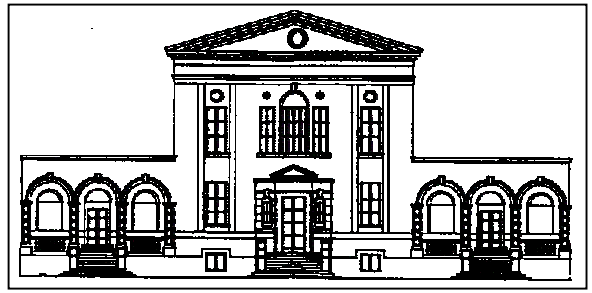
Viral HepatitisPrevention Board



INMI L. Spallanzani Rome, Italy

26th epatitis B, hepatitis C, and other blood-borne infections in health-care workers

Rome, Italy, March 17-18, 2005.

Transmission of blood-borne viruses in the health-care settting: from patient to patient, from patient to health-care worker, and from health-care worker to patient

Gabriella De Carli

Hepatitis B Virus (HBV)

- Present in blood and body fluids, including saliva
- Concentrations range from a few virions to 10^9 virions/mL, higher in HBeAg+ subjects; concentration in body fluids is generally 1,000-10,000 times lower than in blood
- Only a small inoculum, on the order of 1/10,000 ml of infected plasma, is required for transmission
- Resistant to drying, simple detergents and alcohol; it survives at room temperature for $\geq$ 7 days
- Transmission in health-care settings can occur through inapparent modes

Transmission of HBV in the health-care setting

Patient to patient

• Transmission in the health care setting occurs through **indirect contact**: cross-contamination of HCW's hands, medications, medical equipment, devices, or environmental surfaces

• The annual incidence in **hemodialysis** settings in the US was 6.2% among patients and 5.2% among staff in 1974, before implementation of infection control procedures, HBV vaccination, segregation of infected patients and dedicated staff, reduced blood transfusions and screening of organs. In less-developed countries the risk is still high

• **Surgery** is still a major risk factor for acute B hepatitis

• **Outbreaks** have been reported in other hospital settings, due to **contaminated instruments or multidose vials**

Transmission of HBV in the health-care setting

HCW to Patient

• **Attack rate** in 50 epidemic episodes involving 39 surgeons and 10 nonsurgical HCWs: 0.6-20%

• **Risk of transmission to 1 patient during a single procedure**: 0.024-0.24% (from 240 to 2400 per million interventions; ~1 : 4200 - 1 : 420)

• **Risk of transmission to at least 1 patient during *n* procedures**:

• x 500 interventions: 11-70%

• x 3500 interventions: 57-100%

Transmission of HBV in the health-care setting

Patient to HCW

Prevalence in HCW

- HBsAg+ 1-4%, 5-10-fold >nonHCW
- HBsAb+ 15-40% 2-4-fold >non HCW

Incidence in HCW

- 5% risk of acute hepatitis
- 30% risk of HBV infection
- 30% risk of acute hepatitis
- 60% risk of HBV infection
- 0.55% (1/183; 0.02-3.01%) in SIROH

HBsAg+

HBeAg+

Introduction of vaccination

- Acute B hepatitis in HCW (US)

386 per 100,000 HCW in 1983 (>3)

9.1 per 100,000 HCW in 1995 (<5)

Occupational hepatitis B

- ER nurse: needlestick with an IV catheter stylet used for an HBsAg+, anti-HBc+, anti-Hbe+, HCV-Ab+ IVDU. The HCW was not vaccinated, and at baseline resulted negative for HBV markers

- HBIG (800 UI), and the 1st dose of HBV vaccine were administered within 24 h

- On day 30 anti-Hbs was 23 mUI/ml, and the 2nd dose of vaccine and HBIG were administered. On day 120, anti-Hbs was negative.

- On day 136, the HCW had an acute B hepatitis: 8 days after the onset, HBsAg, anti-Hbc-IgM and anti-Hbe were positive, HBeAg, anti-Delta and Delta-Ag were negative. 20 days after onset, HBV-DNA was negative.

- The HCW showed a complete recovery with ALT normalization, HBsAg, anti-HBc and anti-HBs were repeatedly negative thereafter. Anti-HCV and anti-HIV were negative after 12 months.

