34 | POLYOMAVIRUSES

34.1 | Disease agent

- Polyomaviruses (PVs): BK virus (BKV), JC virus (JCV), simian virus 40 (SV40).

34.2 | Disease agent characteristics

- Family: *Polyomaviridae*; Genus: *Betapolyomavirus*
- Virion morphology and size: Nonenveloped, icosahedral nucleocapsid symmetry, spherical particles, 40–45 nm in size
- Nucleic acid: Circular, double-stranded DNA, 5.0 kb in length with bidirectional transcription
- Physicochemical properties: Inactivated with 0.25% β-propiolactone for 2 h at 37°C; resistant to organic solvents, freezing and thawing and to heating at 56°C for 2 h (avian polyomavirus); inactivated by 0.5% sodium hypochlorite and possibly 70% ethanol for 1–5 min

34.3 | Disease name

- BKV infection (polyomavirus nephropathy and interstitial nephritis; hemorrhagic cystitis).
- JCV infection (progressive multifocal leukoencephalopathy [PML] in the immunocompromised host).
- SV40 infection (PML-like disease in immunocompromised macaques). Human disease associations have not been confirmed.
- Since 2007, the *Polyomaviridae* family has expanded substantially with newly recognized viruses, named for their place of discovery or disease association; e.g., WUPyV from Washington University and MCV for Merkel cell carcinoma, respectively, their country of origin or order of discovery. Seroprevalences for these "newer" virus can range from 25% to 90%.

34.4 | Priority level

- Scientific/Epidemiologic evidence regarding blood safety: Theoretical
- Public perception and/or regulatory concern regarding blood safety: Absent
- Public concern regarding disease agent: Absent

34.5 | Background

- BKV and JCV are nearly ubiquitous in human populations.
  - The seroprevalence of both viruses increases rapidly with age.
- SV40 infects naturally only Old World monkeys; for example, African and Indian macaques, and is much less common in humans unless introduced with contaminated poliovirus vaccines in the 1950–1960s.
- PML incidence increased in frequency during the 1980s and 1990s associated with the immunosuppression from HIV/AIDS.
- Viral infection with BKV and JCV is persistent and usually established in renal tubular cells with high levels of virus excreted in the urine.
  - 20%–30% of both healthy and immunosuppressed individuals may excrete JCV in the urine, while 20%–40% of HIV-infected individuals may be viremic.
  - BKV viruria is more common correlating with more severe immunosuppression.

34.6 | Common human exposure routes

- BKV and JCV infections occur most often in childhood. The route of infection is not clearly established but most likely respiratory, although BK virus is only rarely isolated from the respiratory tract. JCV is easily transmitted from mother to child and is excreted in the urine more commonly than is BKV.

34.7 | Likelihood of secondary transmission

- Unknown

34.8 | At-risk populations

- Immunocompromised patients (especially kidney transplant recipients, hematopoietic stem cell transplant recipients and people living with HIV), pregnant women, diabetics, and the elderly appear to be at higher risk of disease.

34.9 | Vector and reservoir involved

- None

34.10 | Blood phase

- BKV and JCV are known to establish long-term latent infections in B-lymphocytes. The detection of viral mRNA in these cells indicates that viral replication is taking place.
- In a study of 1016 Dutch blood donors, polyomavirus DNA from 14 strains was sought by PCR. Merkel cell viral DNA was found in 3.8%, and all others with lower frequencies. In total 5.4% of donors had polyomavirus DNA detected. The infectivity and transfusion transmission are unknown.
- Among 250 Iranian blood donors, BKV and JCV DNA was amplified from PBMCs in 26.4% and 18% respectively, with coinfection in 4.4% of samples.

34.11 | Survival/persistence in blood products

- Unknown, however, reports exist demonstrating human polyomavirus DNA in blood donors.

34.12 | Transmission by blood transfusion

- Never documented.
- Disease in organ-transplant recipients and other immunocompromised patients is thought to be a result of reactivation rather than de novo infection.

34.13 | Cases/frequency in population

- BKV: Antibody prevalence is close to 100% by age 11, declining thereafter.
- JCV: Antibody prevalence rises to about 75% in adults.

34.14 | Incubation period

- Acute disease is infrequent, but lifelong persistence of BKV and JCV implies that the incubation period may be extremely prolonged.

34.15 | Likelihood of clinical disease

- Unknown, but probably low relative to infection rate

34.16 | Primary disease symptoms

- BKV: Acute respiratory disease has been observed in children. Kidney diseases and especially cystitis or hemorrhagic cystitis have been consistently detected in renal allograft and bone marrow transplant recipients. As a result, a high rate of renal allograft failure (40%–70%) because of polyomavirus-associated nephropathy has been recorded in addition to hemorrhagic cystitis in children who are bone marrow transplant recipients.
- JCV (PML): Speech and vision impairment, cognitive abnormalities consistent with dementia, muscle weakness and gait disturbance rapidly leading to hemiparesis, cortical blindness and sensory abnormalities are observed that are usually fatal within several months to 1 year of onset, usually in adults. The highest rates occur in patients infected with HIV-1, reaching 5%–10%.
- Both viruses may infect the kidney, resulting in viruria.
- All three viruses are oncogenic in experimental animals (rodents, hamsters, New World monkeys, transgenic mice), resulting in different types of tumors. In one study that investigated the prevalence of viral sequences in a series of 225 adult and pediatric brain tumor specimens, nucleotide sequences for JCV, BKV, and SV40 were rarely found to be present.
- Merkel Cell Carcinoma, caused by MCV, is a rare skin cancer ($\approx$3 cases per million population) seen especially among the immunocompromised and aged.

34.17 | Severity of clinical disease

- Clinical disease from polyomaviruses is severe in proportion to the degree of immunosuppression of the host.

34.18 | Mortality

- High for PML

34.19 | Chronic carriage

- Lifelong

34.20 | Treatment available/efficacious

- No consistent results have been seen using drugs to block JCV replication.

34.21 | Agent-specific screening question(s)

- No specific question is in use.
- Not indicated because transfusion transmission has not been demonstrated.
- No sensitive or specific question is feasible.

34.22 | Laboratory test(s) available

- No FDA-licensed blood donor screening test exists.
- Serologic tests, NAT, and viral isolation are available.

34.23 | Currently recommended donor deferral period

- No FDA Guidance or AABB Standard exists.

34.24 | Impact on blood availability

- Agent-specific screening question(s): Not applicable
- Laboratory test(s) available: Not applicable

34.25 | Impact on blood safety

- Agent-specific screening question(s): Not applicable
- Laboratory Test(s) available: Not applicable

34.26 | Leukoreduction efficacy

- Theoretically efficacious based on tropism for B lymphocytes

34.27 | Pathogen reduction efficacy for plasma derivatives

- This is a nonenveloped virus and thus would not be affected by solvent-detergent treatment.

34.28 | Other prevention measures

- None

34.29 | Other comments

- Ubiquitous nature, latency in B-lymphocytes, reactivation disease in immunocompromised patients, severity of disease when it occurs, and potential oncogenicity all suggest a need for concern, but there has been no evidence of transmission or disease directly linked to transfusion or transplantation.

SUGGESTED READING

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