections
  - 31 (4%) clinic-associated HBV infections
- US $25 million settlement

Blood Glucose Monitoring

- Fingersticks = Percutaneous Exposures
- Risks for bloodborne pathogen transmission
  - HBV, HCV, and HIV
  - Settings in which multiple persons require FS
- Hazard was identified shortly after insulin was introduced in 1922 and pre-dates identification of hepatitis B virus

Recent HBV Outbreaks Associated with Blood Glucose Monitoring

- Shared fingerstick devices
  - 1999 – VA – Assisted Living Centers – 4 cases
  - 1999 – CA – Nursing Home – 4 cases
  - 2003 – MS – Nursing Home – 15 cases
  - 2003 – CA – Assisted Living Center – 8 cases
  - 2005 – VA – Assisted Living Centers (2) – 11 cases
- Dedicated fingerstick devices
  - 1999 – CA – Skilled Nursing Facility – 5 cases
  - 2002 – CA – Subacute Hospital – 3 cases
  - 2003 – NC – Nursing Home – 11 cases
HBV and HCV Related to Healthcare Procedures
United States - Summary

- Relatively rare events - not “associated” with sporadic or background infections
  - Difficult to detect
  - Extent of problem unknown
- Most due to unsafe injection practices
- Preventable
  - Single use of disposable needles and syringes
  - Multi-dose vials
    • Limit to single patient; or
    • Restrict to clean centralized preparation area

Unsafe Injection Practices Worldwide

- Inadequate supplies of sterile syringes
- Inadequate sterilization of reusable syringes and needles
- Administration by non-professionals at home
- Syringes shared with others (family, neighbors)
- Overuse of therapeutic injections
### Household Survey of Injections Received
#### Romania, June 1997 - May 1998

<table>
<thead>
<tr>
<th>Type of injection</th>
<th>No.</th>
<th>%</th>
<th>(95% CI)</th>
<th>Total</th>
<th>Median</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vaccine-related</td>
<td>365</td>
<td>10</td>
<td>(8-11)</td>
<td>988</td>
<td>2</td>
<td>1-15</td>
</tr>
<tr>
<td>Therapeutic</td>
<td>1334</td>
<td>36</td>
<td>(33-39)</td>
<td>19,630</td>
<td>8</td>
<td>1-735</td>
</tr>
</tbody>
</table>
HCV Related to Healthcare Procedures
Moderate/High Endemic Countries

- Associated with “background” infections
  - unsafe therapeutic injections
  - hospitalization, surgery, dental work
- Geographic clustering by age, town, region
  - considerable variation within and between countries

Unsafe Injections and HCV Infection
Moderate Endemicity Countries

<table>
<thead>
<tr>
<th>Country</th>
<th>History of Reused Needles/Syringes</th>
<th>HCV Pos</th>
<th>HCV Neg</th>
<th>OR (95% CI)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Italy</td>
<td></td>
<td>63%</td>
<td>31%</td>
<td>3.8 (2.7, 5.3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>89%</td>
<td>53%</td>
<td>7.0 (4.4, 11.2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>76%</td>
<td>72%</td>
<td>1.2 (0.6, 2.5)</td>
</tr>
<tr>
<td>Taiwan</td>
<td></td>
<td>26%</td>
<td>8%</td>
<td>4.2 (1.2, 14.5)</td>
</tr>
<tr>
<td>Pakistan (&gt;5/yr)</td>
<td></td>
<td>36%</td>
<td>6%</td>
<td>8.2 (1.9, 41.4)</td>
</tr>
</tbody>
</table>

* Adjusted for other risk factors
Healthcare Procedures and HCV Infection
Moderate Endemic Countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HCV Pos</td>
</tr>
<tr>
<td>Case-Control</td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td>17%*</td>
</tr>
<tr>
<td>Cross-Sectional</td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td>56%*</td>
</tr>
<tr>
<td></td>
<td>77%</td>
</tr>
<tr>
<td>Taiwan</td>
<td>13%</td>
</tr>
<tr>
<td>Pakistan</td>
<td>No data</td>
</tr>
<tr>
<td>Japan</td>
<td>32%*</td>
</tr>
<tr>
<td>Dental</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HCV Pos</td>
</tr>
<tr>
<td></td>
<td>22%*</td>
</tr>
<tr>
<td></td>
<td>91%*</td>
</tr>
<tr>
<td></td>
<td>90%</td>
</tr>
<tr>
<td></td>
<td>24%</td>
</tr>
<tr>
<td></td>
<td>33%</td>
</tr>
<tr>
<td></td>
<td>No data</td>
</tr>
</tbody>
</table>

* P<.05, after adjusting for other risk factors

Global Burden of HCV Infections Attributable to Contaminated Health Care Injections

<table>
<thead>
<tr>
<th></th>
<th>HBV</th>
<th>HCV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual number of infections (million)</td>
<td>21</td>
<td>2</td>
</tr>
<tr>
<td>Attributable fraction for injections</td>
<td>32%</td>
<td>40%</td>
</tr>
<tr>
<td>Projected deaths 2000-2030</td>
<td>75,000</td>
<td>24,000</td>
</tr>
<tr>
<td>Disability adjusted life years (million)</td>
<td>3</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Source: Hauri et al., Int J STD & AIDS 2004;15:7-16
Preventing Transmission of Bloodborne Pathogens in the Healthcare Setting

- Donor screening; viral inactivation
- Appropriate cleaning and disinfection
- Engineering controls (to prevent injuries)
- Hepatitis B vaccine for all HCWs at risk
- Standard (universal) precautions (infection control)
- Safe injection practices

Safe Injection Practices

- Educate/re-educate all staff
- Aseptic technique
  - Single use of disposable injection equipment
  - Avoid contamination of multi-dose vials
    - Restrict to individual patients
    - Use only in centralized medication preparation area
- Blood glucose monitoring
  - Avoid shared equipment including glucometers
  - Preference for auto-disabling single use lancets
  - Reduce percutaneous procedures to minimum necessary for appropriate diabetes management
  - Adequate staffing for scheduled diabetes care
  - Train, assess, and monitor staff