Poliomyélite

du virus à la maladie
des épidémies à l'éradication

O. Epaulard

Infectiologie

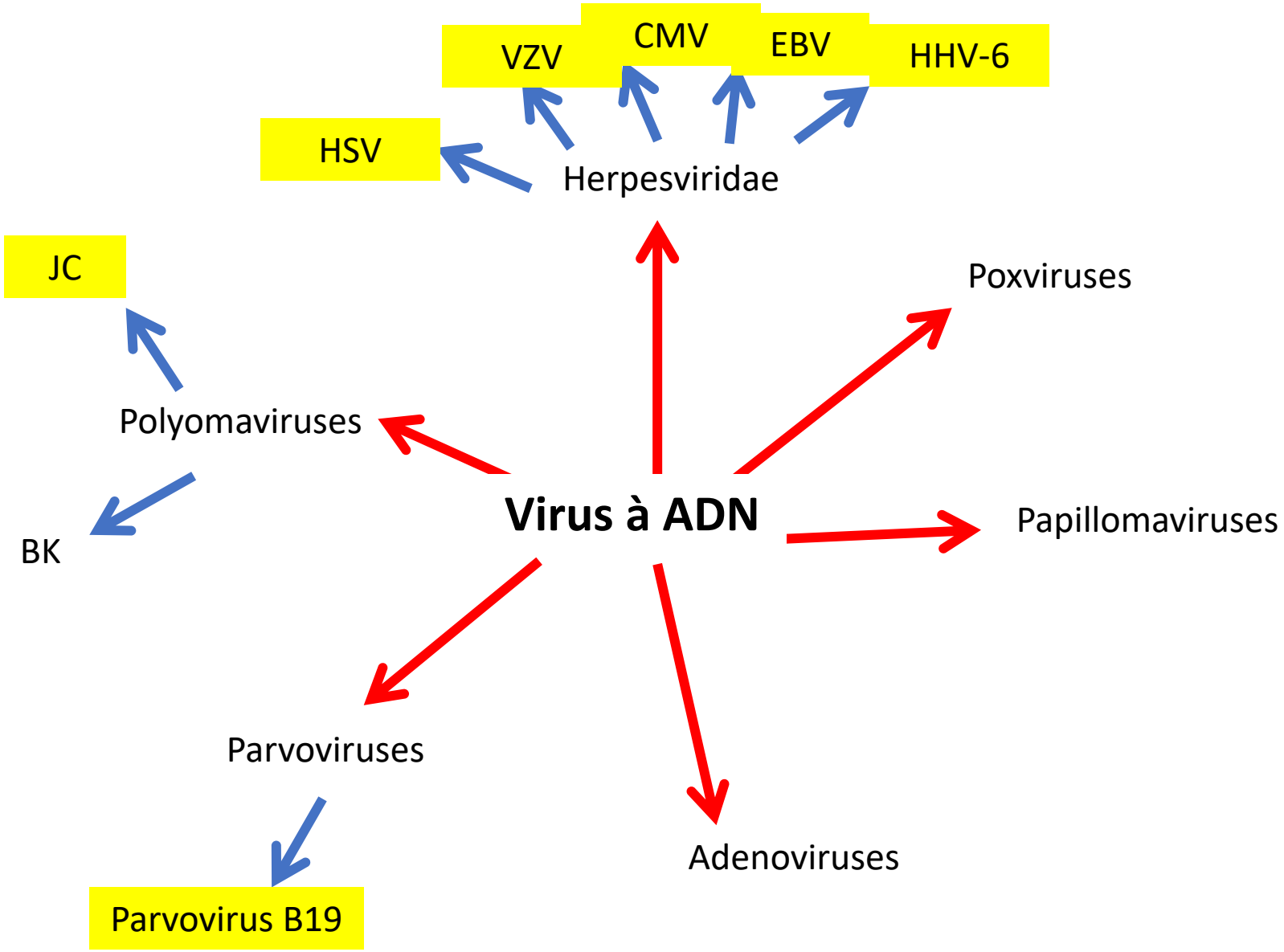
CHU de Grenoble

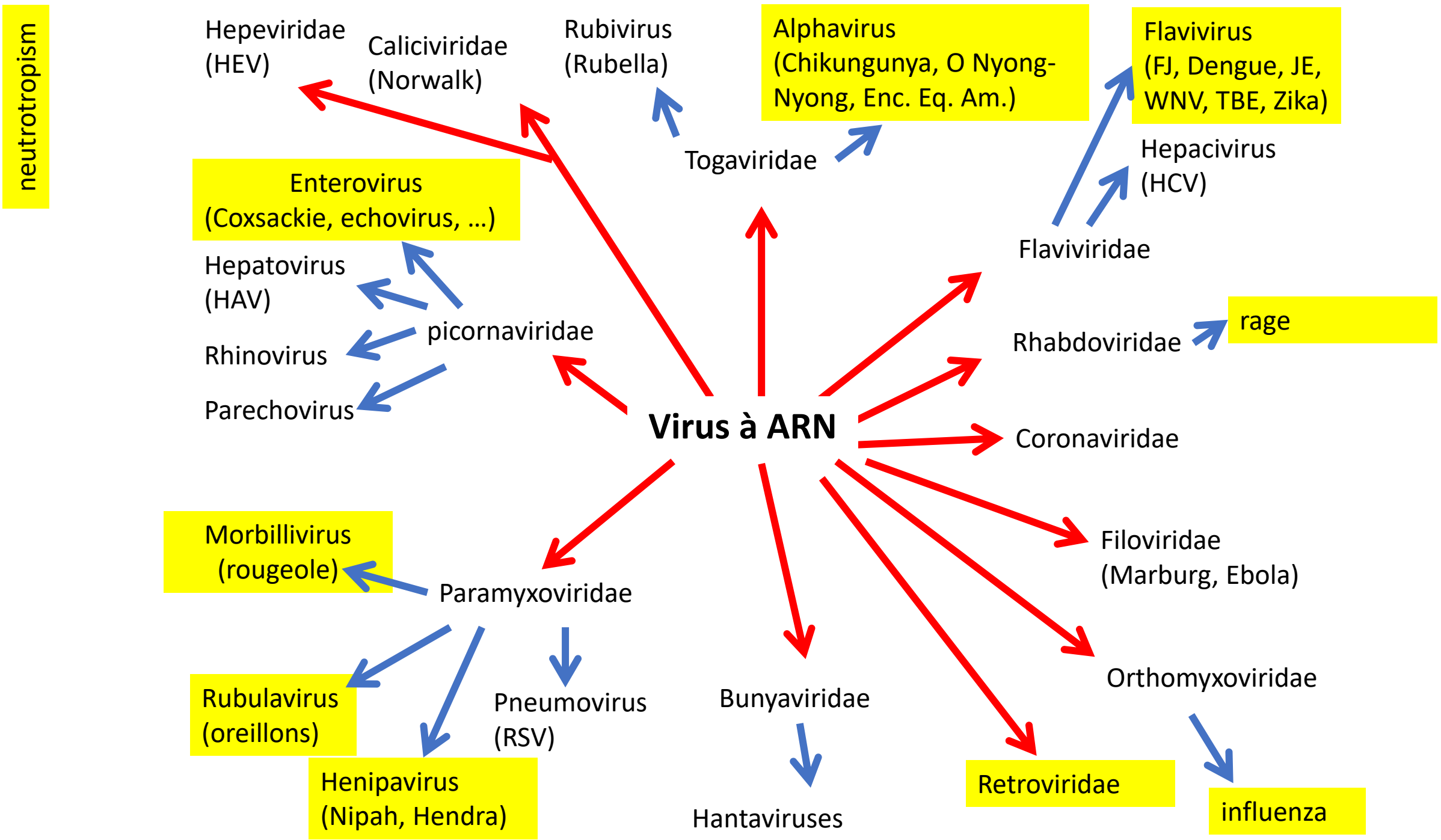
Journées inter-DES sur la vaccination, 11 juin 2026

Sujets abordés ce jour

- Le virus
- L’infection
- La maladie
- Epidémiologie (ancienne … récente … de nos jours)
- Les vaccinS
- *Vaccine-derived poliomyelitis*
- Vers l’éradication ?