Hepatitis C Virus (HCV)

- HCV is efficiently transmitted through large quantities of blood, or through repeated IV exposure to blood (prevalence ranging from 70 to 90% in recipients of blood or blood products treated before 1987 and in IVDU).
- Serum concentrations of HCV generally range from 10^5 to 10^8 genome equivalents per mL. HCV RNA concentrations are relatively stable in individual patients with chronic infection.
- HCV is also present in saliva (2 possible cases of transmission through bites). Although HCV may be detected in semen, vaginal secretions and other body fluids, these are not believed to be efficient vehicles of transmission.
- Data on survival, disinfection, sterilization and decontamination procedures are lacking because a cell culture system to assess viability has not been developed. HCV in dried plasma can cause infection in experimental animals at room temperature for $\geq$ 16 h, but not longer than 4 days. However, epidemiologic data indicate that environmental contamination is not a common route of transmission.

Transmission of HCV in the health-care setting

Patient to patient

• **Prevalence** in **hemodialysis** pts ranges from **1 to 54%** in Europe, increasing with the duration on HD. Contamination of equipment is an important determinant but also contamination of environmental surfaces and gloves have been possibly involved in transmission. Pts dialysed on the same machine as HCV+ or located next to them during dialysis are likely to be at higher risk of infection.

• A recent study in 58 Italian HD units found a **cumulative incidence** of **9.5 new cases /1000 pt-yr**. Nested CCS: Risk factors were high prevalence among pts (OR 4.6), low personnel-pts ratio (OR 5.4), and surgery in the previous 6 months (OR 16.7).

• **Surgery** is still a major risk factor for acute C hepatitis: data from SEIEVA show that the OR ranges from 2.1 for biopsy/endoscopy to 12.1 for gynecologic surgery

• **Outbreaks** or single cases in other hospital settings were linked to **contaminated instruments, multidose vials, anaesthetic circuitry**

Transmission of HCV in the health-care setting

HCW to Patient

• **Attack rate** in 14 epidemic episodes involving 7 surgeons, 5 anesthesiolgists and 2 non specified HCWs: 0.04-10.5% (33 definite cases + 4 probable)

• **Risk of transmission to 1 patient during a single procedure**: 0,00036-0,0036 (from 3.6 to 36 per million interventions; ~1 : 280,000 - 1 : 28,000)

• **Risk of transmission to at least 1 patient during *n* procedures**:

• x 500 interventions: 0.17-1.7%

• **x** 3500 interventions: 1-12%

Transmission of HCV in the health-care setting
Patient to HCW

Prevalence in HCW

- the prevalence among HCWs in a given geographic area similar to or lower than HCV prevalence rates for the general population in the same area and not related to occupational exposure risk

Incidence in HCW

- 0.5% (59/11,324) pooling 14 studies (95% CI 0.4-0.7%; range 0-10.3%)
- 0.31% (14/4,403; 0.15-0.48%) in SIROH

Exceptions: Exposure to HIV-coinfected patients

- Simultaneous transmission of both viruses (10 cases in the literature)
- Delayed seroconversion/acute infection for HCV or HIV/HCV
- Transmission from severely immunodepressed patients anti-HCV negative at the time of exposure (2 cases observed within the SIROH, 1 in US)

Multivariate conditional logistic regression analysis of risk factors for HCV transmission to health care workers after percutaneous exposure to HCV-infected body fluids

Variables	adjusted matched OR (95% CI)	P-value
Device		
Suture needle and other sharp objects	1.0	
Hollow-bore needle	10.6 (0.9- 128.4)	0.063
Hollow-bore needle in vein / artery	**100.1** (7.3-1365.7)	0.0005
Severity		
Superficial	1.0	
Moderate	**47.7** (2.3- 974.1)	0.01
Deep	**155.2** (7.1-3417.2)	0.001
Health care worker **gender**		
Female	1.0	
Male	**3.1** (1.0-10.0)	0.056

