Viral Hepatitis

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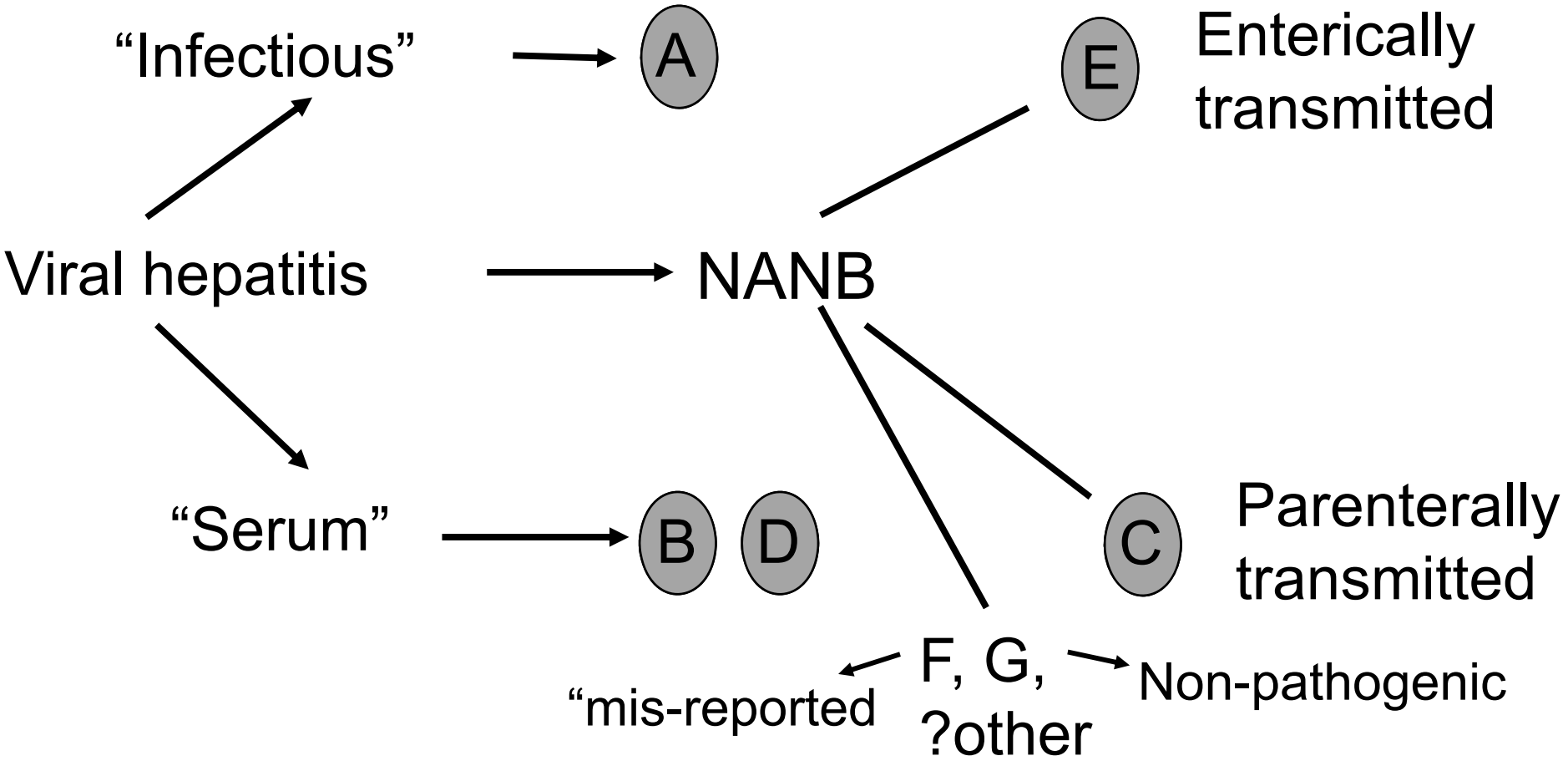
Viral Hepatitis - Overview

- Primary infection of the liver caused by at least five unrelated viruses: A, B, C, D, E
- HAV and HEV
  - Fecal-oral route
  - Acute self-limited disease; no chronic infection
- HBV, HCV, HDV
  - Percutaneous or mucosal exposures to blood
  - Chronic infection – major causes of cirrhosis and hepatocellular carcinoma worldwide

Viral Hepatitis – Historical Perspective



Viral Hepatitis - Overview

	Type of Hepatitis				
	A	**B**	**C**	**D**	**E**
Source of virus	feces	blood/ blood-derived body fluids	blood/ blood-derived body fluids	blood/ blood-derived body fluids	feces
Route of transmission	fecal-oral	percutaneous permucosal	percutaneous permucosal	percutaneous permucosal	fecal-oral
Chronic infection	no	yes	yes	yes	no
Prevention	pre/post-exposure immunization	pre/post-exposure immunization	blood donor screening; risk behavior modification	pre/post-exposure immunization; risk behavior modification	ensure safe drinking water

Clinical Features of Hepatitis

Common

- malaise
- anorexia
- nausea & vomiting
- fever
- jaundice
- abdominal pain
- hepatomegaly

Less Common

- diarrhea
- arthralgias
- pruritis
- rash

Enterically Transmitted Viral Hepatitis

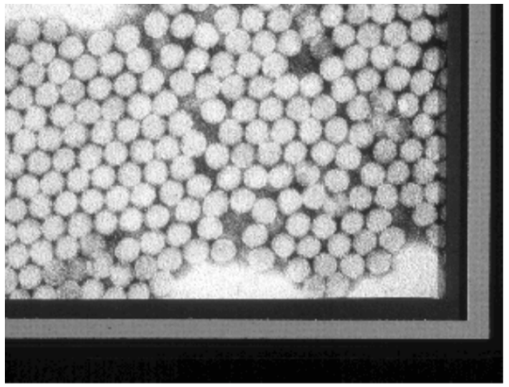
Hepatitis A—Highlights

- Estimated 1.5 million clinical cases of hepatitis A annually worldwide
- Tens of millions of hepatitis A virus infections occur each year
- Transition to lower rates of endemic HAV infection occurring on a global scale
- Universal childhood vaccination effective in countries with varying endemic rates
  - Reduces morbidity and mortality

Wasley A, Epidemiologic Reviews 2006

Hepatitis A Virus

- RNA Picornavirus
- Single serotype worldwide
- Acute disease and asymptomatic infection
- No chronic infection
- Protective antibodies develop in response to infection - confers lifelong immunity
- Vaccine preventable



Transmission of Hepatitis A Virus

- Fecal-oral transmission leads to spread between close contacts
- Greatest period of communicability: 2 weeks before onset of jaundice
- Stable in environment for months

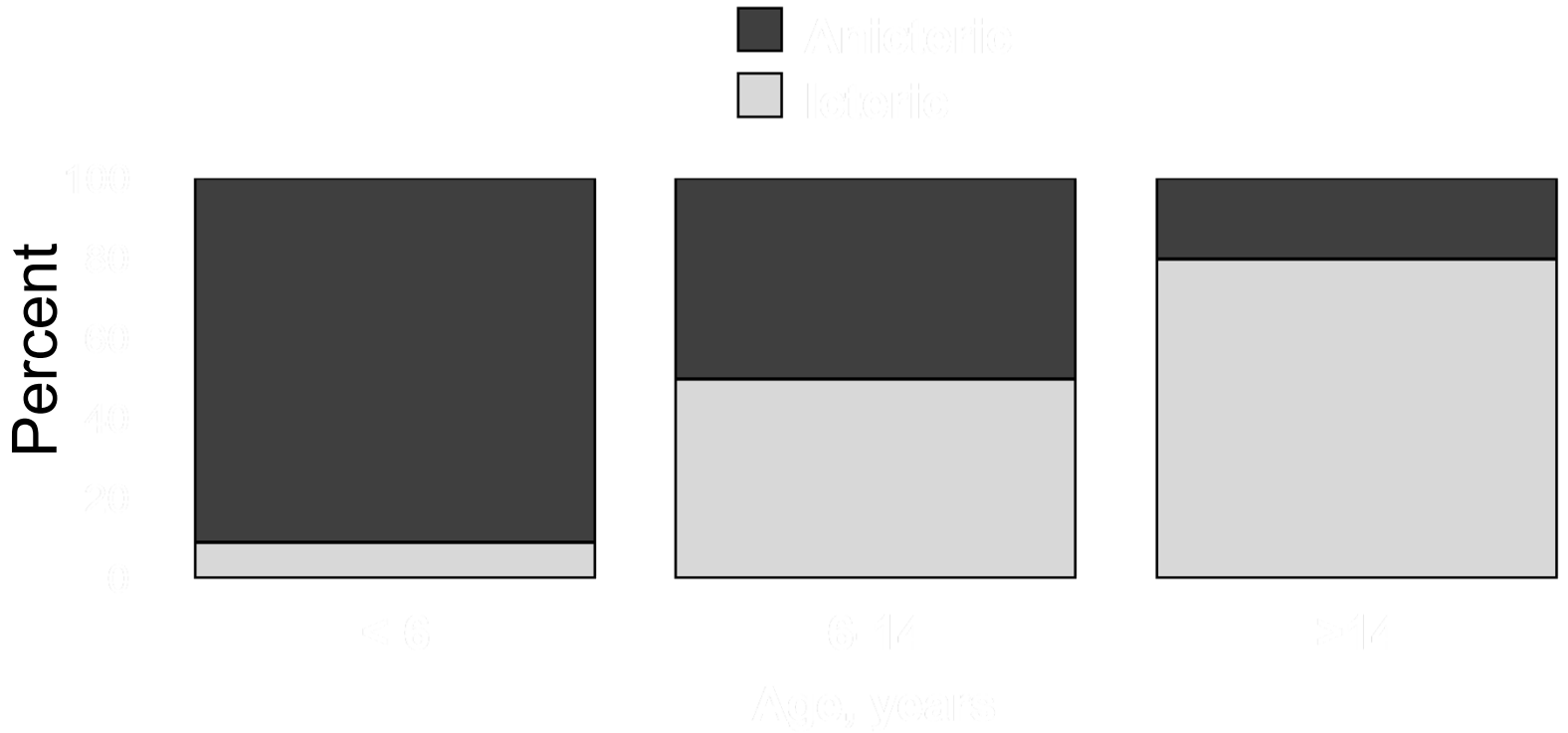
Transmission of Hepatitis A Virus

- Close personal contact
  (e.g., household contact, sex contact)
- Contaminated food (water)
  (e.g., infected food handlers, produce)
- Blood exposure
  (e.g., injecting drug use, transfusion)