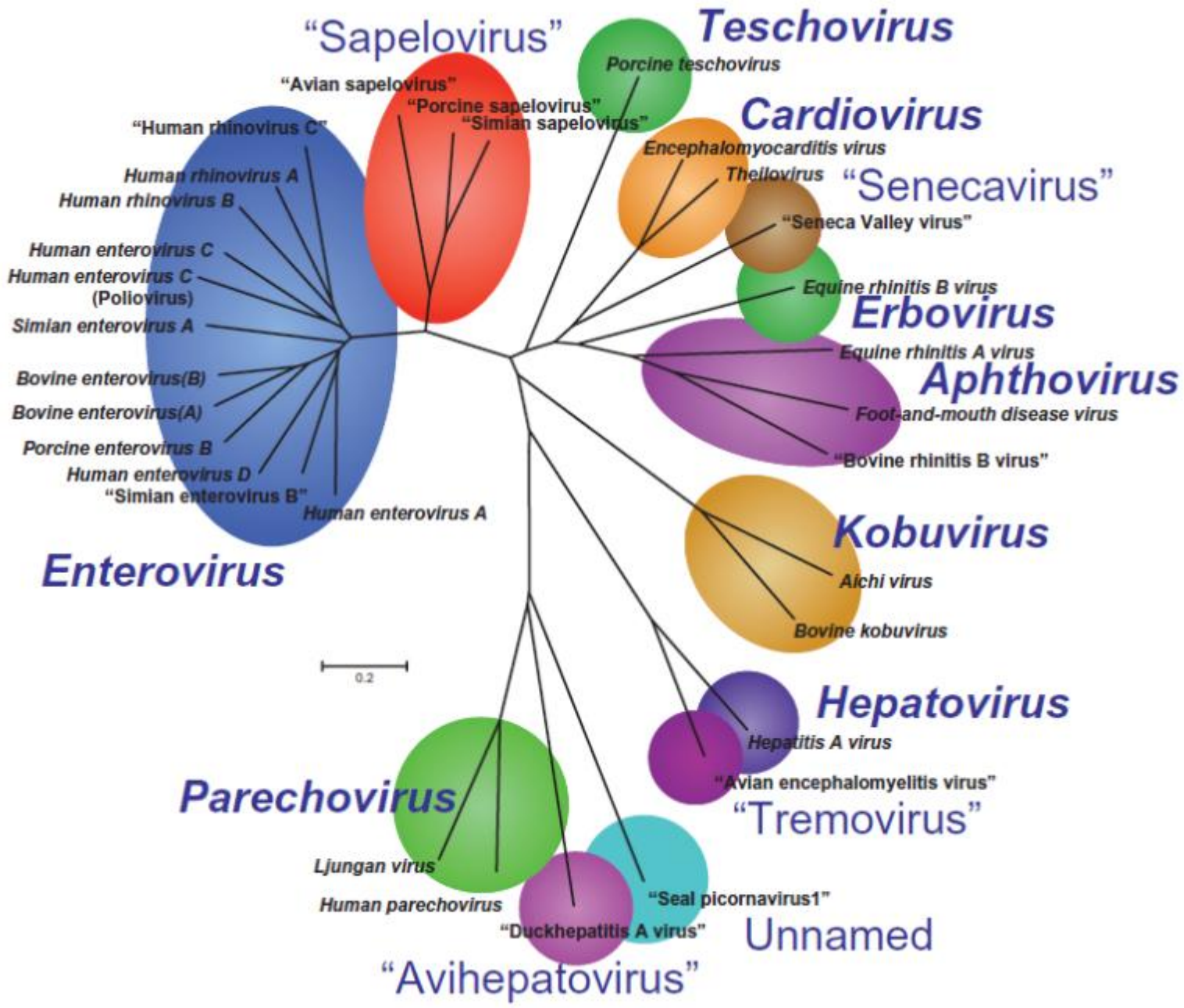
neutrotropism




neutrotropism
Hepeviridae
(HEV)
Caliciviridae
(Norwalk)
Rubivirus
(Rubella)
Alphavirus
(Chikungunya, O Nyong-Nyong, Enc. Eq. Am.)
Flavivirus
(FJ, Dengue, JE, WNV, TBE, Zika)
Hepacivirus
(HCV)
Togaviridae
Enterovirus
(Coxsackie, echovirus, …)
Hepatovirus
(HAV)
picornaviridae
Rhinovirus
Parechovirus
Flaviviridae
Rhabdoviridae
rage
Virus à ARN
Coronaviridae
Filoviridae
(Marburg, Ebola)
Morbillivirus
(rougeole)
Paramyxoviridae
Orthomyxoviridae
Rubulavirus
(oreillons)
Pneumovirus
(RSV)
Henipavirus
(Nipah, Hendra)
Bunyaviridae
Hantaviruses
Retroviridae
influenza

Picornaviridae

Icosaédriques
Non enveloppés
Monocaténaire
Brin d'ARN positif
Séquences régulatrices non codantes en 5' et 3'

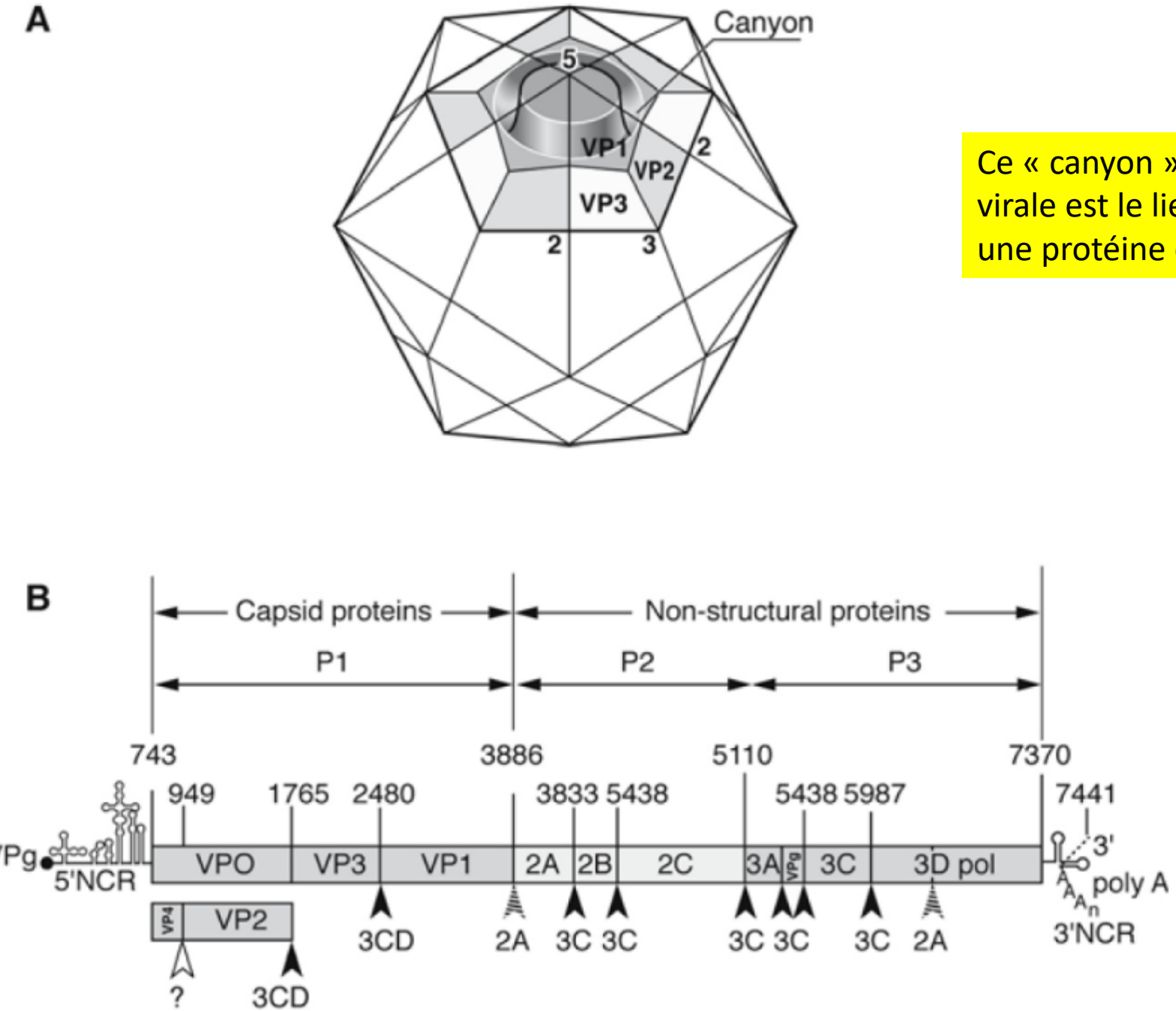


Fenner's Veterinary Virology, 2011

Enterovirus

- 4 espèces (A à D) de virus humains et simiens,
- 5 espèces (E à H et J) de virus animaux
- 3 espèces (A à C) de rhinovirus humains (HRV).

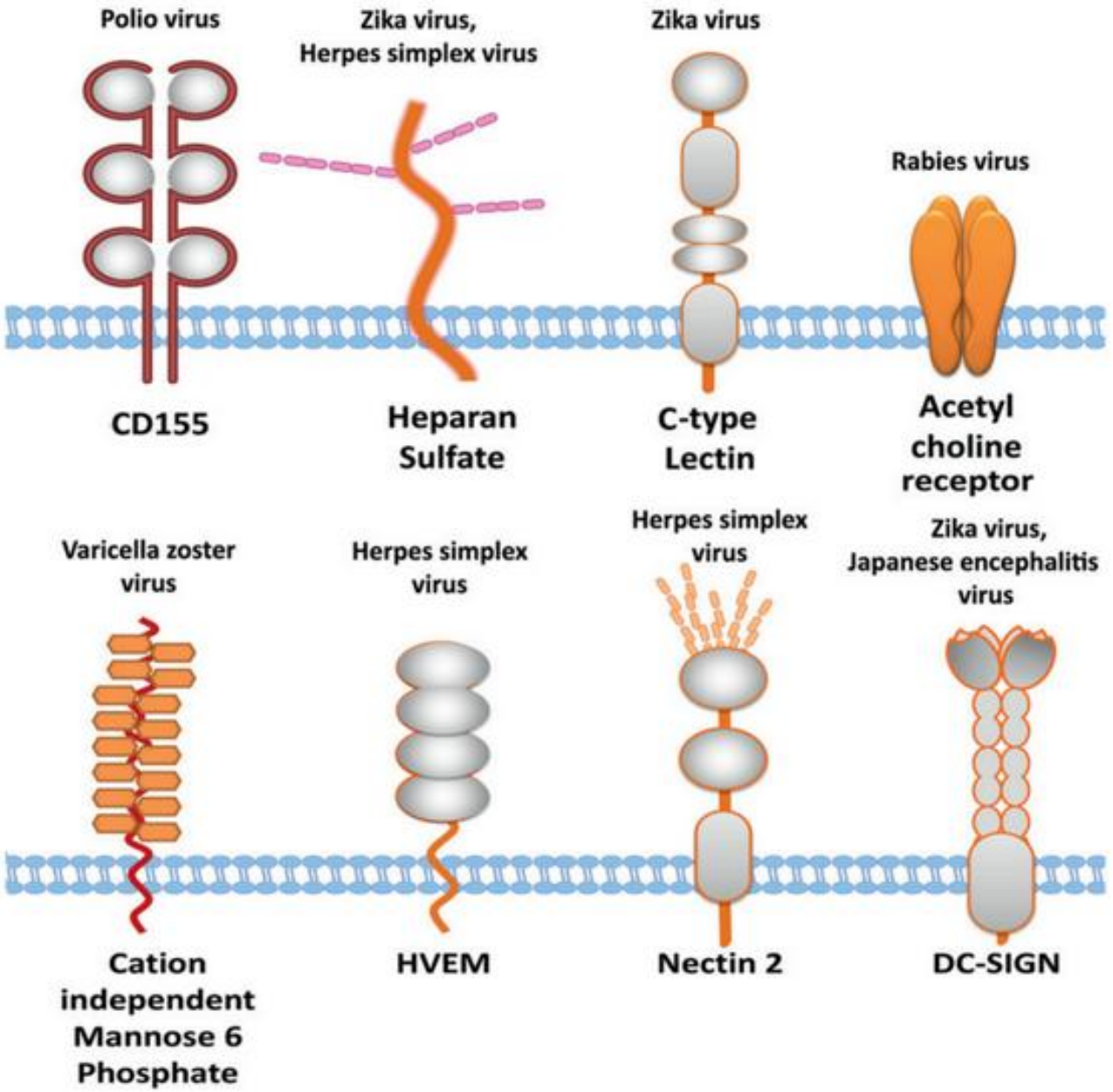
- EV-A :
  - 11 génotypes de coxsackievirus A
  - 9 génotypes d'entérovirus
- EV-B :
  - 1 génotype de coxsackievirus A
  - 6 génotypes de coxsackievirus B, 28 génotypes d'echovirus
  - 24 genotypes d'entérovirus.
- EV-C :
  - **3 génotypes de poliovirus**
  - 9 génotypes de coxsackievirus A
  - 11 génotypes d'entérovirus
- EV-D :
  - 4 genotypes d'entérovirus