Characteristics of source patients, for cases and matched controls

Variables	Cases n=60 No (%)	Controls n=204 No (%)	Unadjusted matched OR (95% CI)	P value
HIV status				
Negative	42 (70.0)	122 (59.8)	1.0	
Positive	12 (20.0)	41 (20.0)	0.9 (0.4-2.1)	0.80
HBV status				
Negative	43 (71.6)	133 (65.2)	1.0	
Positive	6 (10.0)	14 (6.9)	2.1 (0.6-7.0)	0.24
HCV viral load				
≤ 4 $\log_{10}$ cp/mL	1 (1.7)	11 (5.4)	1.0	
$> 4 \leq 6$	5 (8.3)	10 (4.9)	5.5 (0.6- 55.5)	0.15
> 6	6 (10.0)	6 (2.9)	**11.0** (1.1-114.1)	0.04

Human Immunodeficiency Virus (HIV)

- HIV has been detected in virtually all body substances, including fluid from blisters.
- Transmission in the health care setting is primarily linked to blood. Among occupational infections, apart from three cases of research laboratory workers who handled concentrated HIV and were infected, all cases followed exposure to blood, bloody fluids (one case involved bloody pleural fluid) or blood components (a lab technician acquired infection through a conjunctival contamination with serum droplets).
- HIV was found to be stable at room temperature in blood-filled syringes up to 42 days. Duration of viability decreases with storage temperature, being <1 day at 37°C. No cases were identified following exposure to syringes or needles abandoned in the environment.

Transmission of HIV in the health-care setting

Patient to patient

- **19 instances of iatrogenic transmission** reported between 1986 and 1999
- **8** involving transmission **from one subject to another** mainly through **inadvertent reuse of syringes or needles** (4 children)
- **3** involving **423 children and 23 women**, mainly through reuse of syringes or other equipment **due to lack of disposable needles/sharps**
- **3** involving **>135 hemodialysis pts**.(reused filters, improperly reprocessed dialysis tubing, access needles and blood lines)
- **4** in commercial blood banks involving **301 plasma donors** (IV tubing used to collect plasma from multiple donors?)
- **1** involving **4 pts** undergoing **minor surgery** (outpatient clinic)

Transmission of HIV in the health-care setting

HCW to Patient

- **4 episodes** involving 2 surgeons, 1 dentist and 1 nurse (9 definite cases)
- R**isk of transmission to 1 patient during a single procedure**: 0,00024-0,0024 (from 2.4 to 24 per million interventions; ~1 : 420,000 - 1 : 42,000)
- R**isk of transmission to at least 1 patient during *n* procedures**:
- x 500 interventions: : 0.12-1.2%
- x 3500 interventions: 0.8-8.1%

Transmission of HIV in the health-care setting

Patient to HCW

Case reports

- **106** documented and **238** probable cases up to Dec 2002, **only 6 after 1997** when 3-drug PEP became widely available (4 with HIV drug-resistant strains, 2 inadverted exposures); overall **24 despite PEP**

