Transmission of polioviruses in IPV immunized populations

It varies

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Outline

- Theoretical considerations on key determinants
- Two extremes:
  - Widespread transmission: PV3 in Finland in1984
  - Minimal transmission: PV3 in The Netherlands in1992

Key determinants; relative impacts ??

- Virus introductions
  - Occur frequently (WT in the past, SL today), but most importations likely to initiate an abortive transmission chain only in an immunized population
- Opportunities for transmission
  - Known: Excretion via feco-oral and naso/oropharyngeal routes
  - Not known: Relative impacts of the two routes in entry
  - Via hands: virus survival on intermediating objects
  - Birth rates, population densities, household contacts
  - Personal hand/food hygiene; community sanitation
- Nature of immunity; capacity to restrict transmission
  - Systemic – mucosal; naso/oropharyngeal – intestinal
  - Ig subclasses; CMI?

Observed transmission of PV in IPV immunized populations

It varies;

Two extreme examples

in the following

Finland 1984 – 1985

- No reported polio cases since 1965 through 1983; no evidence for poliovirus circulation in spite of intensive search in 1970es
- Old IPV (7 doses) only used, timely coverage of childhood vaccinations 80 - 90% at 3 years of age; Prevalence of PV3-NTab alarmingly low in children since early 1970es ***Lapinleimu Rev Infect Dis. 1984;6 Suppl 2:S457-60.***
- An outbreak of PV3W discovered in November 1984; time range August 1984 till February 1985 (5-6 mo); 10 patients with CNS symptoms; not linked!
- Nationwide spreading of virus: stool surveys in contacts of index case 82/209 children, 14/53 adults; 5-20% in other child groups; environmental surveillance: 26/34 sewage locations PV3W+

  Hovi et al. Lancet 1986;i:1427-32; Pöyry et al AEM 1988;54:371-374
- Estimated number of infected individuals100,000 or more in the total population of about 5 millions
- **Conclusion: PV3W was spreading easily in an IPV immunized population - why in a high-hygiene country?**

Finland outbreak 1984-5: Hypothesis

1. Cumulative weakening of herd immunity

- Increasing proportion of the population had immunity by vaccination only (all young children and almost all of their parents)
- Low-potency type 3 component in the used IPV preparation - different from those used in the other ”IPV countries”

  Lapinleimu Rev Infect Dis. 1984;6 Suppl 2:S457-60.
- Antigenically aberrant epidemic strain

  Magrath et al. JGV 1986;67:899-905; Pöyry et al. JGV 1990;71:2535-2541)
- Low-level antibodies largely targeted to a ”useless” antigenic site ***Roivainen & Hovi J Virol 1987;61:3749-53***
- Replication under low level of antibodies selected further antigenic variants

  Huovilainen et al. JGV 1987;68:1373-8;Kinnunen et al. JGV 1990;71:317- 24; Hovi et al. JGV 1995;76:1861- 5

Hypothesis

1. Cumulative weakening of herd immunity
2. **Spreading via the naso/oropharyngeal route (mainly?)**

- A typical faeco-orally transmitted disease, hepatitis A, disappeared from Finland in 1960es before the vaccine era, and importations have not lead to outbreaks ::: F-O route was controlled
- Antigenic drift documented in sequential specimens in several individuals but main epidemic spreading by the ”early” variants

Huovilainen et al. JGV 1987; 68:1373-8; JGV 1988;69:1941-8

- Extra doses of IPV given before the OPV campaign contributed to ceasing the outbreak, although had little effect on ongoing faecal excretion ***Hovi et al. Lancet 1986;i:1427-32***

(IPV is known to stimulate NP antibody secretion)