Ce « canyon » dans la capside virale est le lieu d'ancrage avec une protéine cellulaire : CD155

Blondel 2005

The Molecular Immunology of Neurological Diseases



Différents virus, différentes protéines d'ancrage cellulaire

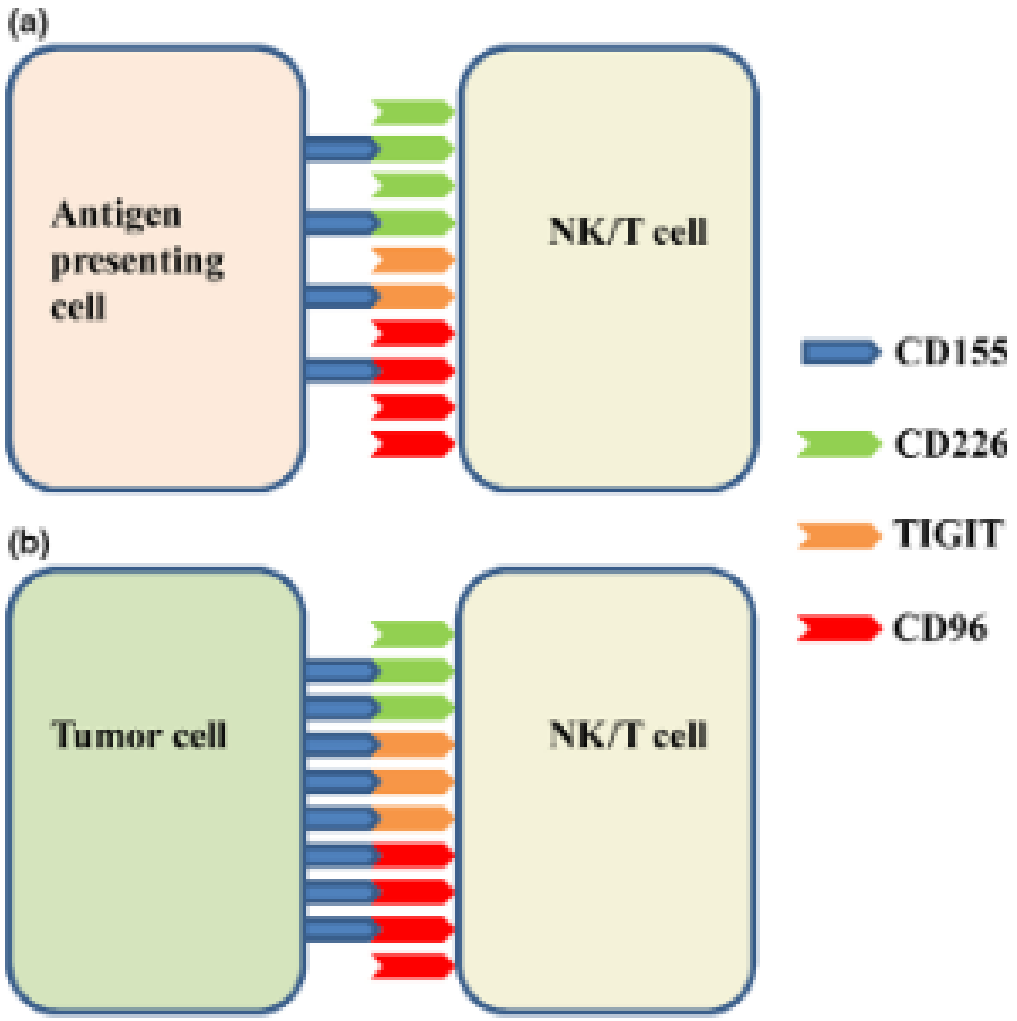
Cancer Science
Japanese Cancer Association JCA
Open Access
Review Article

CD155, an onco-immunologic molecule in human tumors

Jian Gao,[1,2,3] Qianqian Zheng,[1,3] Na Xin,[1] Wei Wang[1] and Chenghai Zhao[1]

[1]Department of Pathophysiology, College of Basic Medical Science; [2]Center of Laboratory Technology and Experimental Medicine, China Medical University, Shenyang, China

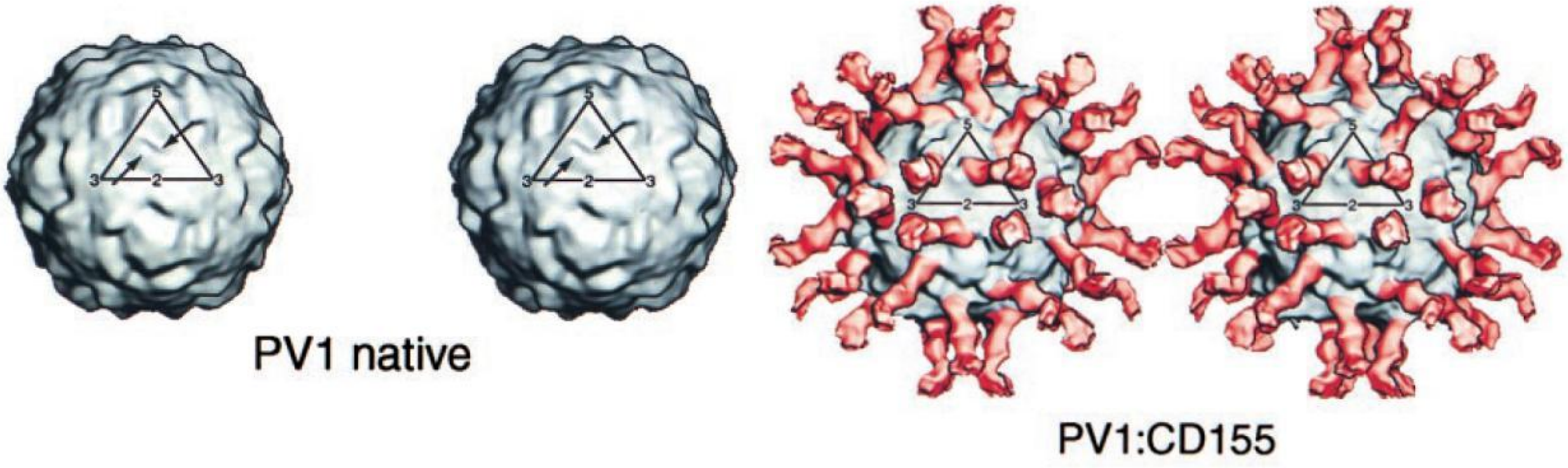
CD155 a par ailleurs plusieurs fonctions immunitaires



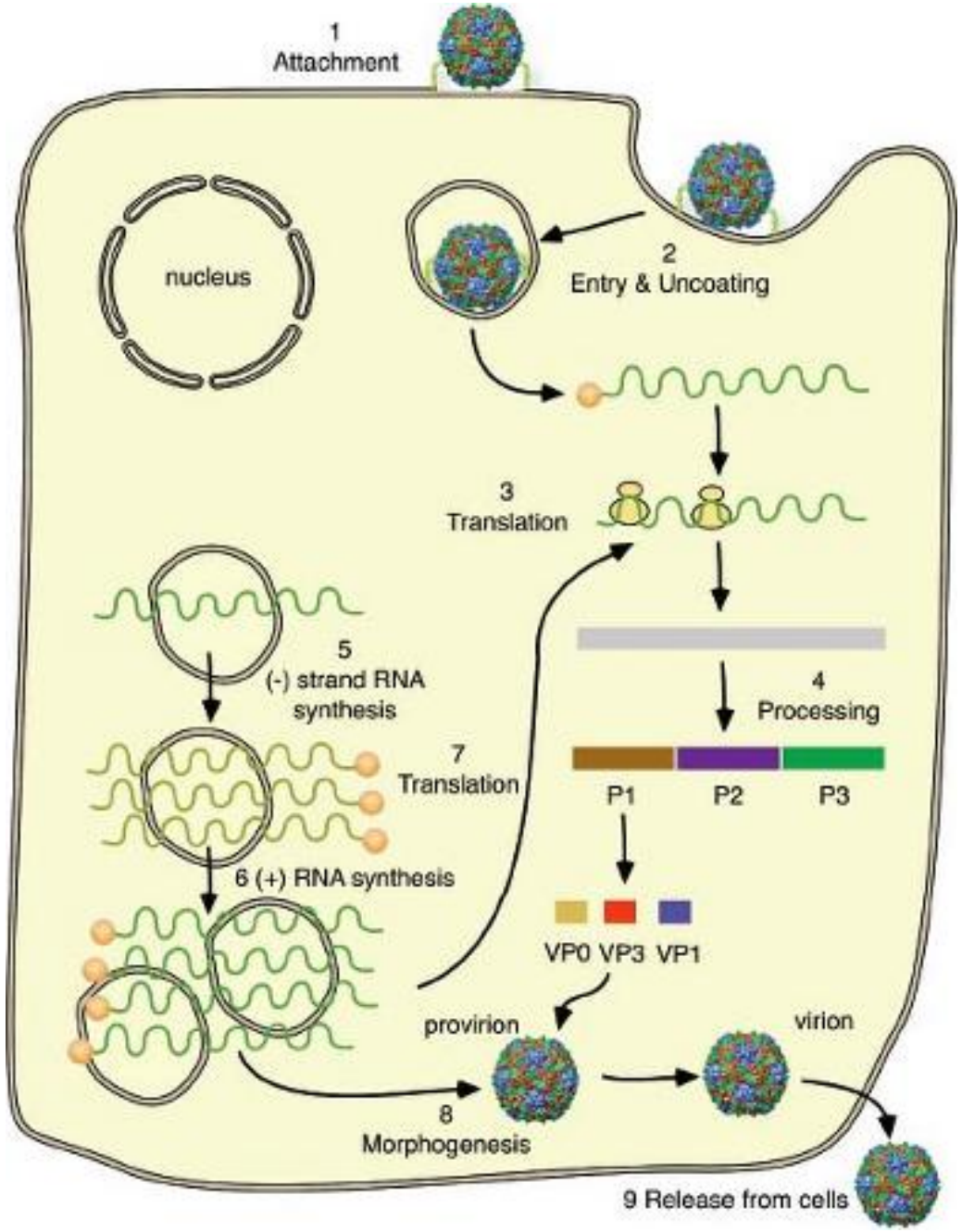
Interaction of the poliovirus receptor with poliovirus