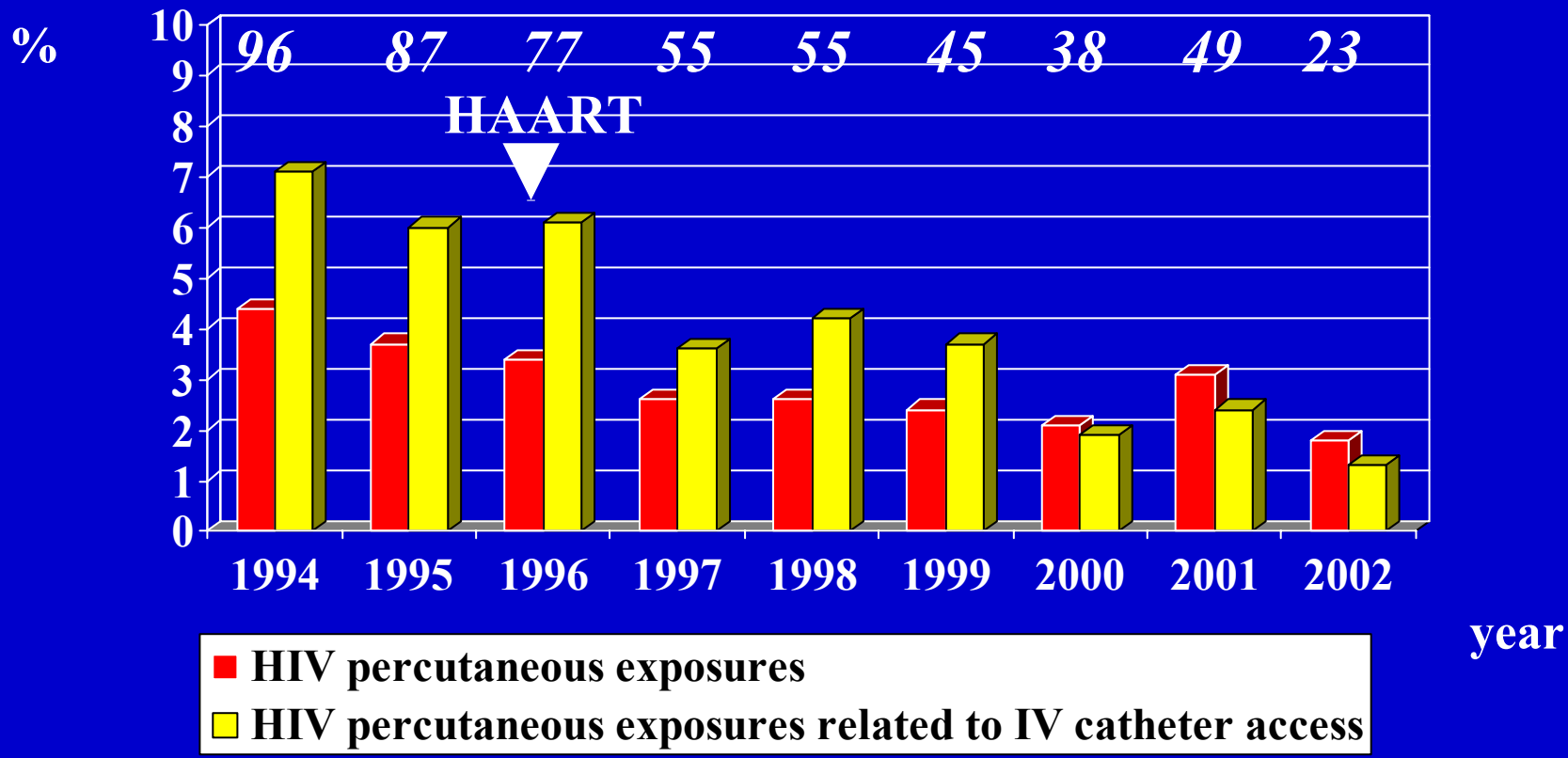
Prevalence in HCW

- Prevalence among HCWs is lower/equal that of the general population, and several large studies failed to identify cases among highly exposed professionals with no behavioural risks.

Incidence in HCW

- **0.31%** (22/6,955) (95% CI 0.18-0.45%) for **percutaneous** exposures pooling 25 studies and **0.03%** (1/2,910) (95% CI 0.006-0.19%) for **mucocutaneous** exposures pooling 21 studies
- **0.12%** (3/2,539; 0.02-0.35%) and **0.28%** (2/740; 0.03-1.02) in SIROH