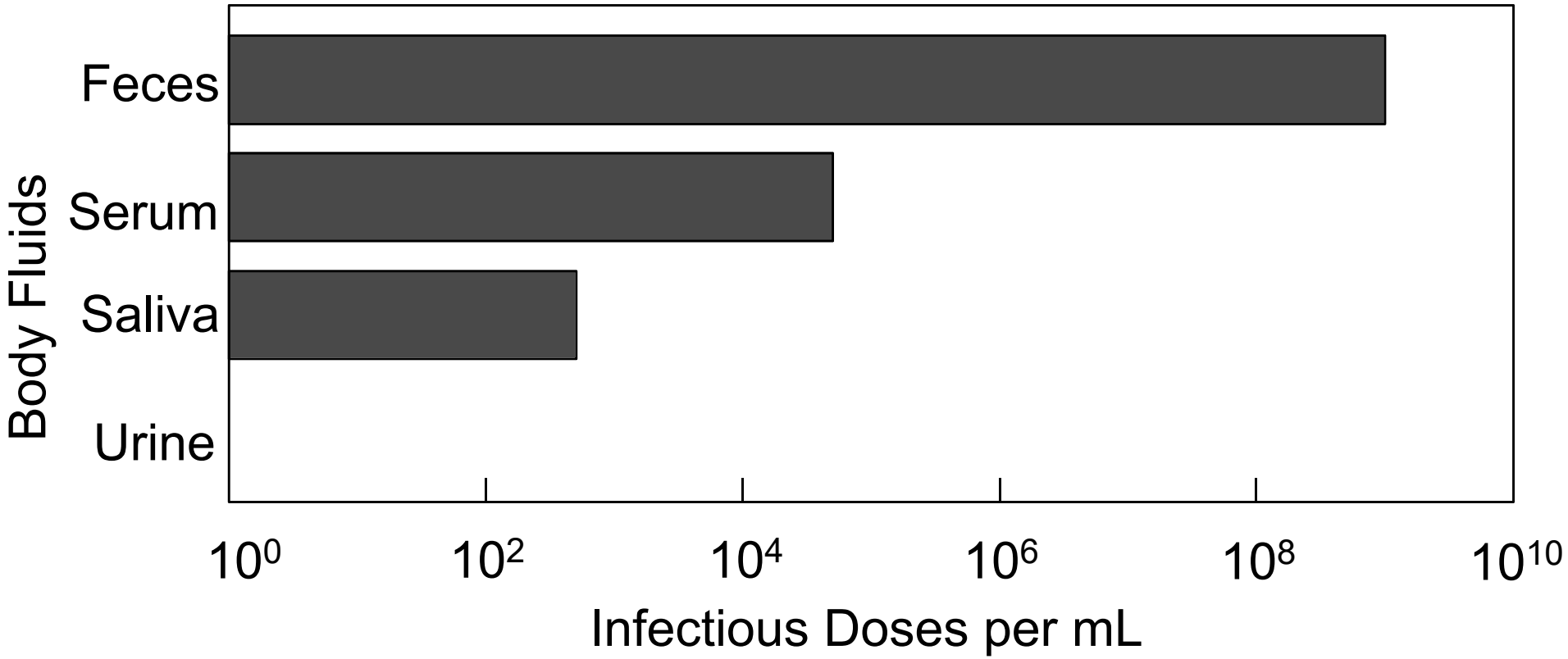
Hepatitis A - Clinical Features

Incubation period	Average 30 days Range 15-50 days
Jaundice by age	<6 yrs <10% 6-14 yrs 40%-50% >14 yrs 70%-80%
Case fatality rate	0.3% (0.2%-2.0%)
Complications	Fulminant; cholestatic; relapsing
Chronic sequelae	None (prolonged shedding in neonates and immunocompromised)

Relative Frequency of Jaundice with Hepatitis A, by Age

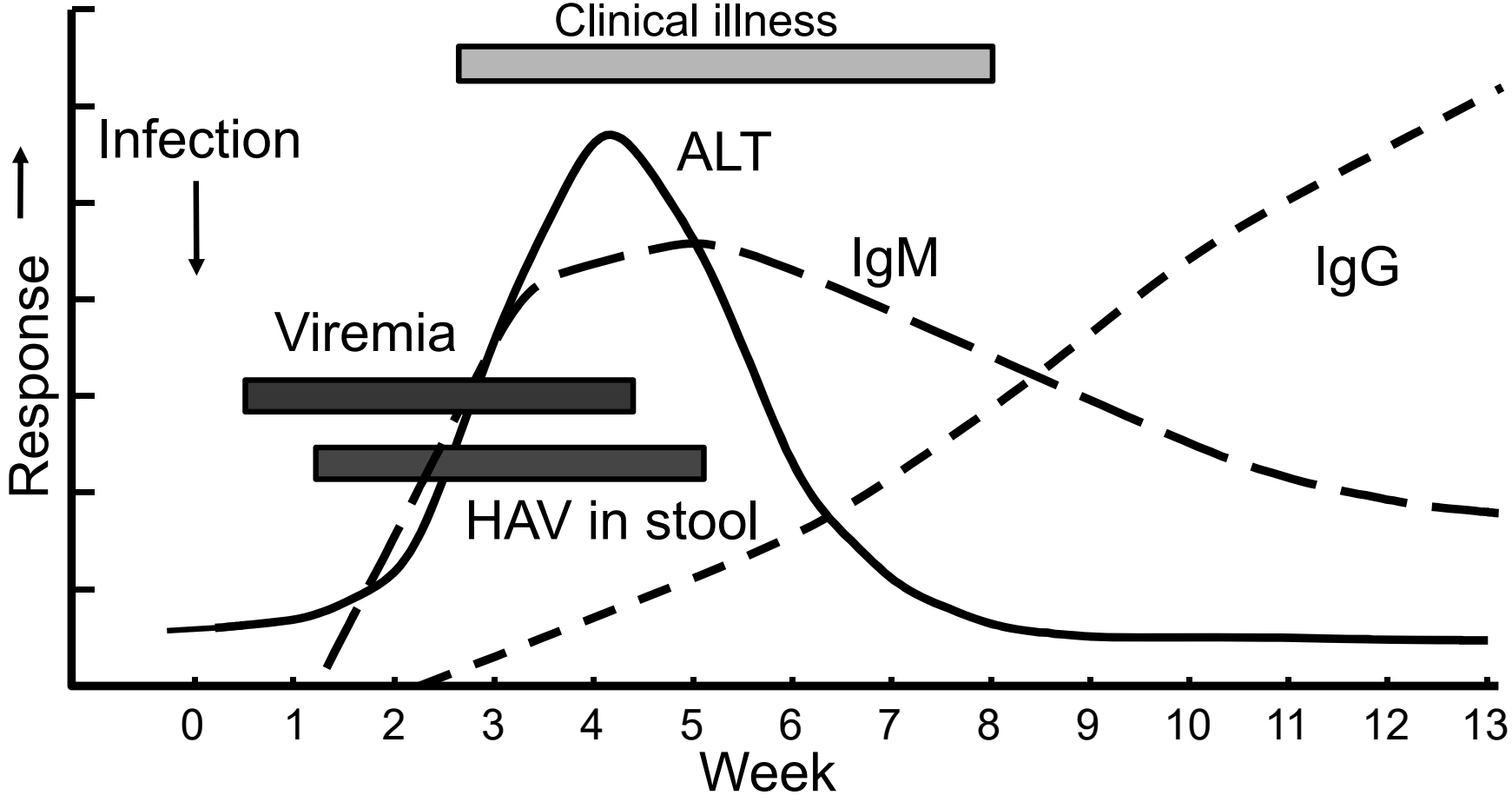


Concentration of Hepatitis A Virus in Various Body Fluids

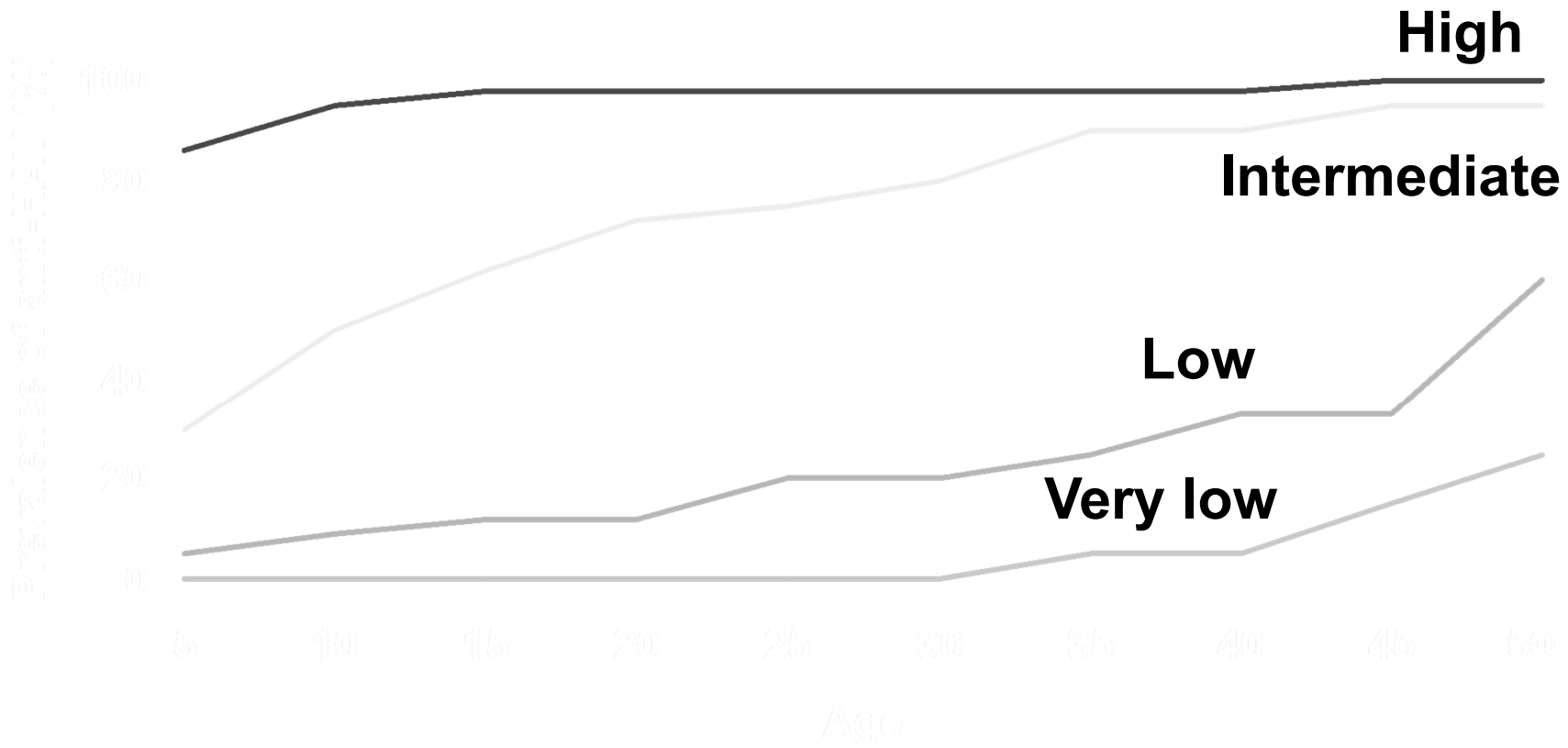


Source: Viral Hepatitis and Liver Disease 1984;9-22; J Infect Dis 1989;160:887-890

Events in Hepatitis A Virus Infection



Patterns of Hepatitis A Virus Infection Worldwide



Hepatitis A Virus Transmission
Global Patterns

Endemicity	Disease Rate	Age at Infection	Transmission patterns
High	Low	Early childhood	Person to person; outbreaks uncommon
Intermediate	High	Late childhood/ young adults	Person to person; food and waterborne outbreaks
Low	Low to high	Late childhood/ young adults	Person to person; food and waterborne outbreaks
Very low	Very low	Adults	Travelers; outbreaks uncommon