Yongning He*, Valorie D. Bowman*†, Steffen Mueller†‡, Carol M. Bator*, Jordi Bella*§, Xiaozhong Peng‡, Timothy S. Baker*, Eckard Wimmer‡, Richard J. Kuhn*, and Michael G. Rossmann*¶

*Department of Biological Sciences, Purdue University, West Lafayette, IN 47907-1392; and ‡Department of Molecular Genetics and Microbiology, School of Medicine, Health Sciences Center, State University of New York, Stony Brook, NY 11794-8621

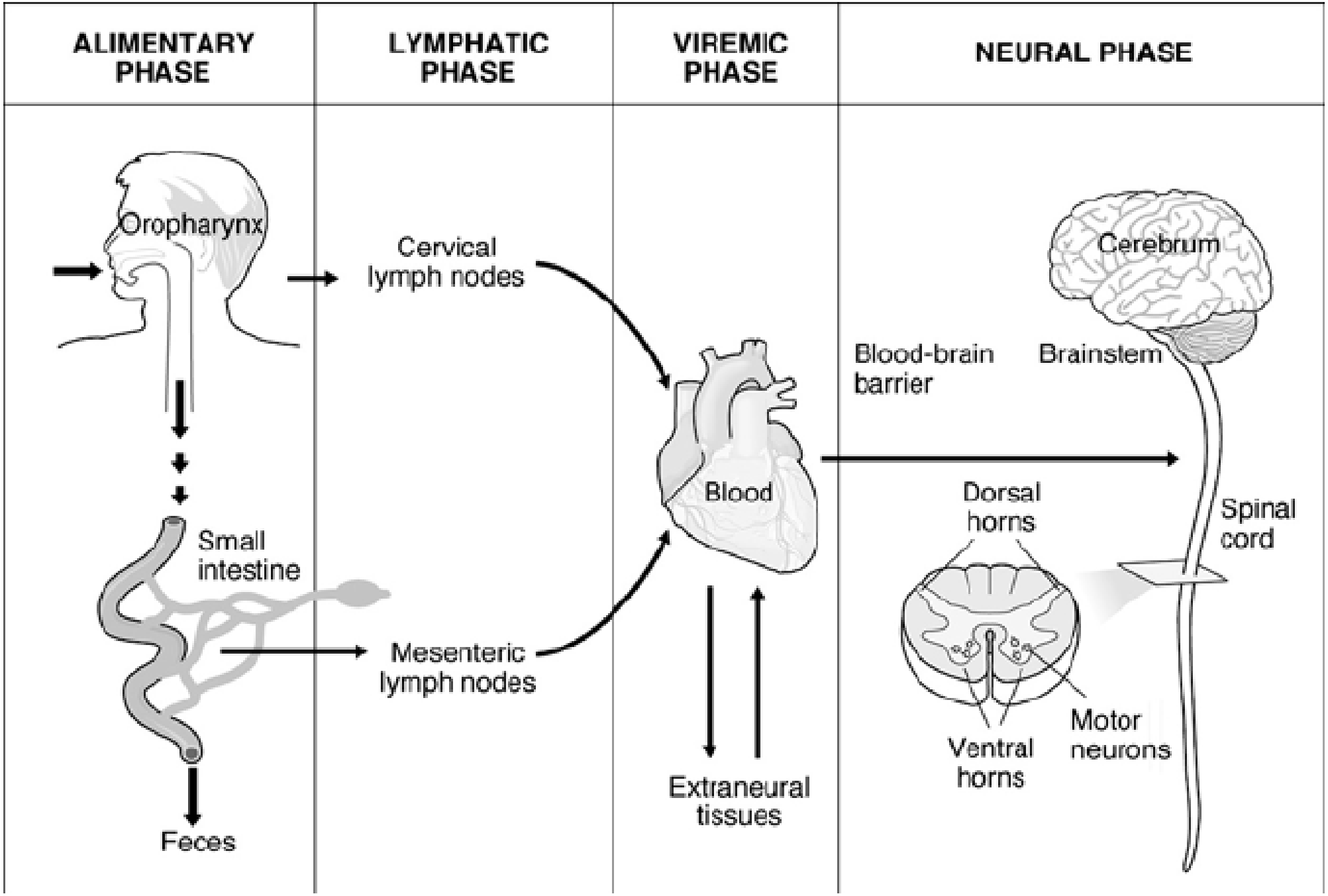


Cycle viral

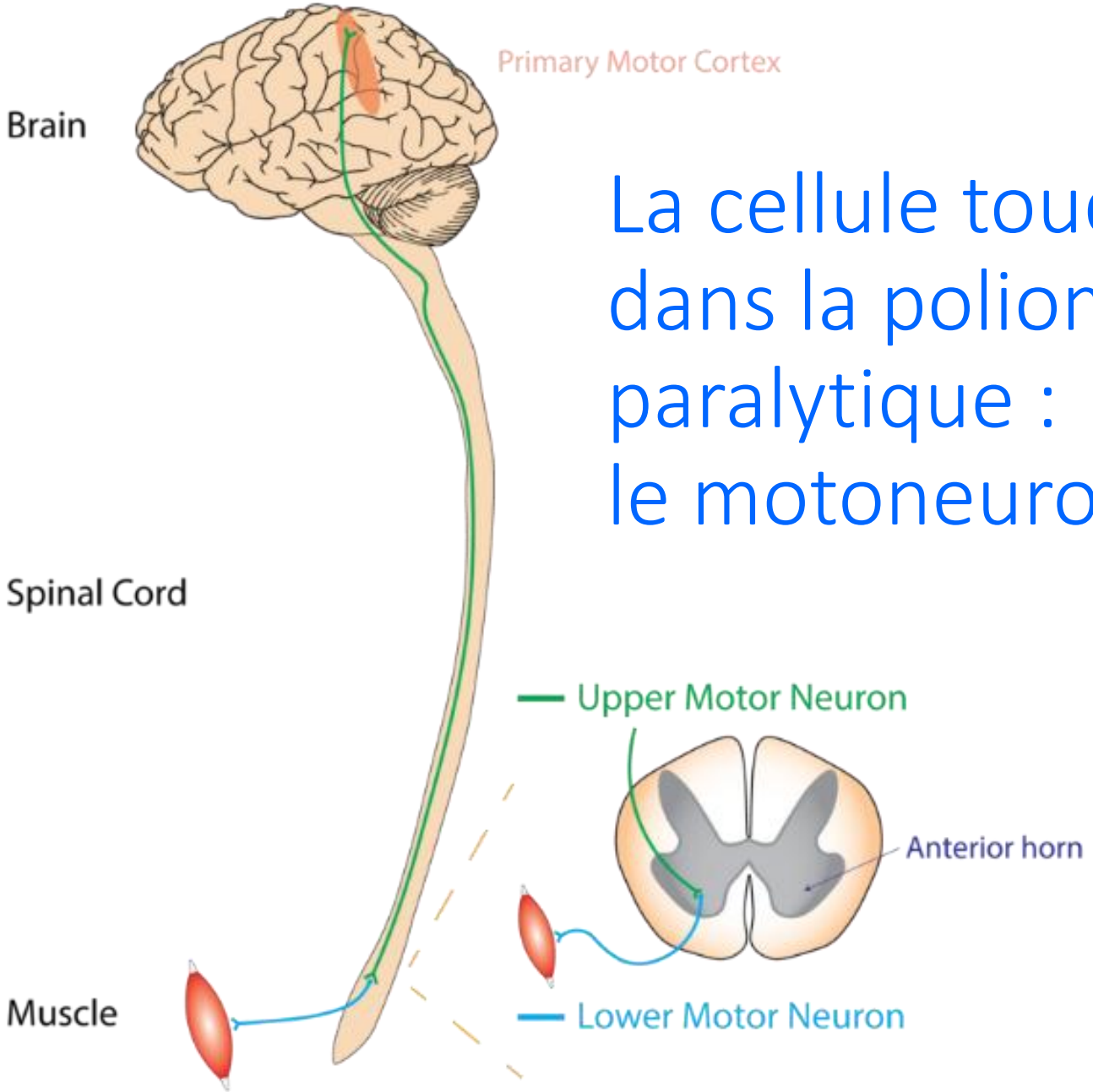

1
Attachment
nucleus
2
Entry & Uncoating
3
Translation
4
Processing
P1
P2
P3
5
(-) strand RNA
synthesis
6 (+) RNA synthesis
7
Translation
VP0 VP3 VP1
provirion
virion
8
Morphogenesis
9 Release from cells