Percutaneous exposures to HIV
18 hospitals, 1994-2002



De Carli et al., J Biol Regul Homeostat Agents 2001;15:235-7. Updated

Percutaneous exposures to HCV
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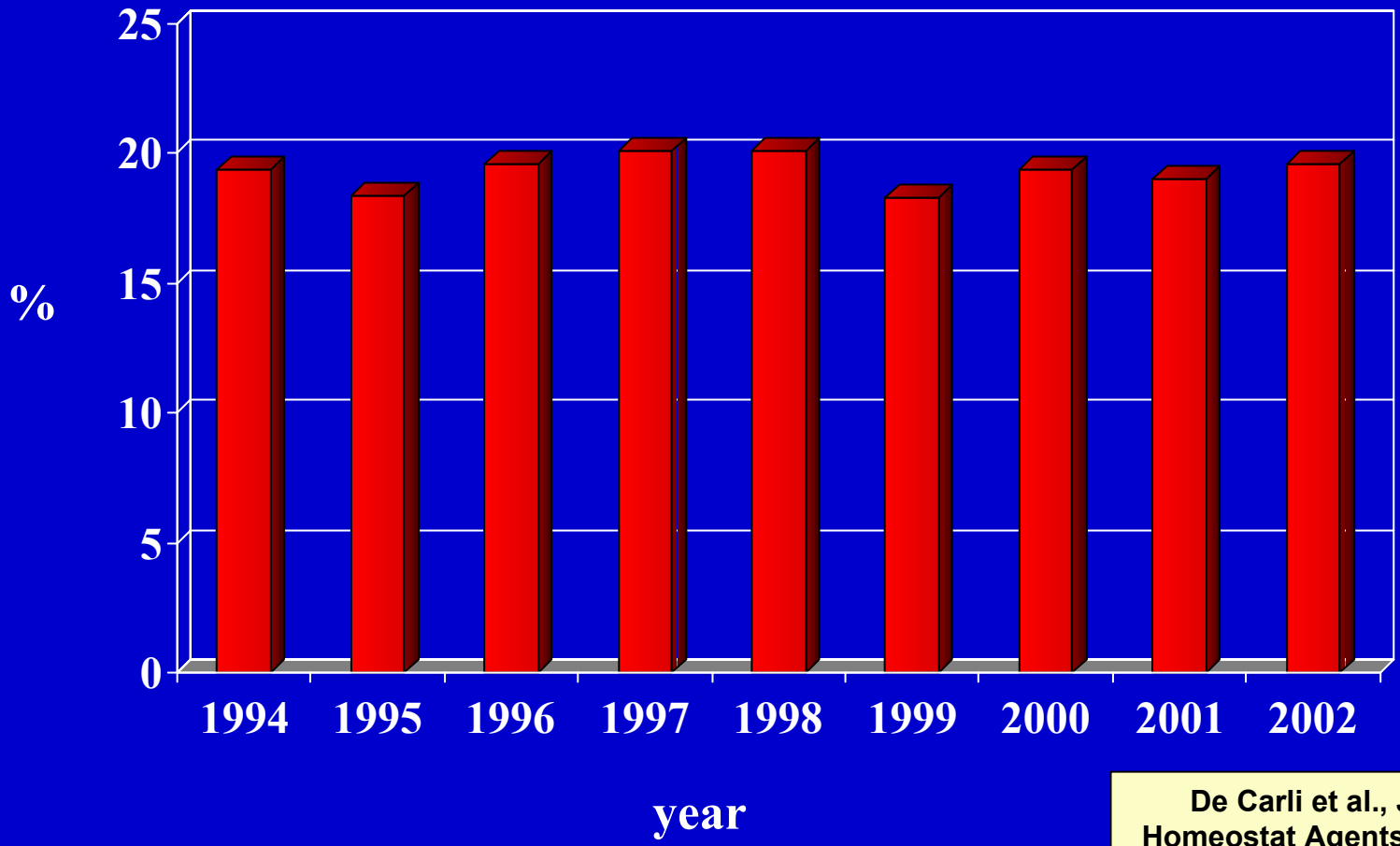

De Carli et al., J Biol Regul Homeostat Agents 2001;15:235-7.
Updated

TABLE 2—Transmission Risk Estimates for the Mathematical Model of Blood-Borne Pathogen Transmission During Phlebotomy Needle Reuse: Palo Alto, Calif, 1999

Scenario a	Baseline Prevalence	No. of Reused Needles	Transmissin Probability	Risk per Draw	Expected New Infections	Fraction of Infections From Reuse
HIV						
A	0.005	7	0.0025	1.4×10^{-8}	8.7×10^{-5}	4.6×10^{-6}
B	0.005	70	0.0025	1.4×10^{-7}	8.7×10^{-4}	4.6×10^{-5}
C	0.005	700	0.0025	1.4×10^{-6}	8.7×10^{-3}	4.6×10^{-4}
D	0.012	7	0.0025	3.4×10^{-8}	2.1×10^{-4}	4.5×10^{-6}
E	0.005	7	0.005	2.8×10^{-8}	1.7×10^{-4}	9.1×10^{-6}
F	0.012	700	0.005	6.8×10^{-6}	0.042	9.1×10^{-4}