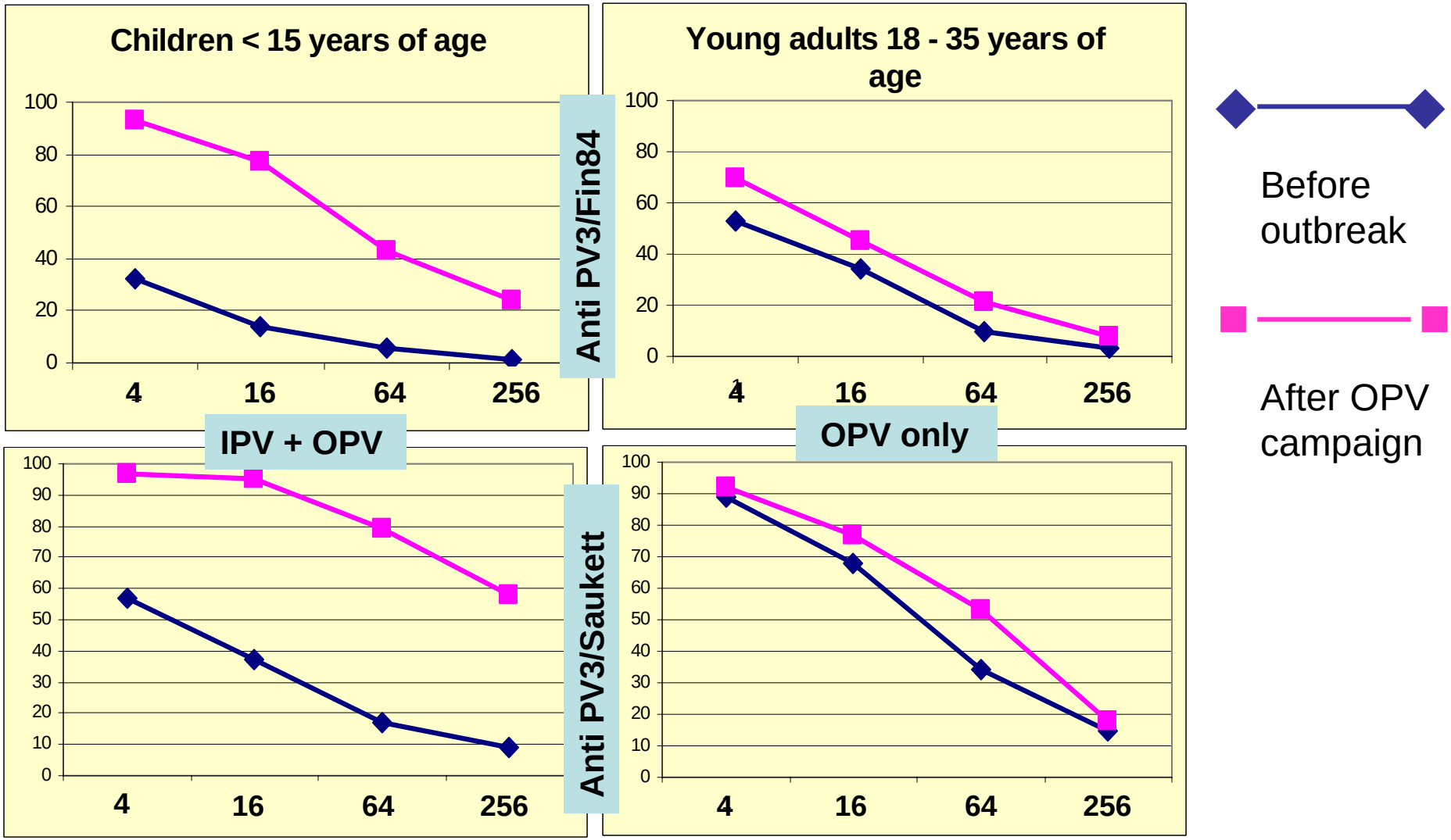
Time scale of events in the Finland 1984-5 outbreak

- Outbreak discovered in November 1994
- 1.5 M extra doses of ”old” **tIPV given to children <18 y in Dec 1984 - Jan1985 (tOPV Feb 10 – Mar 15, 1985)**
- No new cases in the IPV target group after Nov 1984