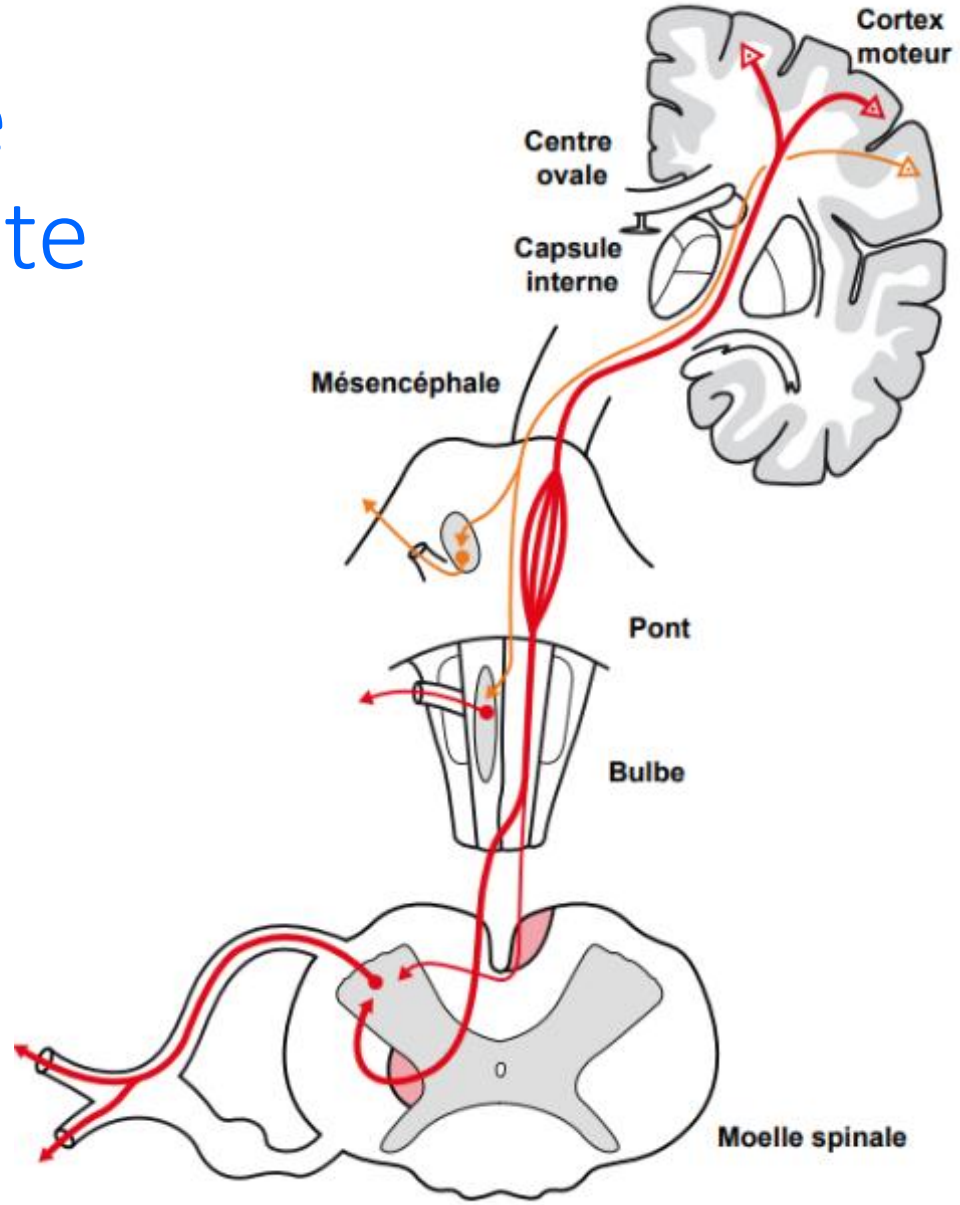
Étapes de l’infection

- Contamination par voie orale
  - En particulier à partir de l’environnement
- Infection des cellules épithéliales digestives
- Virémie
- Localisation inconstante dans le système nerveux central
  - Voire infection des motoneurones de la corne antérieure de la moëlle


ALIMENTARY PHASE
LYMPHATIC PHASE
VIREMIC PHASE
NEURAL PHASE
Oropharynx
Cervical lymph nodes
Small intestine
Mesenteric lymph nodes
Feces
Blood
Extraneural tissues
Blood-brain barrier
Cerebrum
Brainstem
Spinal cord
Dorsal horns
Ventral horns
Motor neurons

La cellule touchée dans la poliomyélite paralytique : le motoneurone





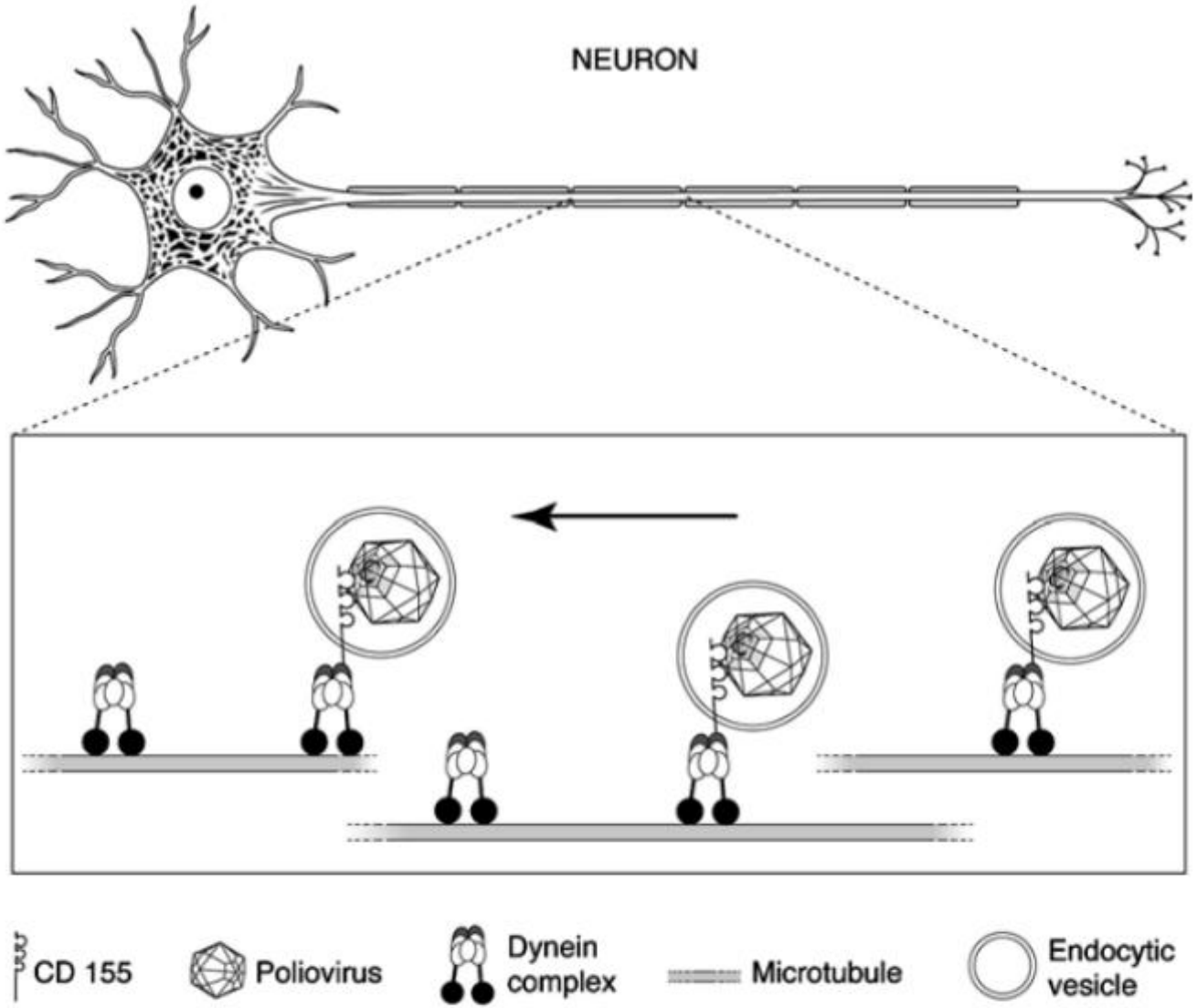


Fig. 2 Model of retrograde axonal transport of PV. A neuron, with an enlarged portion of the axon, is shown. The cytoplasmic domain of CD155 interacts with the light chain Tctex-1 (in *gray*) of the dynein motor complex, and the virus enclosed in endocytic vesicles is transported along microtubules by fast retrograde axonal transport. (Adapted from Ohka and Nomoto 2001; Mueller et al. 2002)

Comme d'autres virus, le virus de la poliomyélite utilise les systèmes de transit intracellulaires d'organelles pour progresser à l'intérieur du neurone

Blondel 2006

boone 2010 - horse Poliomyelitis with intraneuronal Negri bodies

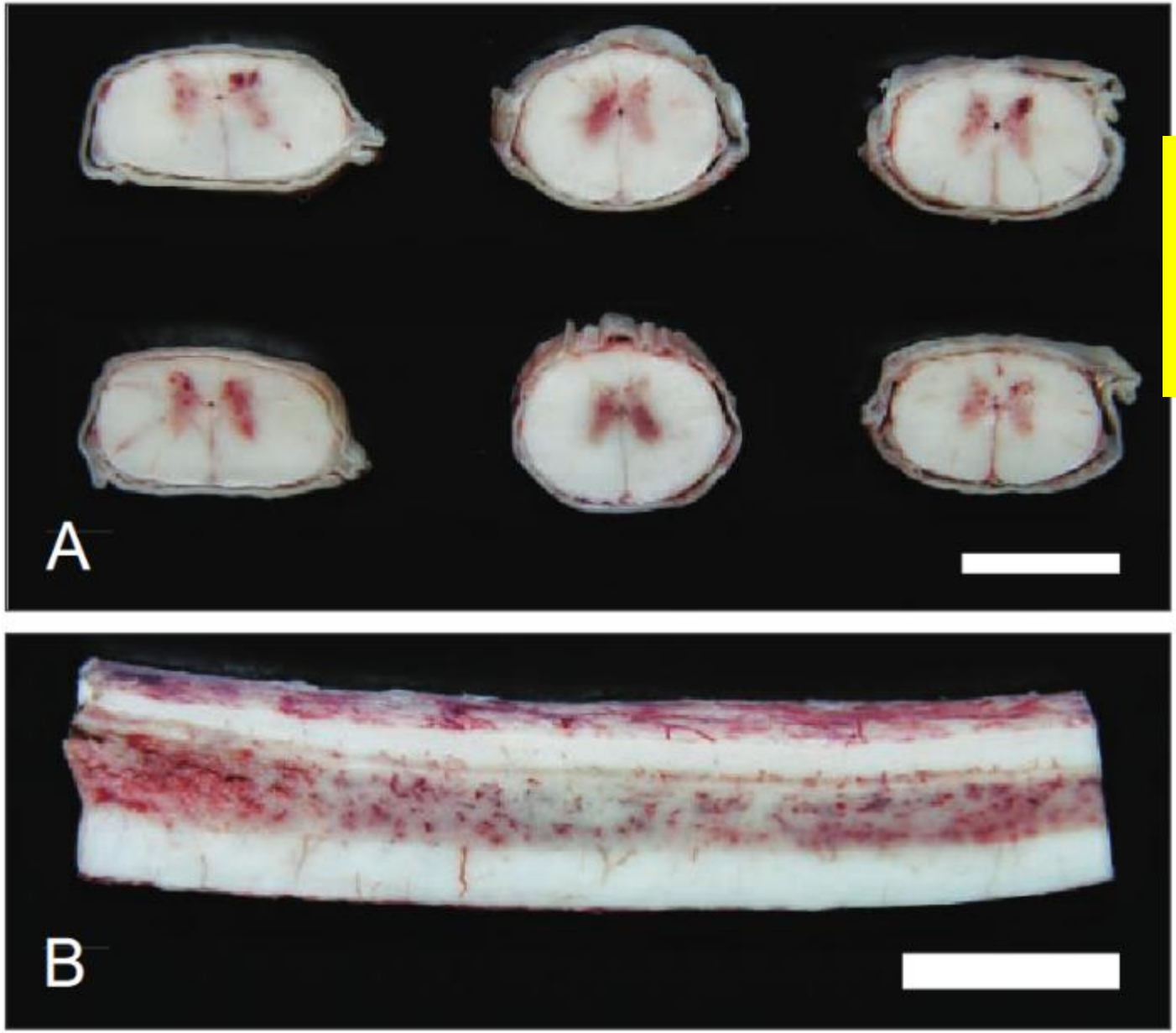


Figure 1—Photograph of transverse spinal cord sections (A) and a longitudinal section of the lumbar portion of the spinal cord (B) of a horse that had apparently normal mentation, a flaccid tail, pelvic limb paresis, and urinary bladder atonia. In panel A,