Global Patterns of Hepatitis A Endemicity

High

High/Intermediate

Intermediate

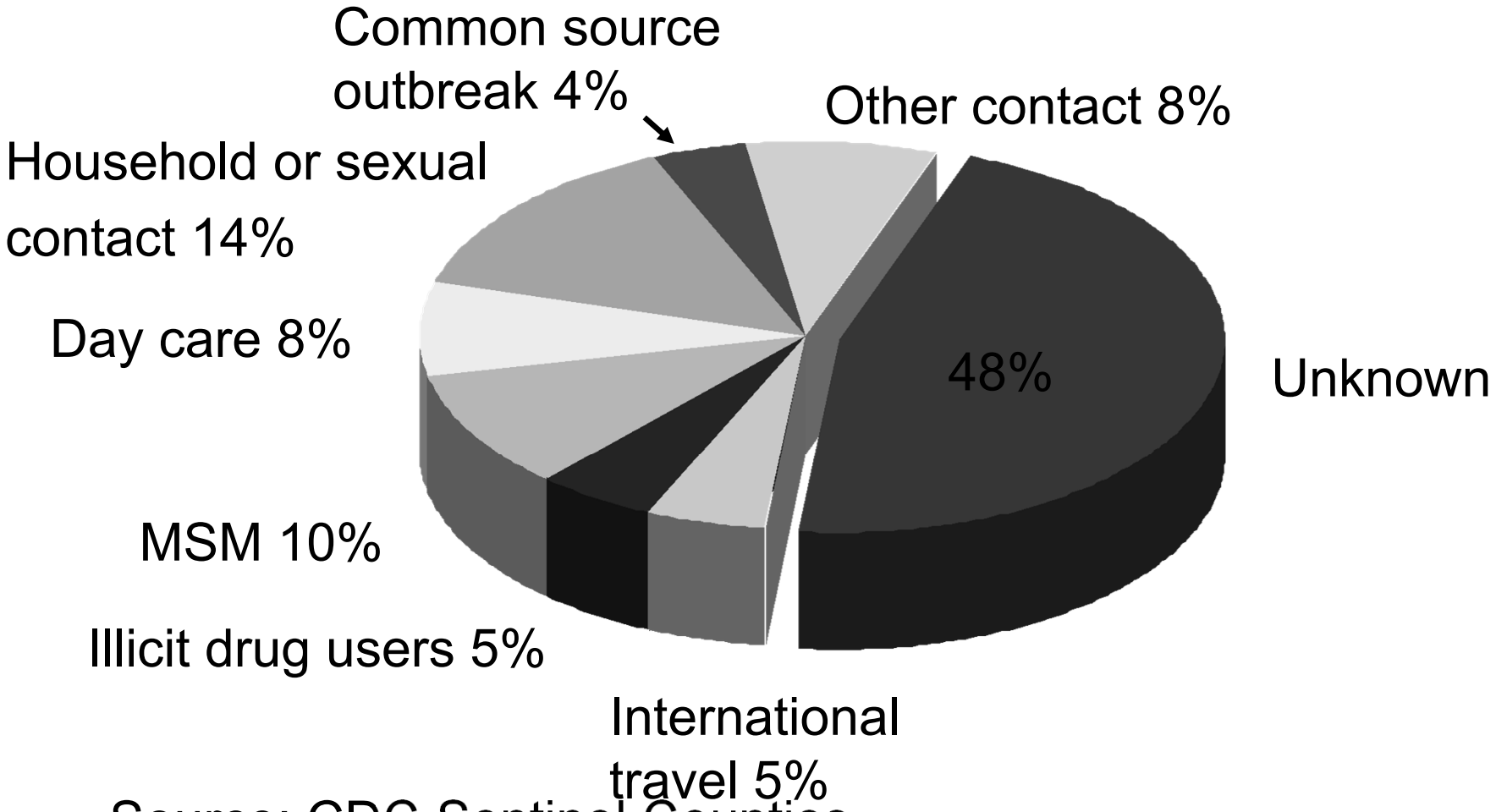
Low

Very Low

Epidemiologic Features of Hepatitis A in the United States

- Wide geographic and temporal variation in incidence
  - Areas with highest rates account for most reported cases
- Most disease occurs in the context of community-wide outbreaks
- Infection transmitted from person to person in households and extended family settings
  - Facilitated by asymptomatic infection among children
- Groups at increased risk can be identified
  - Specific factor varies
  - Do not account for majority of cases
- No risk factor identified for 30%-40% of cases

Risk Factors Among Persons with Hepatitis A, Reported Cases, United States, 1990-2000



Source: CDC Sentinel Counties

Source: Viral Hepatitis Surveillance Program

HEPATITIS A VACCINE EFFICACY STUDIES

Vaccine	Site/ Age Group	N	Vaccine Efficacy (95 % CI)
HAVRIX ®* (GSK) 2 doses 360 EL.U.	Thailand 1-16 yrs	38,157	94% (79%-99%)
VAQTA ® * * (Merck) 1 dose 25 units	New York 2-16 yrs	1,037	100% (85%-100%)

JAMA 1994;271:1363-4; N Engl J Med 1992;327:453-7

HEPATITIS A VACCINES

Recommended Dosages of Hepatitis A Vaccines

Vaccine	Age (yrs)	Dose	Volume (mL)	2-Dose Schedule (mos)
HAVRIX ® #	2-18	720 (EL.U.*)	0.5	0, 6-12
	>18	1,440	1.0	0, 6-12
VAQTA ® ##	2-18	25 (U**)	0.5	0, 6-18
	>18	50	1.0	0, 6-12

* EL.U. – Enzyme-linked immunosorbent assay (ELISA) units

** Units

has 2-phenoxyethanol as a preservative

has no preservative

SAFETY OF HEPATITIS A VACCINE

- Most common side effects
  - Soreness/tenderness at injection site - 50%
  - Headache - 15%
  - Malaise - 7%

- No severe adverse reactions attributed to vaccine
- Safety in pregnancy not determined – risk likely low
- Contraindications - severe adverse reaction to previous dose or allergy to a vaccine component
- No special precautions for immunocompromised persons

Immunogenicity of Inactivated Hepatitis A Vaccines

- 2-dose series 6-18 months apart (dosage varies by manufacturer)
- 95%-100% had protective levels of antibody one month after receiving one dose
- 100% had protective levels of antibody one month after receiving second dose with high geometric mean titers

Prevention of Hepatitis A

- Worldwide
  - Hygiene and sanitation
    - Handwashing and clean water sources
    - Prevent contamination of fresh produce
- Low endemic countries
  - Preexposure vaccination
    - All children aged ≥1 years
    - Risk groups (travelers, MSM, illegal drug users, persons with chronic liver disease)
  - Postexposure prophylaxis (vaccine or IG)
    - Household and sex contacts
    - Common source exposure (prepared food by infected handler)

Hepatitis E Virus (HEV)

Hepatitis E—Highlights

Like HAV

- Fecal-oral
- Acute self-limiting infection
  - Exception—may persist in immunologically compromised host
- Vaccine preventable

Unlike HAV

- Incubation period ~10 days longer
- Clinical response dose-dependent
  - Not age dependent
  - Infection rare in children and household contacts
- Higher mortality overall
  - Much higher in pregnant women
- Sporadic disease very rare in developed countries, Ab relatively common
  - Not always associated with travel*
  - *Zoonotic* source

Purcell RH, Emerson SU, J Hepatology 2008

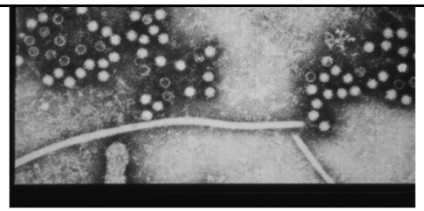
* Autochthonous

First Recognized Outbreak of Hepatitis E New Delhi, India (1956)

- 35,000 cases acute jaundice
- City water system contaminated by sewage
- Highest attack rate persons 15-40 years old
- Case-fatality rate 10.5% among pregnant women
- Originally thought to be hepatitis A

History

- 1983 human challenge experiment
  - Ingested pooled stool from outbreak-related cases
  - Developed acute non-A, non-B hepatitis
  - Excretion of virus-like particles
  - Stool infectious for non-human primates
- Classified enterically-transmitted NANB hepatitis
- 1990 HEV genome cloned
  - Classified as calicivirus



Diagnosis of Acute Hepatitis E

- Clinical illness indistinguishable from other types of acute viral hepatitis (A, B, C, D,….)
- Definitive diagnosis requires laboratory confirmation
- Serology:
  - IgM anti-HEV, IgG anti-HEV
  - Acute infection - good sensitivity and specificity
  - Prevalent infection - discordance between tests
- Research labs
  - HEV RNA by PCR (serum, stool, liver)
  - HEVAg by immunofluorescent probe (liver)

Hepatitis E - Clinical Features

Incubation period	Average 40 days; Range 15-60 days
Clinical illness	Case/infection ratio and severity increase with age
Chronic sequelae	None (“chronic” viremia recently reported in transplant patients)
Case-fatality rate	Overall 1-3% Pregnant women 15-20%
Factors related to increased severity	Chronic liver disease, large inoculum, pregnancy

Hepatitis E in Pregnancy

- Reasons for poor outcomes are unclear
- Most severe in 3rd trimester
  - 1/2: asymptomatic or mild HEV infection
  - 1/2: acute HE
    - 1/3 have FHF (fulminant hepatic failure, in resource-poor settings: high mortality)
    - 2/3 preterm delivery
    - High rates of obstetric complications
- Vertical transmission is common with 3rd trimester
  - Rate 33%-100%
  - Clinical outcome in infants is highly variable
    - Asymptomatic infection to hepatic necrosis
    - Hypoglycemia and hypothermia associated with mortality

Treatment

- Supportive
- No specific antiviral therapy
- Acute HE in pregnant women
  - No published data on potential benefits of early delivery

Epidemiologic Features of HEV

- Responsible for sporadic cases of acute hepatitis and outbreaks
- Mode of transmission fecal-oral
  - Recent report of solid organ transplant-related
- Pattern
  - Outbreaks - fecally contaminated drinking water
  - Sporadic cases - not known
- Highest attack rate in young adults
- Minimal person-to-person transmission
- Animal reservoir

Geographic Distribution of HEV

Outbreaks or
Confirmed Infection in >25% of Sporadic Non-ABC Hepatitis

HEV may be most common etiology of acute viral hepatitis

“Endemic” Countries

- Outbreaks
  - Waterborne
  - Flooding, disruptions in water systems
- Sporadic Hepatitis E
  - HEV accounts for a variable proportion of acute viral hepatitis
  - Source of transmission not clear

“Non-Endemic” Countries

- No outbreaks
- Sporadic HE
  - Travel-related
    - Most commonly after travel to Asia, especially India and China
  - Domestically acquired
    - Rare
    - Source unknown

Prevention of Hepatitis E

- Treatment - None
- Vaccine – effective, high-risk populations
- Immune globulin - Not effective
- Clean and reliable water supply
  - Virus probably inactivated by boiling
  - Effect of chlorination not known
- Proper sanitation (e.g., safe disposal of human and animal sewage)