TABLE 2—Transmission Risk Estimates for the Mathematical Model of Blood-Borne Pathogen Transmission During Phlebotomy Needle Reuse: Palo Alto, Calif, 1999

Scenario a	Baseline Prevalence	No. of Reused Needles	Transmissin Probability	Risk per Draw	Expected New Infections	Fraction of Infections From Reuse
HCV						
A	0.018	7	0.018	3.6×10^{-7}	2.2×10^{-3}	3.2×10^{-5}
B	0.018	70	0.018	3.6×10^{-6}	0.022	3.2×10^{-4}
C	0.018	700	0.018	3.6×10^{-5}	0.22	3.2×10^{-3}
D	0.058	7	0.018	1.2×10^{-6}	6.9×10^{-3}	3.1×10^{-5}
E	0.018	7	0.074	1.5×10^{-6}	9.2×10^{-3}	1.3×10^{-4}
F	0.058	700	0.074	4.8×10^{-4}	2.8	0.013

TABLE 2—Transmission Risk Estimates for the Mathematical Model of Blood-Borne Pathogen Transmission During Phlebotomy Needle Reuse: Palo Alto, Calif, 1999

Scenario a	Baseline Prevalence	No. of Reused Needles	Transmissin Probability	Risk per Draw	Expected New Infections	Fraction of Infections From Reuse
HBV						
A	0.005	7	0.19	1.1 ×10 –6	6.6 ×10 –3	3.5 ×10 –4
B	0.005	70	0.19	1.1 ×10 –5	0.066	3.5 ×10 –3
C	0.005	700	0.19	1.1 ×10 –4	0.66	0.034
D	0.035	7	0.19	7.4 ×10 –6	0.045	3.4 ×10 –4
E	0.005	7	0.3	1.7 ×10 –6	0.01	5.5 ×10 –4
F	0.035	700	0.3	1.2 ×10 –3	7.1	0.05

The role of parenteral antischistosomal therapy in the spread of hepatitis C virus in Egypt.

Frank C, Mohamed MK, Strickland GT, Lavanchy D, Arthur RR, Magder LS, El Khoby T, Abdel-Wahab Y, Aly Ohn ES, Anwar W, Sallam I.

Lancet 2000 Mar 11;355(9207):887-91

A cohort-specific exposure index for Parenteral antischistosomal therapy (PAT) was calculated and compared with cohort-specific HCV seroprevalence rates in four regions of Egypt.

- **HCV prevalence was calculated for 8499 Egyptians aged 10-50 years**

- **A significant association between seroprevalence of HCV Ab and the exposure index (p=0.007) was identified across four different regions**

- **The comparison of age-specific prevalence and exposure index has shown a strong association between the two factors beyond the increase of HCV prevalence with age in any population.**

→Egypt's mass campaigns of PAT (discontinued only in the 1980s) may represent the world's largest iatrogenic transmission of blood-borne pathogens

Occupational infections following percutaneous exposures

Bacterial

Syphilis 1913

Diphteritis 1923

Leptospirosis 1937

Scrub typhus 1945

Gonhorrea 1947

Brucellosis 1966

Rocky Mountain Spotted Fever 1967

Mycoplasmosis 1971

Mycobacteriosis 1977

Staph.aureus 1983

Strept.pyogenes 1980

- necrotizing fasciitis 1997

Tuberculosis 1931

- from HIV+ 1998

Viral

Herpes Simplex 1962

Haemorragic fevers (Ebola/Marburg) 1974

Herpes Zoster 1976

Hepatitis B (1949) 1982

HIV 1984

Hepatitis nAnB 1987

Creutzfeldt-Jakob 1988

Herpesvirus simiae 1991

Hepatitis C 1992

Simian Immunodeficiency virus 1994

Dengue 1998

Hepatitis G 1998

Protozoal

Toxoplasmosis 1951

Malaria 1972

Leishmaniasis 1997

Fungal

Blastomycosis 1903

Sporotrichosis 1977

Cryptococcosis 1985

- from HIV+ 1994

Tumors

Human colonic adenocarcinoma 1986

Sarcoma 1996

Jagger J, De Carli G, Perry J et al. In Wenzel RP: Prevention and Control of Nosocomial Infections, 2003. Updated.