Un exemple d'atteinte
de la substance grise de la moelle
(polio = gris en grec)
par le virus de la poliomyélite
(ici chez le cheval)

boone 2010 - horse Poliomyelitis with intraneuronal Negri bodies

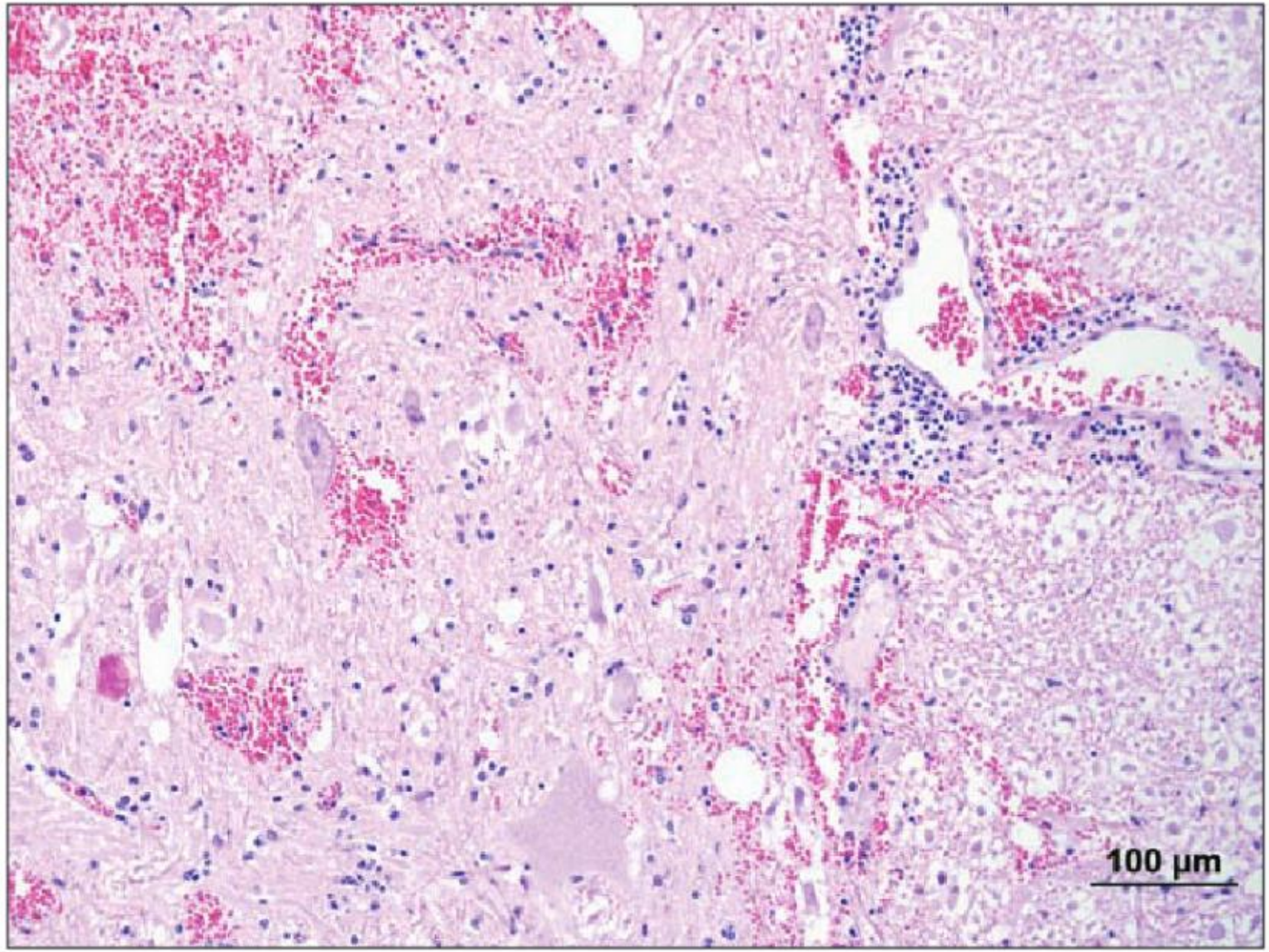


Figure 2—Photomicrograph of a section from the lumbar portion of the spinal cord in the horse in Figure 1. Perivascular hemorrhages and lymphocytic cuffing expand the Virchow-Robin space. H&E stain; bar = 100 µm.

boone 2010 - horse Poliomyelitis with intraneuronal Negri bodies

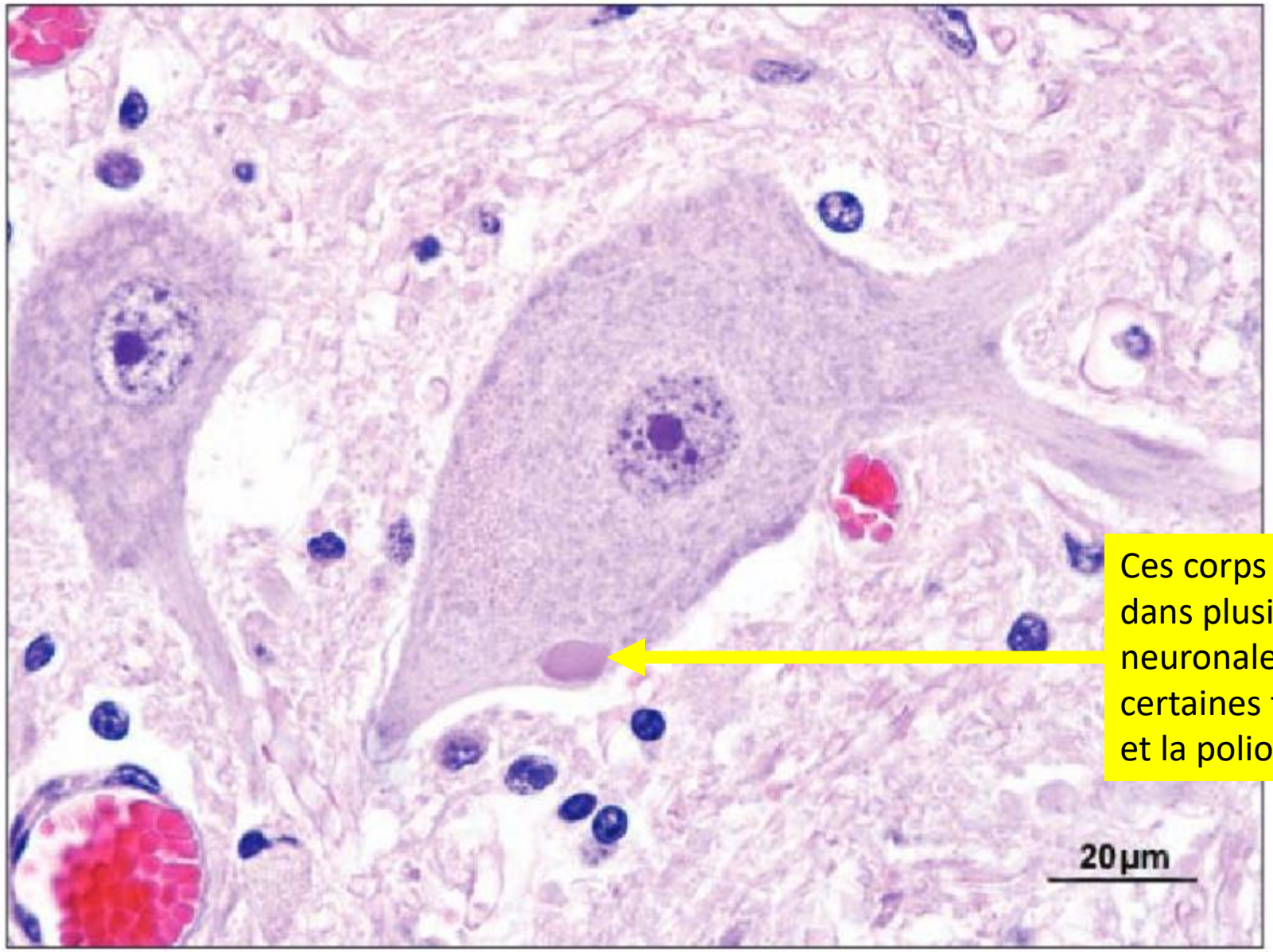


Figure 3—Photomicrograph of a section from the lumbar portion of the spinal cord in the horse in Figure 1. An oval eosinophilic intracytoplasmic Negri body is present within the perikaryon of a neuron in the dorsal horn of the spinal cord. H&E stain; bar = 20 µm.

Ces corps de Negri se voient dans plusieurs infections neuronales, dont la rage et certaines formes de rougeole – et la poliomyélite donc.