Bloodborne Viral Hepatitis

Hepatitis B Virus

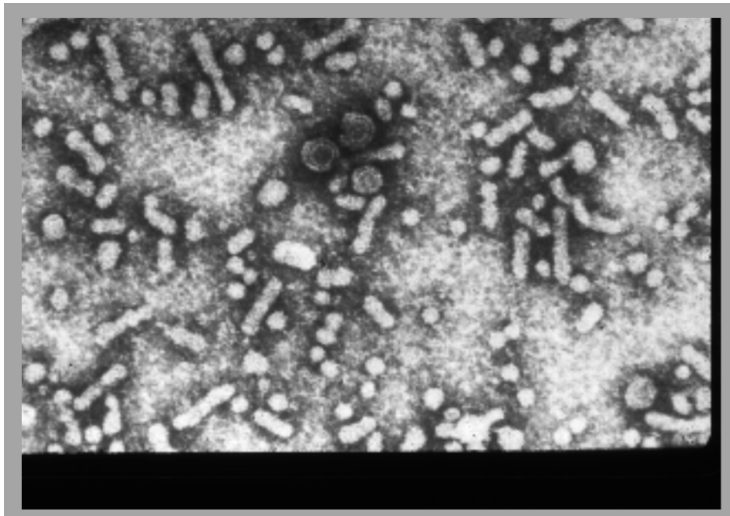
Hepatitis C Virus

Hepatitis D Virus

Bloodborne Viral Hepatitis
HBV and HCV—Highlights

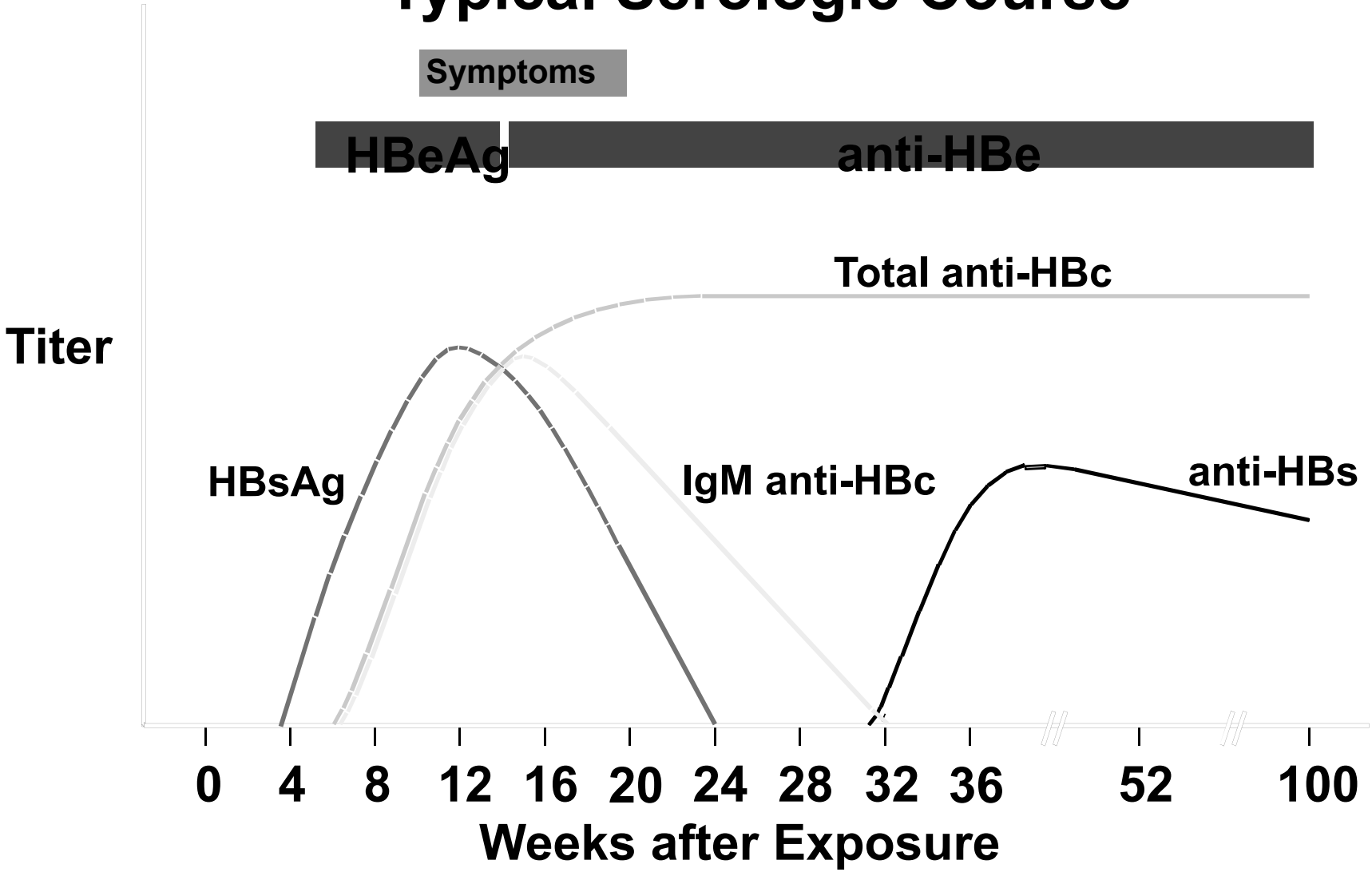
- HBV
  - Status of universal childhood immunization
- HBV and HCV
  - Transfusion Safety
  - Injection Safety
  - Changing epidemiology
  - Chronic disease burden

Hepatitis B Virus



Acute Hepatitis B Virus Infection with Recovery

Typical Serologic Course



Ten Leading Causes of Infectious Disease Deaths Worldwide (2000)

Disease	Deaths per Year
Lower resp tract infections	~3.5 million
HIV/AIDS	~3.0 million
Diarrheal diseases	~2.2 million
Tuberculosis	~2.0 million
Malaria	~1-3 million
Measles	~888,000
Hepatitis B	~750,000
Pertussis	~355,000
Neonatal tetanus	~300,000
Hepatitis C	~ 250,000

Source: CDC, WHO, UNICEF, UNAIDS

Global and US Disease Burden from Bloodborne Viral Infections

	Estimated No. Chronic Infections	
	Global	US
HBV	370 million	1.25 million
HCV	130 million	3-4 million
HIV	40 million	1 million
HIV / HBV	(3–4 million)	(250,000)
HIV / HCV	(4–5 million)	(40-50,000)

Sources: WHO and CDC, unpublished data.

Features of HBV & HCV Infection

	HBV	HCV
Virus Classification	DNA	RNA
	Hepadnavirus	Flavivirus
Incubation period – average	8–12 wks	6–7 wks
– range	6–26 wks	2–26 wks
Specific serologic markers		
acute infection	Yes	No
active infection	Yes	No
chronic infection	Yes	No
Clinical illness (jaundice)	30%–50%	20%
Chronic infection	90% (infants)	~70%
	5–10% (adults)	
Mortality from CLD, cirrhosis, HCC	25%	1-5%

Relative Efficiency of Transmission by Type of Exposure

Type of exposure	Efficiency of transmission		
to infected source	HBV	HCV	HIV
Transfusion	++++	++++	++++
Injecting drug use	++++	++++	++++
Unsafe injections	+++	+++	++
Needlestick	+++	+	<+
Sexual	+++	+	+++
Perinatal	++++	++	+++
Non-intact skin	++	+/-	+/-

Relative Infectivity of HBV, HCV, HIV

	HBV	HCV	HIV
Copies/mL	10^{8-9}	10^{5}	10^{3}
Environmental stability	++++	++	-
Infectious after drying at room temperature	≥7d	≥16h (<4d)	0

Bond WW, Lancet 1981;1:550-51; Kamili S, Infect Control Hosp Epi 2006.

Environmental Stability of HBV and HCV Facilitates Their Transmission

- More rapid acquisition among IDUs
  - Clean needles and syringes alone insufficient to interrupt transmission because virus can live on contaminated drug preparation equipment (i.e., cookers and cotton)
- Iatrogenic transmission
  - Virus can live in contaminated multi-dose vials and on needles and syringes

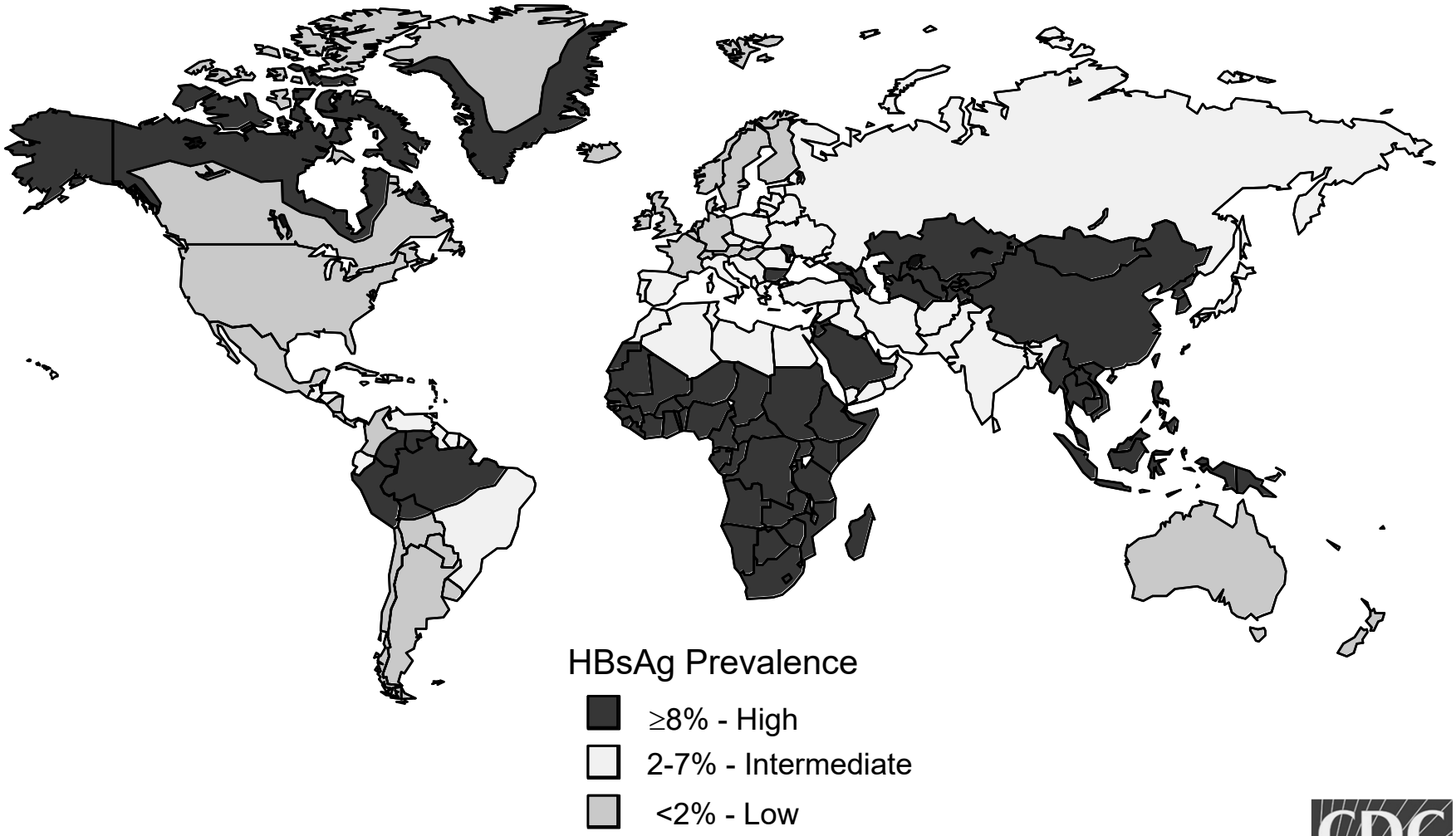
Routes of HBV Transmission

Age Group	Routes of Infection
Newborn	Mother to infant (perinatal)
Childhood	Household (non-intact skin)
Adolescent/Adult	Sexual contact
	Injecting drug use equipment
	Occupational exposures
All ages	Unsafe injections
	Transfusion from unscreened donors
	Other health care related

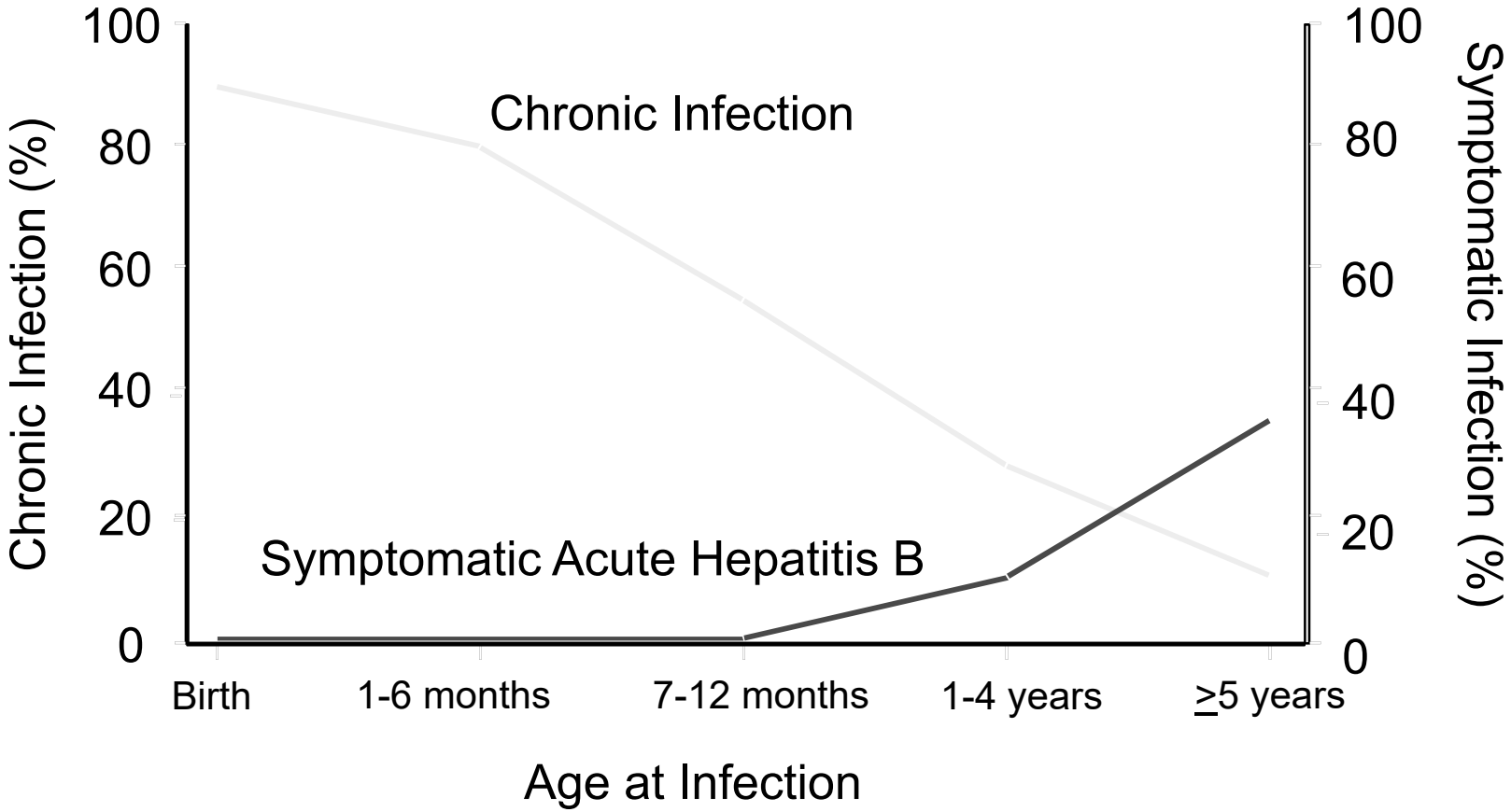
Global Differences in HBV Transmission Patterns