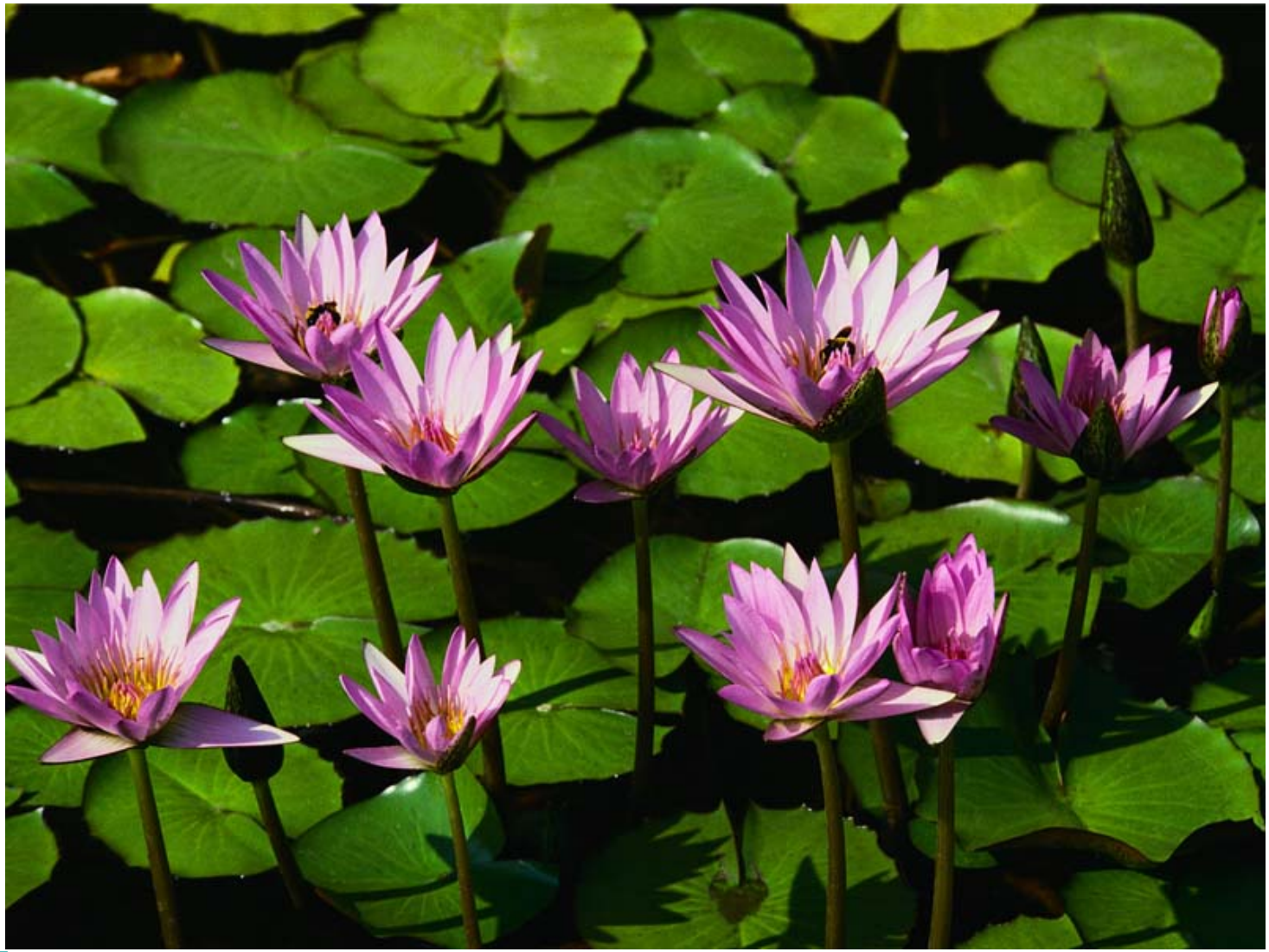
  Hovi et al. Lancet 1986;i:1427-32; Kinnunen et al. Scand JID 1986;18:15-8
- Excretion of PV3W started to decrease in Dec 1984 (surveys on stools of healthy children and young adults, and environment)

  Hovi et al. Lancet 1986;i:1427-32; Pöyry et al. AEM 1988;54:371-4
- Antibody response dramatically better in the IPV + OPV group as compared to that in the recipients of OPV only

Extra dose of IPV was highly immunogenic



The Netherlands in 1992



Outbreak of PV3W in The Netherlands in 1992-3

- Repeated polio outbreaks among the orthodox-reformed (OR) subpopulation officially refusing from vaccinations on religious grounds; about 100,000 people living in the ”Bible Belt” regions of the country

Oostvogel et al. Lancet 1994;344:665-70

- Sept 1992- Feb 1993: 71 patients with CNS symptoms, all but one (also unvaccinated) OR

- Conclusion 1: The IPV-immunized general population was well protected from disease

The Netherlands 1992-3; Poliovirus transmission

- Spreading of the virus into the general population was very limited
  - 2775 faecal specimens examined from non-AFP, non-AM patients: No PV3W
  - Random sample of 1467 children < 15 y and 1715 adults (40-64 y): only 8 children excreted the PV3W, all from ”risk area”

    Conyn-van Spaendonck et al. Am J Epidemiol 1996;143:929-35
  - 269 sewage samples collected during the outbreak revealed PV3W in 23 samples, all from the OR communities. OPV offered to unvaccinated people resulted in detection of OPV derived viruses in 28 locations, all inside or bordering the OR communities

    Van der Avoort H et al., Epidemiol Infect 1995;114:481-491
- Conclusion 2: IPV immunization protected the population well from poliovirus transmission

CONCLUSION

- Transmission of poliovirus in IPV immunized populations: It varies
- Type of vaccine is only one key determinant in the desired restriction of transmission
- Research on efficacy of IPV in high infection pressure conditions needed