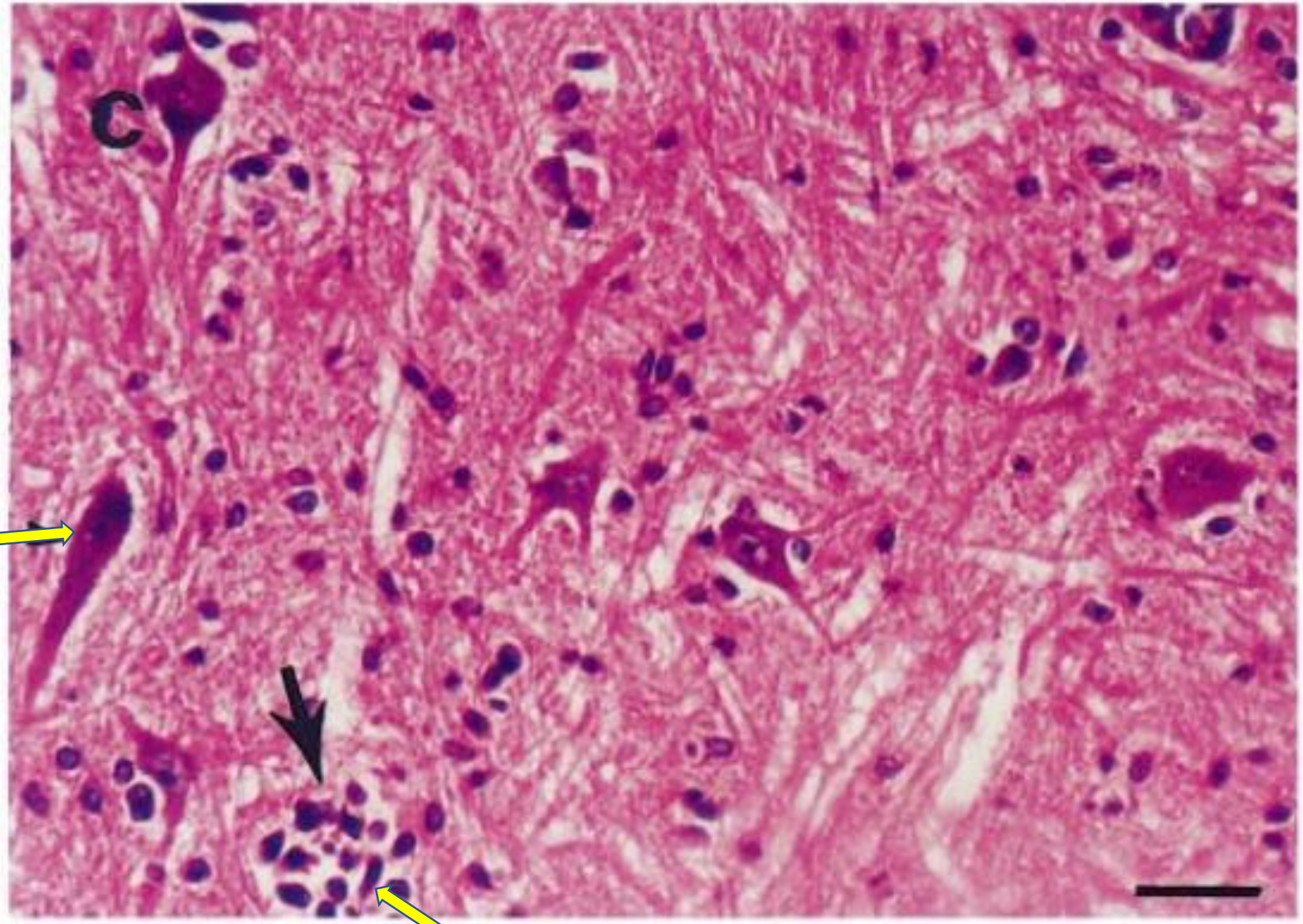
Journal of General Virology (1998), **79**, 2393–2403. Printed in Great Britain

Cell-to-cell spread of poliovirus in the spinal cord of bonnet monkeys (*Macaca radiata*)

Esther M. Ponnuraj,[1,2] T. Jacob John,[1] Myron J. Levin[2] and Eric A. F. Simoes[2]

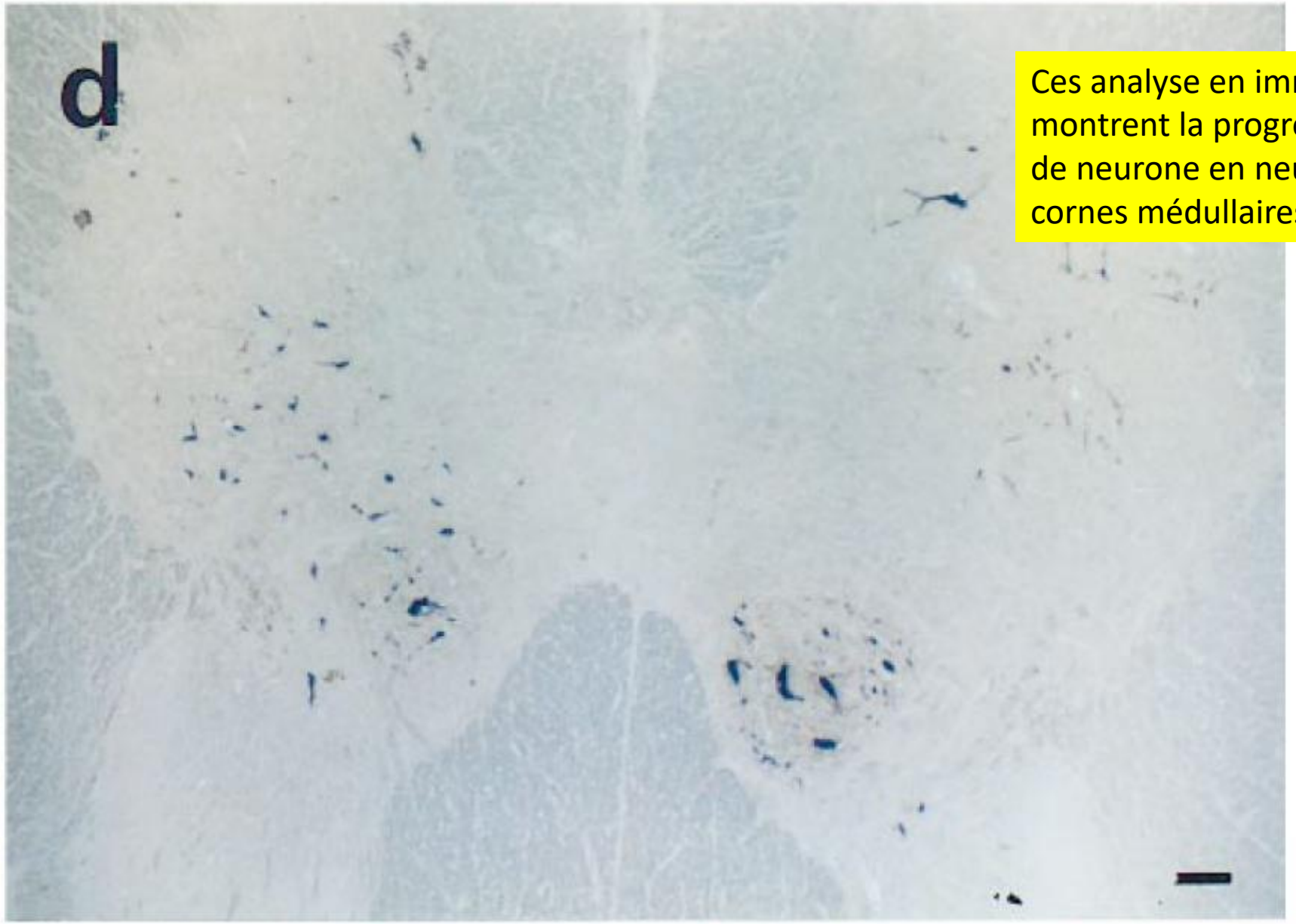
[1] Department of Microbiology and Virology, Christian Medical College and Hospital, Vellore 632004, India

[2] Department of Pediatrics, Section of Infectious Diseases, University of Colorado Health Sciences Center, Box B-126, 4200 East Ninth Avenue, Denver, CO 80262, USA


C
Intact neuron
Neuronophagie

Day 6

In situ hybridization with a fragment (nt 1±1809) of the 5’ end of poliovirus genome



Ces analyse en immunohistochimie montrent la progression du virus de neurone en neurone dans les cornes médullaires

Day 6

In situ hybridization with a fragment (nt 1±1809) of the 5’ end of poliovirus genome