Chronic infection (% immune)	Primary Age at Infection	Primary Modes of Transmission
High ≥8% (≥60%)	Infants Young children	Perinatal, horizontal, unsafe injections, unscreened blood
Intermediate 2-7% (20-60%)	All age groups	Perinatal, horizontal, unsafe injections, sexual, IDU
Low <2% (5-20%)	Adolescents Adults	Sexual, IDU

Geographic Distribution of Chronic HBV Infection



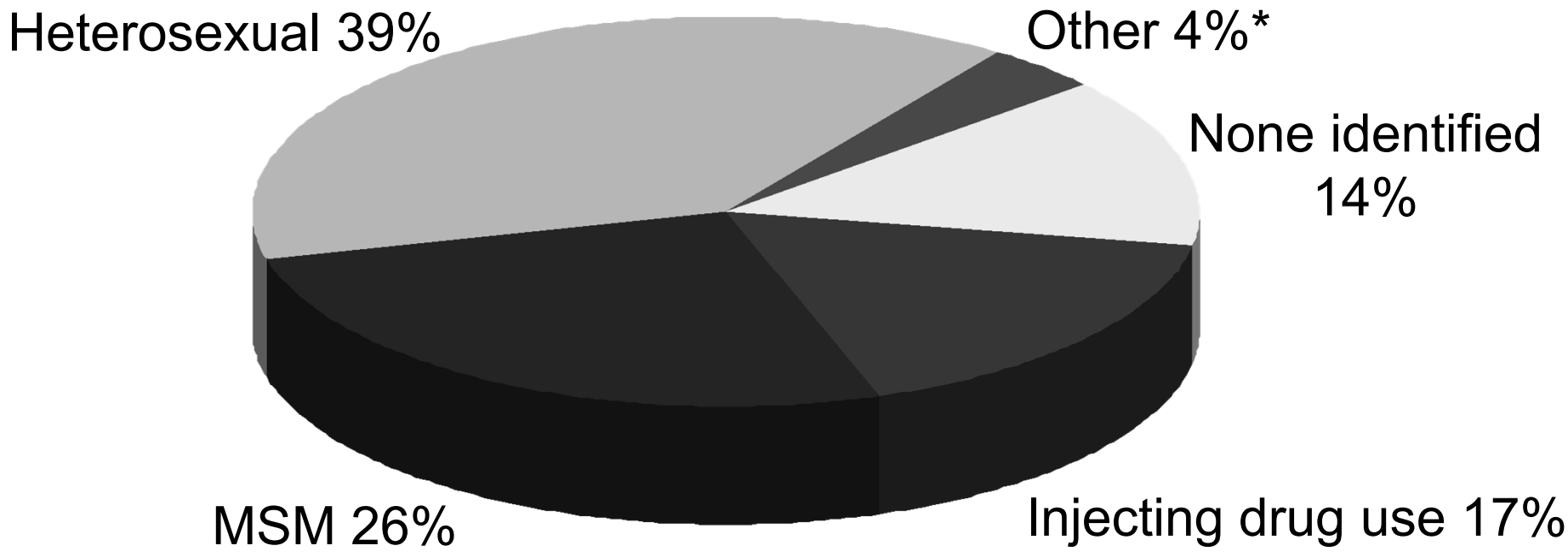
Outcome of HBV Infection by Age at Infection



Global Strategy to Prevent HBV Transmission

- Hepatitis B Vaccination
  - Routine infant vaccination (all countries)
  - Catch-up vaccination of older children/adolescents
  - Vaccination of high-risk groups
- Prevention of Iatrogenic transmission
  - Routine screening of transfused blood
    - developed countries -100% screen
    - least developed countries - 35% screen (?)
  - Safe injection practices
  - Proper infection control practices

Risk Factors Reported by Cases of Acute Hepatitis B, United States, 2000-2003



* Other - Household contact, occupational exposure, hemodialysis, institutionalization, transfusion

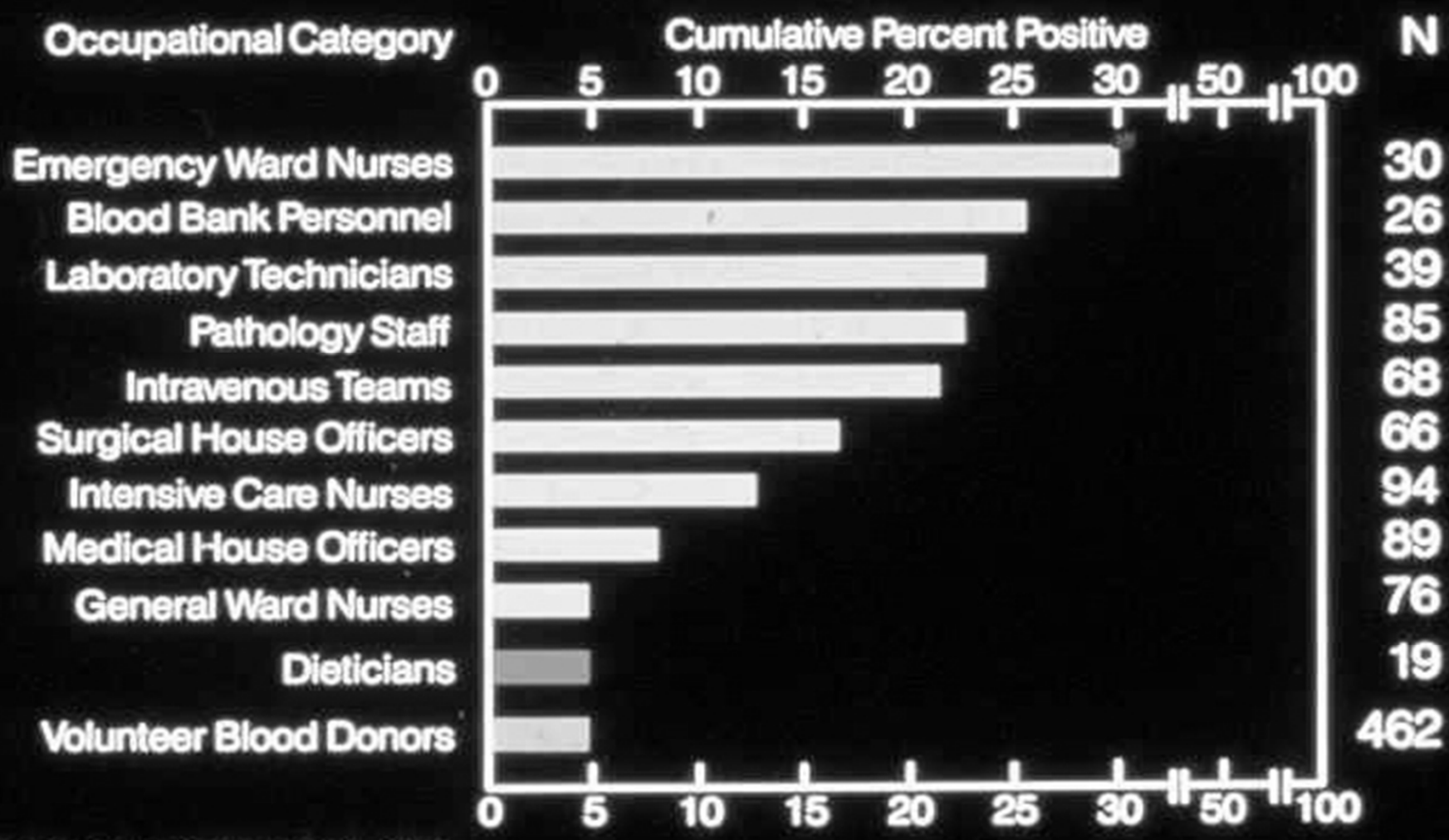
Source: Adapted from Sentinel Counties and NNDSS, CDC

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

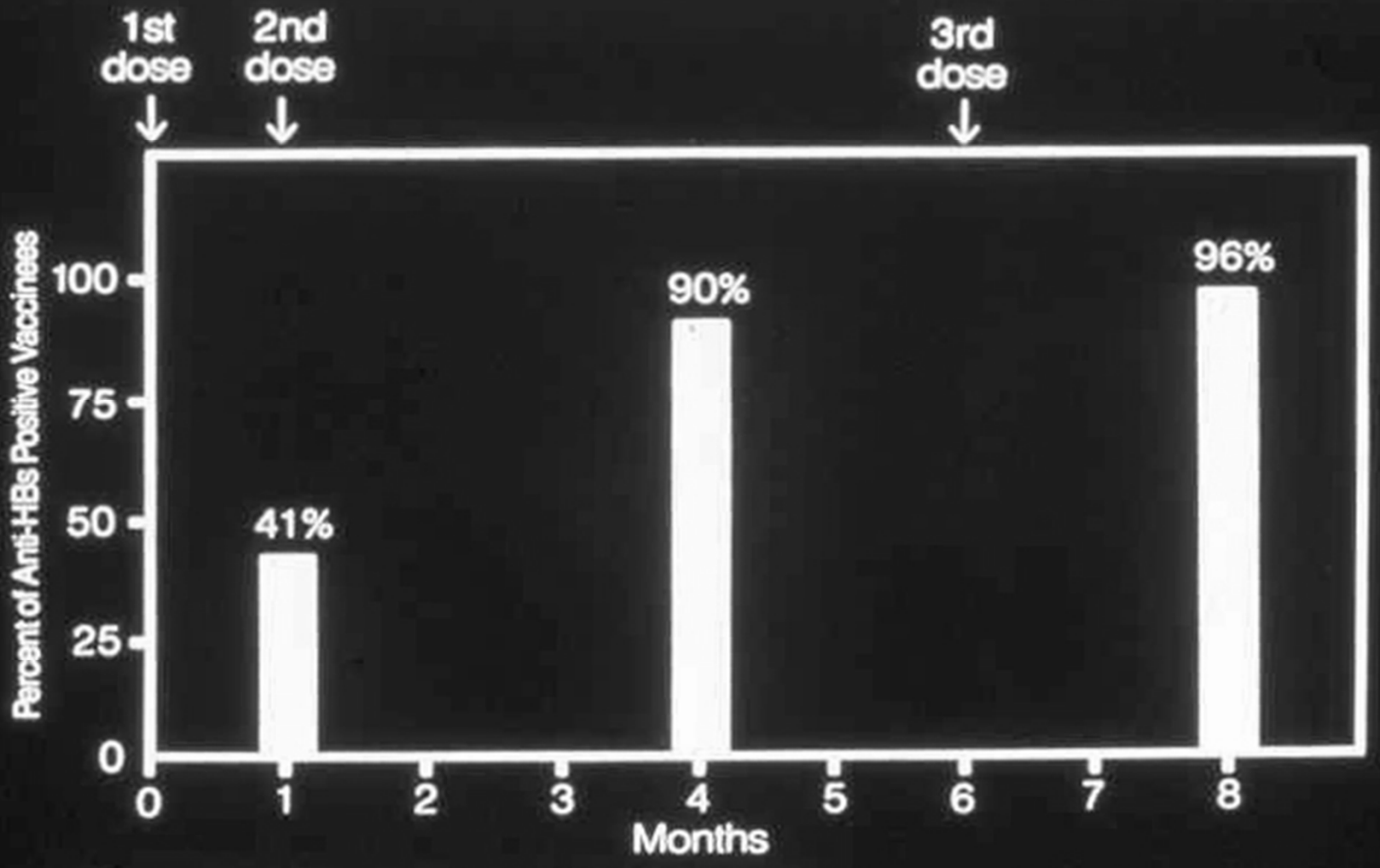
Hepatitis B in Health-Care Personnel

Prevalence of HBV Serologic Markers in 624 Hospital Personnel and 462 Nonhospital Controls



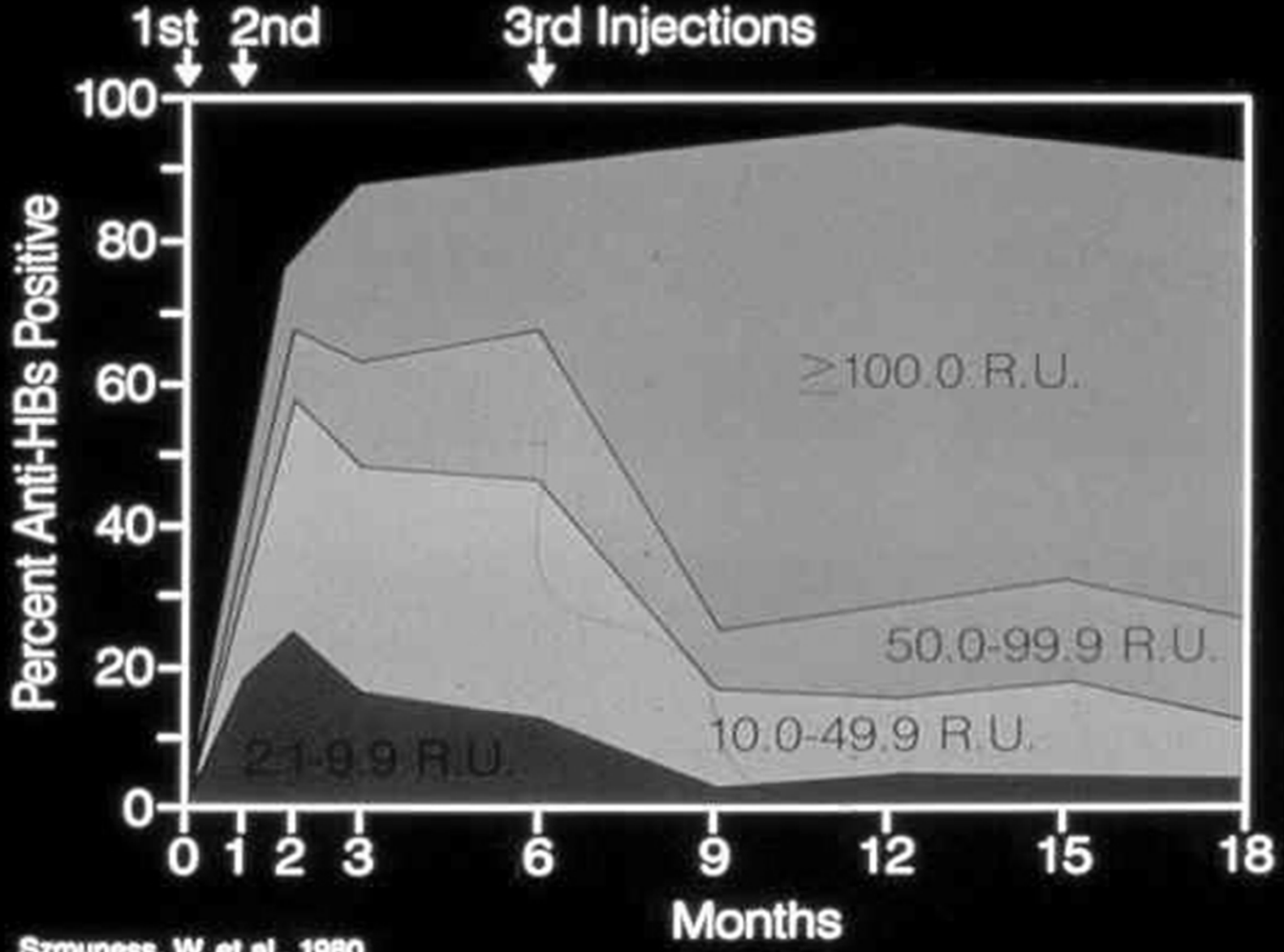
Dienstag, J. L. and Ryan, D. M., 1982

Immunogenicity of Heptavax-B® (Hepatitis B Vaccine | MSD)



Adapted from Szmuness, W. et al., J. Med. Virol., 1981

Immunogenicity of Hepatitis B Vaccine



Szmuness, W. et al., 1980

Hepatitis B Vaccine

Factor	Response	Factor	Response
Age 20-29	95%	Diabetes	70-80%
Age 30-39	90%	Liver disease	60-70%
Age 40-49	86%	Gender	Female>male
Age 50-59	71%	Obesity	Decreased
Age ≥60	47%	Smokers	Decreased
Renal Failure	50-80%	Gluteal injection	Decreased
HIV infection	50-70%		

Response is defined as ≥ 10 mIU/mL

Hepatitis B Vaccine: Administration 2

- Schedule
  - 0, 1, 6 mo
  - 0, 1, 2, 12 mo (more rapid antibody rise) (Engerix)
- Pre-exposure
  - ACP: Three doses, obtain titer (1-6 mo). If antibody negative, provide up to 3 additional doses (titer 1-2 mo after each dose)
  - If no response after 6 doses, provide HBIG for exposures

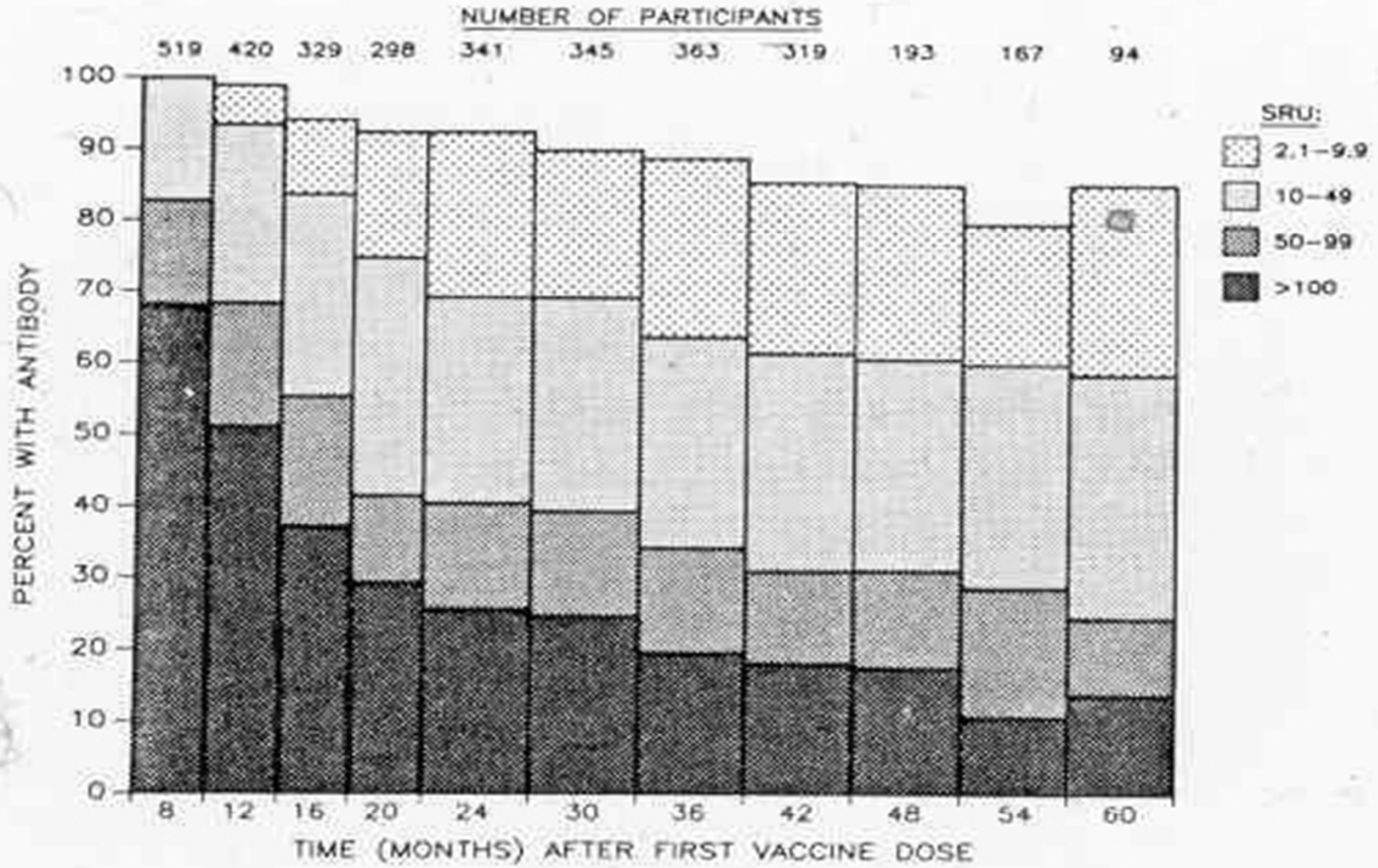
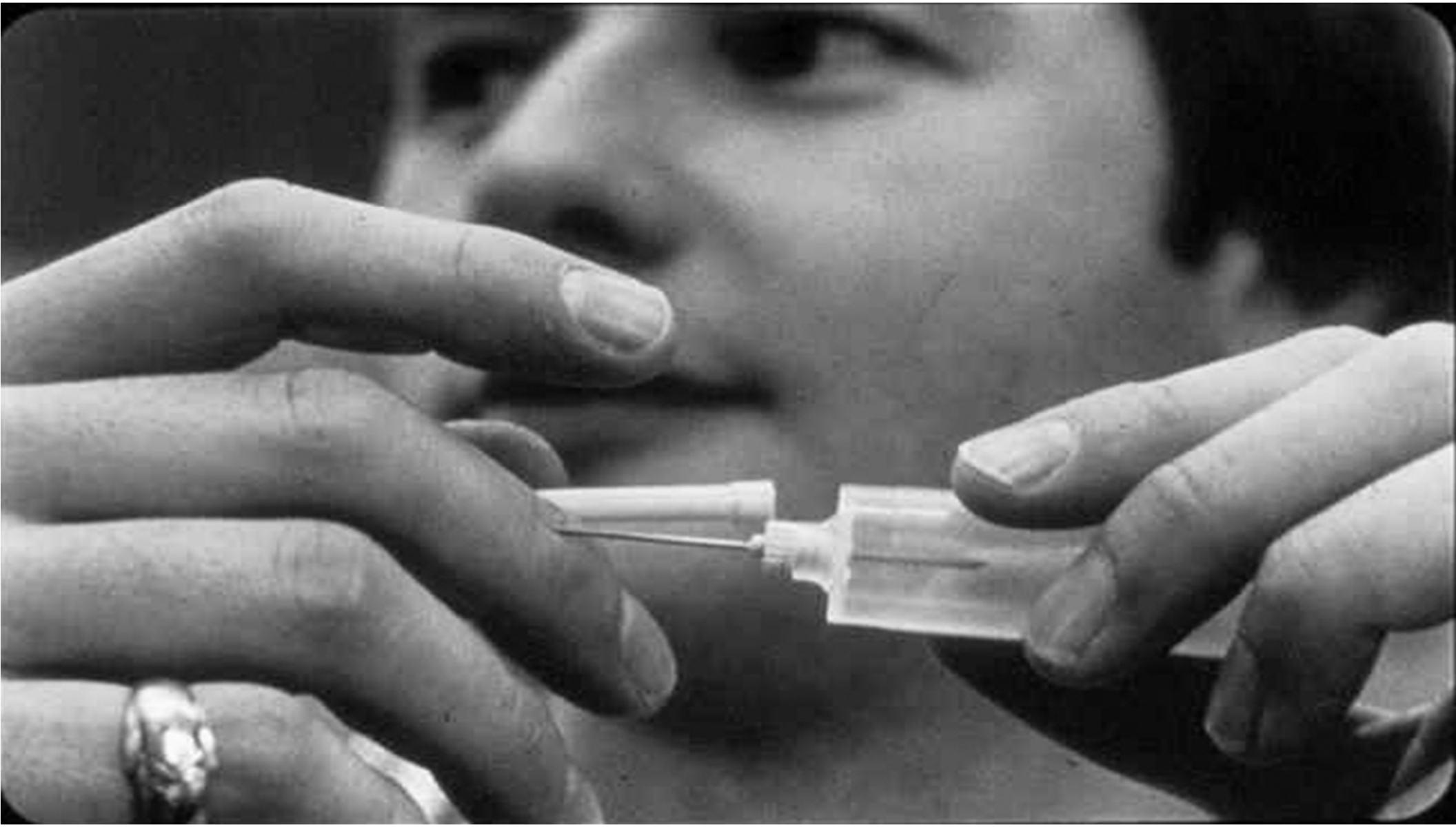


Figure 1. Long-Term Persistence of Anti-HBs in Persons in Whom Anti-HBs Levels above 9.9 SRU Developed after Standard Three-Dose Vaccination.



HBV: POST-EXPOSURE PROPHYLAXIS

Exposed person	Source HBsAg+	Source HBsAg-	Source unknown
Unvaccinated	HBIG x 1 HBV vaccine	HBV vaccine	HBV vaccine
Vaccinated, Responder	No therapy	No therapy	No therapy
Vaccinated, Nonresponder	HBIG x 2 or HBIG x 1 & HBV vaccine	No therapy	If known high-risk source, treat as if source HBsAg+
Vaccinated, Response unknown	Obtain anti-HBs * If ok, no therapy * If low, HBIG x 1 & vaccine	No therapy	Obtain anti-HBs * If OK, no therapy * If low, vaccine booster

Adequate anti-HBs is ≥10 mIU/mL; HBIG = 0.06 mg/kg IM

Hepatitis C Virus

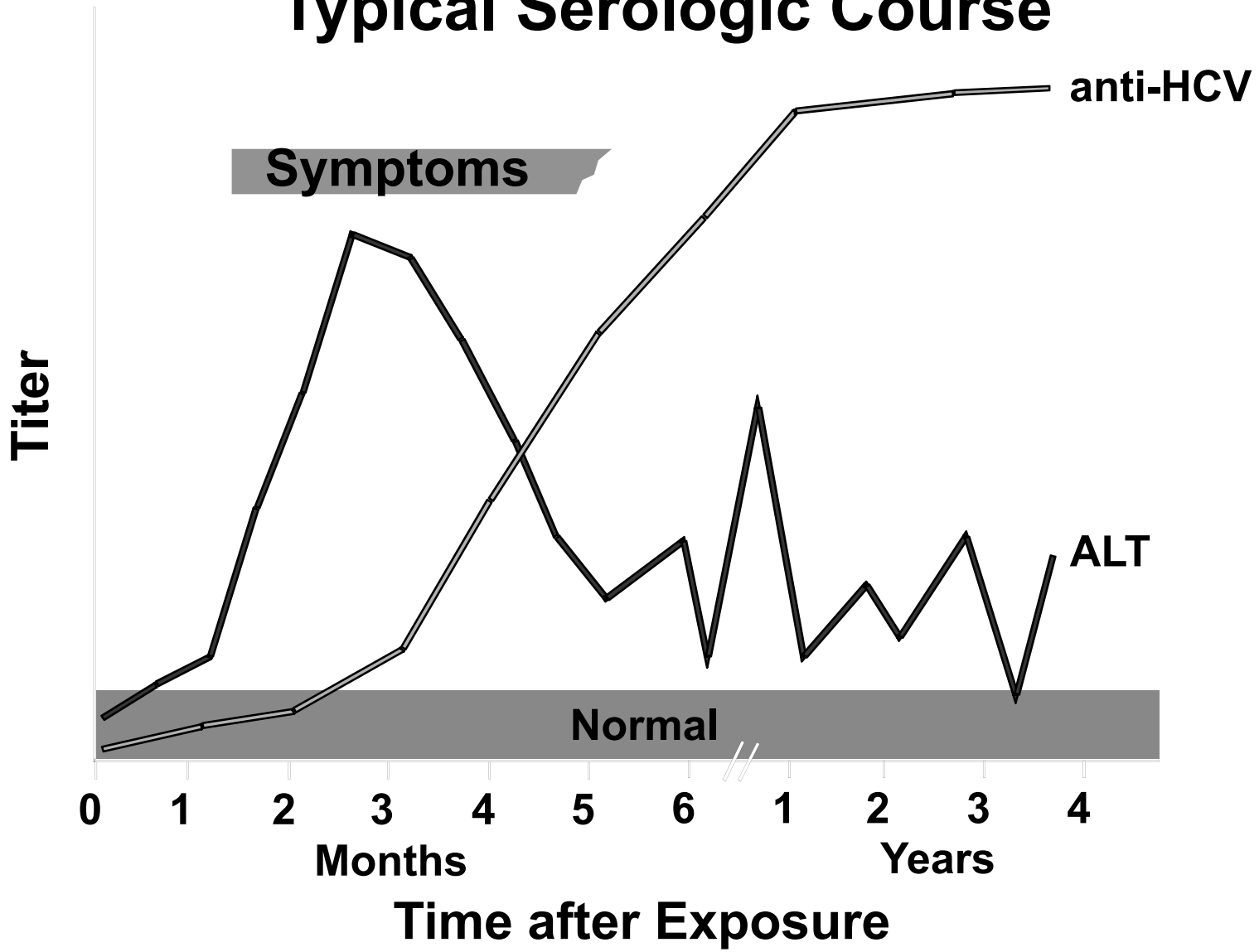
- RNA Flavivirus (Hepacivirus)
  - **Discovery using recombinant DNA technology reported in 1989**
  - **Clinical entity (non-A, non-B hepatitis) in transfused patients reported late 1960s**
  - **Target organ liver**
- Bloodborne (primarily) and sexually-transmitted
- No vaccine
  - **Mutations occur during viral replication**
  - **Substantial heterogeneity (quasispecies) prevents effective neutralization**
- Treatable and curable (most people free of virus in months)

Features of Hepatitis C Virus Infection

Incubation period	Average 6-7 weeks Range 2-26 weeks
Acute illness (jaundice)	Mild (20%-30%)
Case fatality rate	Low
Chronic infection	75%-85%
Chronic hepatitis	70%
Mortality from CLD	1%-5%

Hepatitis C Virus Infection

Typical Serologic Course

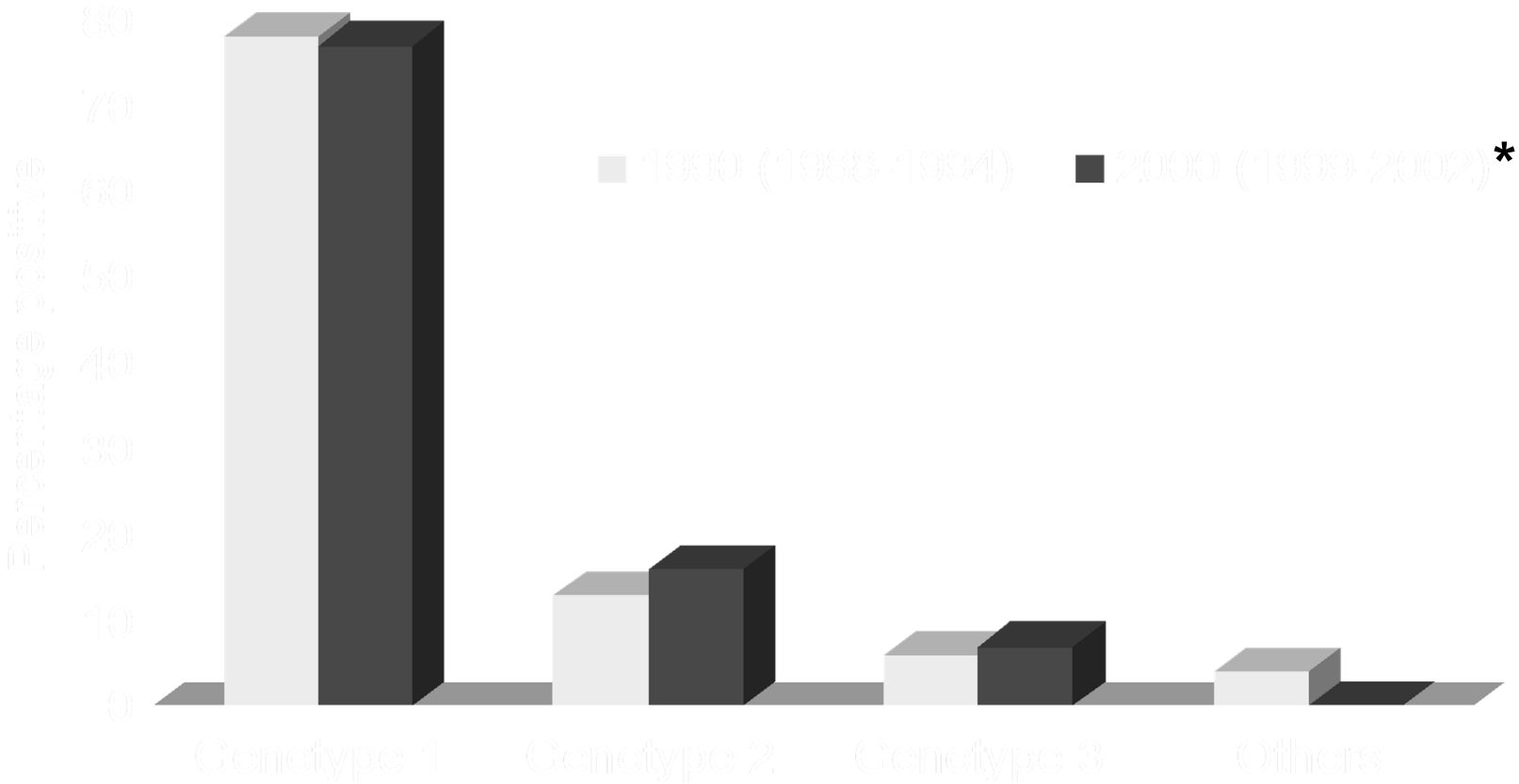


Hepatitis C Virus Infection
United States

New infections per year 1985-89	242,000
2006	20,000
Deaths from acute liver failure	Rare
Persons ever infected (1.6%)	4.1 million (3.4-4.9)*
Persons with chronic infection	3.1 million (2.5-3.7)*
HCV-related chronic liver disease	40% - 60%
Deaths from chronic disease/year	8,000-10,000

*** 95% confidence interval (data from 1999-2002)**

Distribution of HCV Genotypes in the General Population, 1990 vs. 2000, US



Nainan OV. Gastroenterol 2006;131:478-484

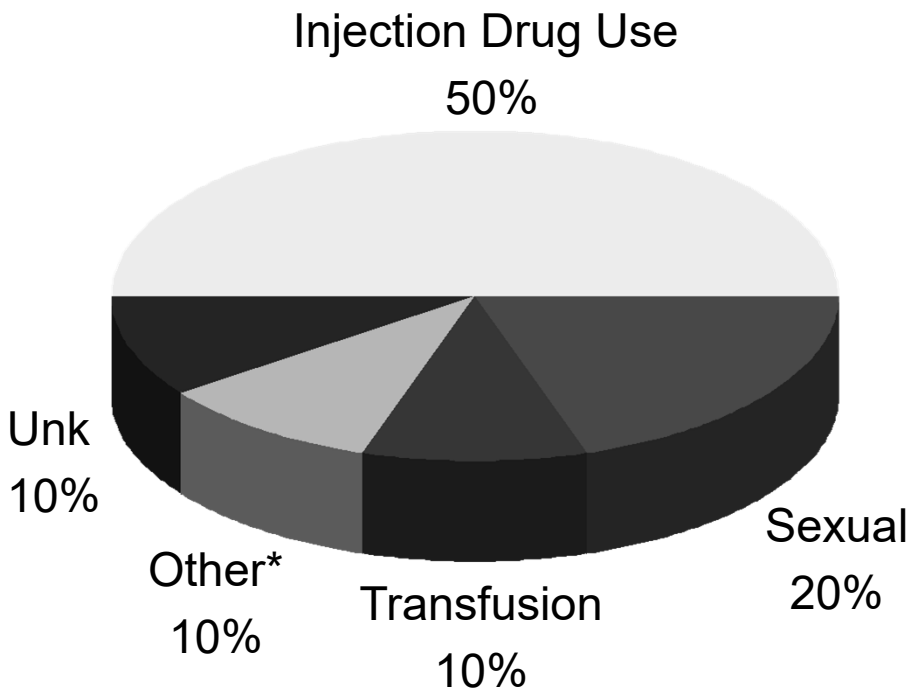
*CDC, preliminary unpublished data

Transmission of HCV

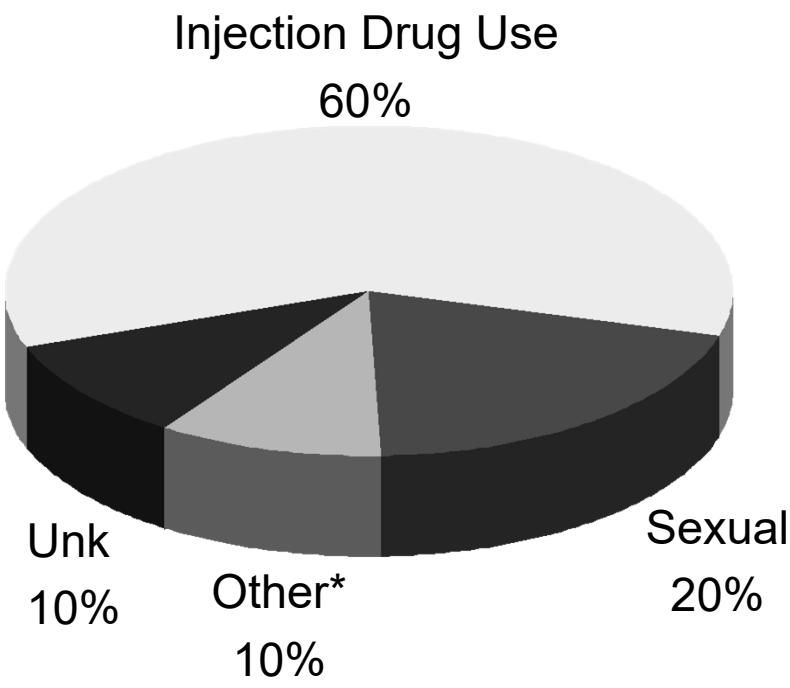
- Percutaneous
  - Injecting drug use
  - Clotting factors before viral inactivation
  - Transfusion, transplant from infected donor
  - Therapeutic (contaminated equipment, unsafe injection practices)
  - Occupational (needlestick)
- Permucosal
  - Perinatal
  - Sexual

Risk Factors For Persons with Acute or Chronic Hepatitis C 1999-2002, U.S.

Chronic (Prevalent)



Acute (Incident)



* Other includes occupational, nosocomial, iatrogenic, perinatal

Armstrong GL, Ann Intern Med 2006;144:705-14; CDC Sentinel Counties, unpublished data

Iatrogenic-Related Outbreaks of HCV Infections in Developed Countries

- In- and outpatient care
  - Chronic hemodialysis, surgery, endoscopy, pain management clinic, oncology clinic, in-patient ward
- Most due to unsafe injection practices, i.e., failure to use aseptic techniques
  - Contamination of multi-dose medication vials and IV solutions
  - Reuse of syringes/needles
  - Contamination of finger stick devices
- Infected HCW rarely source
  - Usually due to self-injection of patients' narcotics

Williams IT, Clin Infect Dis 2004;38:1592-1598

Health-Care Related HCV Transmission

- Blood transfusion from unscreened donors
  - including plasma-derived products not inactivated
- Unsafe injection practices
  - inadequate sterilization of reuseable needles and syringes
  - sharing of disposable needles and syringes
- Contaminated equipment
  - inadequate cleaning and disinfection
    - health care settings
    - alternative medicine practices, rituals

Global Burden of Disease Associated with Unsafe Injections

- Estimated annual incidence, 2000
  - > 20 million HBV infections
    - 30% of new infections
  - > 2 million HCV infections
    - 40% of new infections
  - > 250,000 HIV infections
    - 5% of new infections

Ezzati M et al. *Lancet. 360(9343):1347-60, 2002.*

Unsafe Injection Practices

Developing Countries

- Inadequate supplies of sterile syringes
- Inadequate sterilization of reusable syringes and needles
- Administration at home by non-professionals
- Syringes shared with others (family, neighbors)
- Overuse of therapeutic injections

Developed Countries

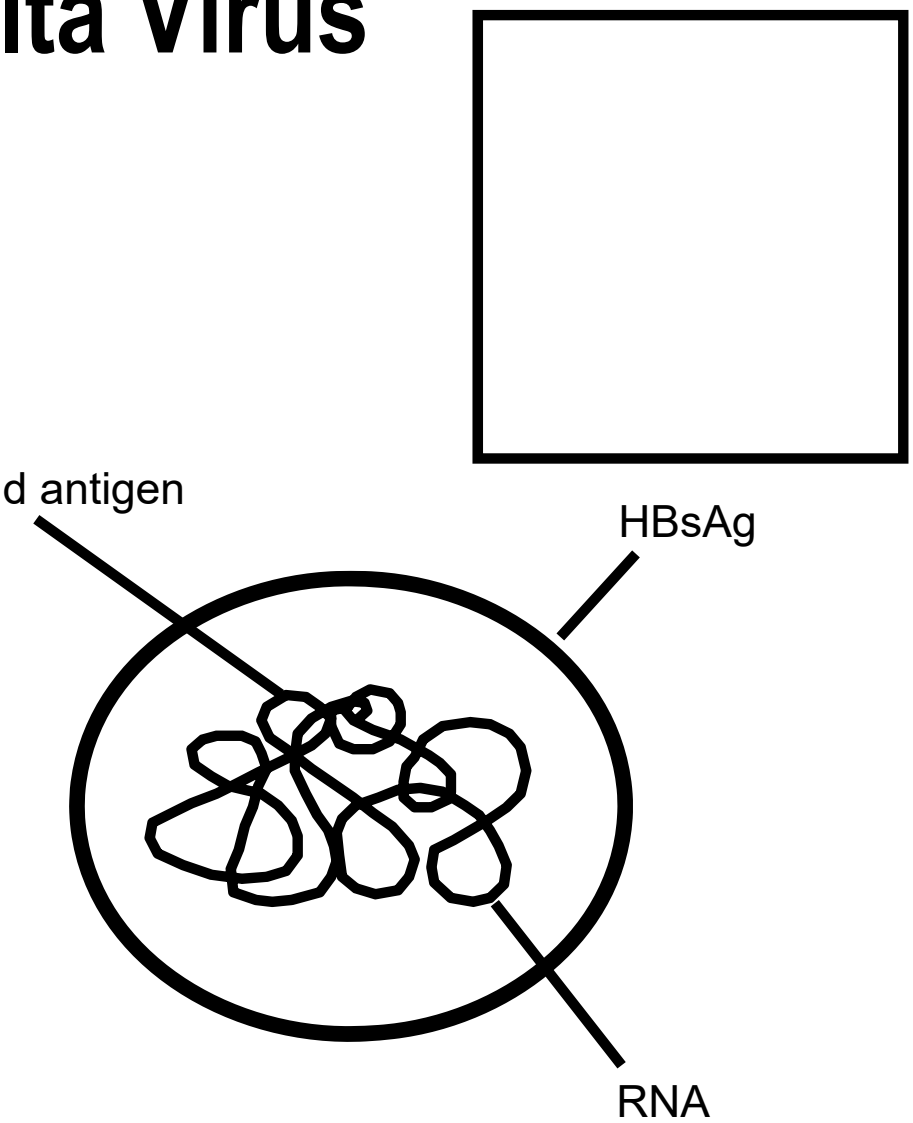
- Failure to use aseptic techniques
  - Reuse of same syringe and needle to administer meds to multiple patients
  - Medication preparation and blood sample handling in same area
  - Contamination of multiple dose medication vials
- Infected HCW rarely source
  - Usually due to self-injection of patients' narcotics


Chloroquine phos

Children Handling Medical Waste, Bangladesh

Hepatitis Delta Virus

- Referred to as “defective” virus
  - HDV RNA
  - surrounded by coat of HBsAg
- HDV dependent on presence of HBV to establish infection
  - requires a protein coat of HBsAg to be released from infected hepatocytes
  - HBsAg mfg by HBV



Infection with HDV

HBV-HDV Coinfection

- Simultaneous infection with HBV and HDV in a person susceptible to HBV
- Low risk of death from chronic liver disease

HBV-HDV Superinfection

- Infection with HDV in a person with chronic HBV
- High risk of severe chronic liver disease and death

Persons immune from HBV infection – either through vaccination or resolved infection – cannot become infected with HDV

Epidemiologic Features of HDV

- Transmission similar to HBV
  - Percutaneous – highly efficient
  - Sexual
  - Perinatal

  } Much less efficient than HBV
- Uncommon in U.S. - seen mainly in IDU's
- Worldwide, endemic in Amazon, Mediterranean, Central Asia, Africa

Prevention of HDV

HBV-HDV coinfection

- Hepatitis B vaccinaton

HBV-HDV superinfecton

- Prevent exposure to HBV
  - screen blood for HBV (need HBV for HDV)
- Reduce high-risk behaviors
  - safer sex practices
  - safer injection practices

Current and Future Issues

- Identification of infected persons
  - Screening and testing not routinely performed
  - Lack effective methods for reaching those whose risk was in the remote past
    - Risk factor ascertainment in routine healthcare visits is rare
- Therapy regimens less than ideal, especially those with genotype 1
  - In US, treatment offered to low % of HCV-positives
- Implications of multiple co-factors on liver disease progression and response to therapies not well understood
  - Impact likely to grow creating an even greater challenge
- Need to be alert to changes in epidemiology

Viral Hepatitis - Overview

- Primary infection of the liver caused by at least five unrelated viruses: A, B, C, D, E
- HAV and HEV
  - Fecal-oral route
  - Acute self-limited disease; no chronic infection
- HBV, HCV, HDV
  - Percutaneous or mucosal exposures to blood
  - Chronic infection – major causes of cirrhosis and hepatocellular carcinoma worldwide

Acknowledgment

- Most slides provided by Miriam J. Alter, Ph.D. University of Texas, Galveston

Geographic Differences in HCV Transmission Patterns

Exposures among prevalent infections	Contribution of exposures to disease burden by HCV prevalence		
	Low	Moderate	High
Injecting drug use	++++	++	+
Transfusions (before testing)	+++	+++	+++
Unsafe therapeutic injections	+	++++	++++
Occupational	+	+	+
Perinatal	+	+	+
High-risk sex	++	+	+/-

Specific and Actionable Expectations and Objectives

- Research/Science-assist in the execution of microbiologic and clinical study plans that enhance the science and marketability of PDI products
- Business Development-evaluate science behind new disinfection and antisepsis technologies that represent potential acquisitions or partnership opportunities for PDI
- Consultation-respond to disinfection, antisepsis and infection prevention queries from clinical affairs, sales, marketing, and business development.
- Education-participate in national and state APIC conferences as well as other conferences/scientific meetings (e.g., APSIC, SHEA, HIS, IFIC, IDWeek, APSIC) to enhance knowledge on the infection prevention value of antisepsis and disinfection of environmental surfaces.