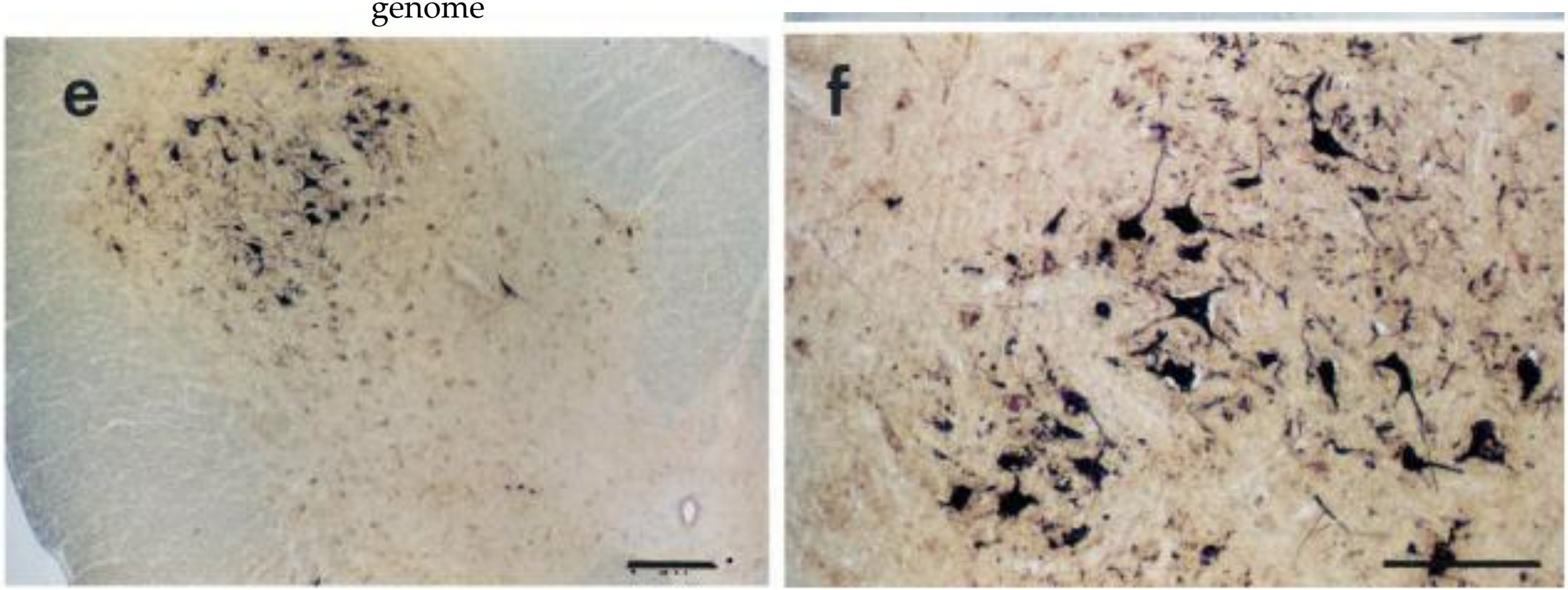


Fig. 4. Photomicrograph of *in situ* hybridization of spinal cord tissues. (*a*) Upper cervical region showing neurons with signals in the anterior horn region of monkey no. 2055 on day 3 p.i. (*b*) Lower cervical region of monkey no. 2056 with signals on day 3 p.i. (*c*) Lumbar cord without signals on day 3 p.i. (*d*) Upper lumbar segment showing signals in neurons and a few axons on day 6 p.i. (*e*) Lower lumbar segment with signals in the neurons and its processes on day 6 p.i. (*f*) Higher magnification of lower lumbar segment with signals in the neurons and its processes. Bars, 20 µm.

Ces analyse en immunohistochimie montrent la progression du virus de neurone en neurone dans les cornes médullaires

Manifestations cliniques de la poliomyélite

- 20-25% des personnes infectées sont symptomatiques : **poliomyélite dite abortive**
  - Fièvre, nausées, asthénie, douleurs abdominales, pendant 2 ou 3 jours
  - Tableau souvent léger
  - En rapport avec une virémie peu intense

- 1-5% des personnes infectées ont une atteinte du système nerveux central : **poliomyélite aiguë non paralytique**
  - Secondaire à une virémie intense
  - méningite clinique et biologique

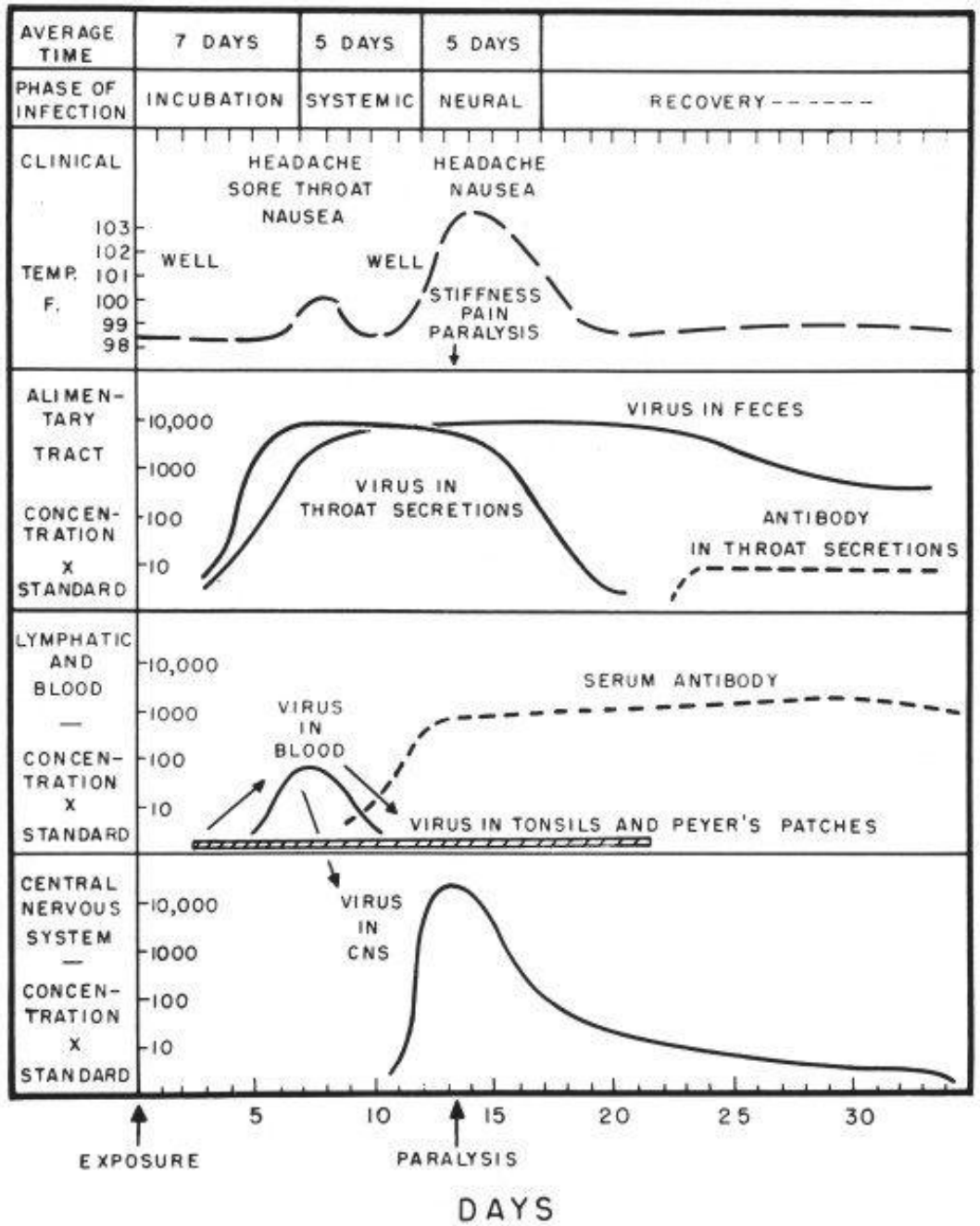
Manifestations cliniques de la poliomyélite

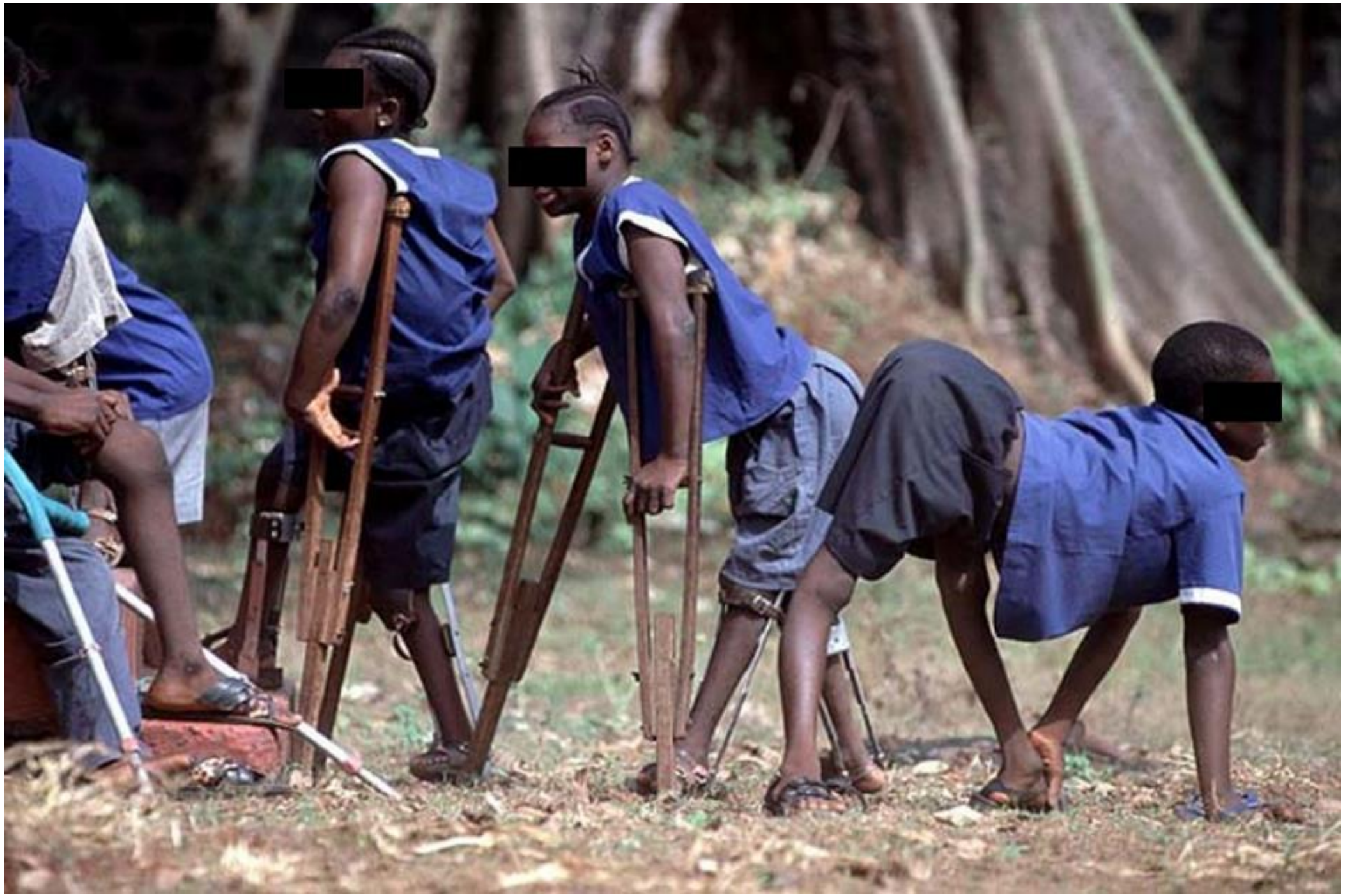
- 0,5-1% des personnes infectées développent une **poliomyélite paralytique aiguë**
  - Douleurs musculaires
  - Hyperesthésies et paresthésies
  - Troubles sphinctériens
  - Spasmes musculaires
  - Paralysie flasque asymétrique s'installant en 48 heures
    - Risque de paralysie définitive : 50%
    - Mortalité 5 à 10%

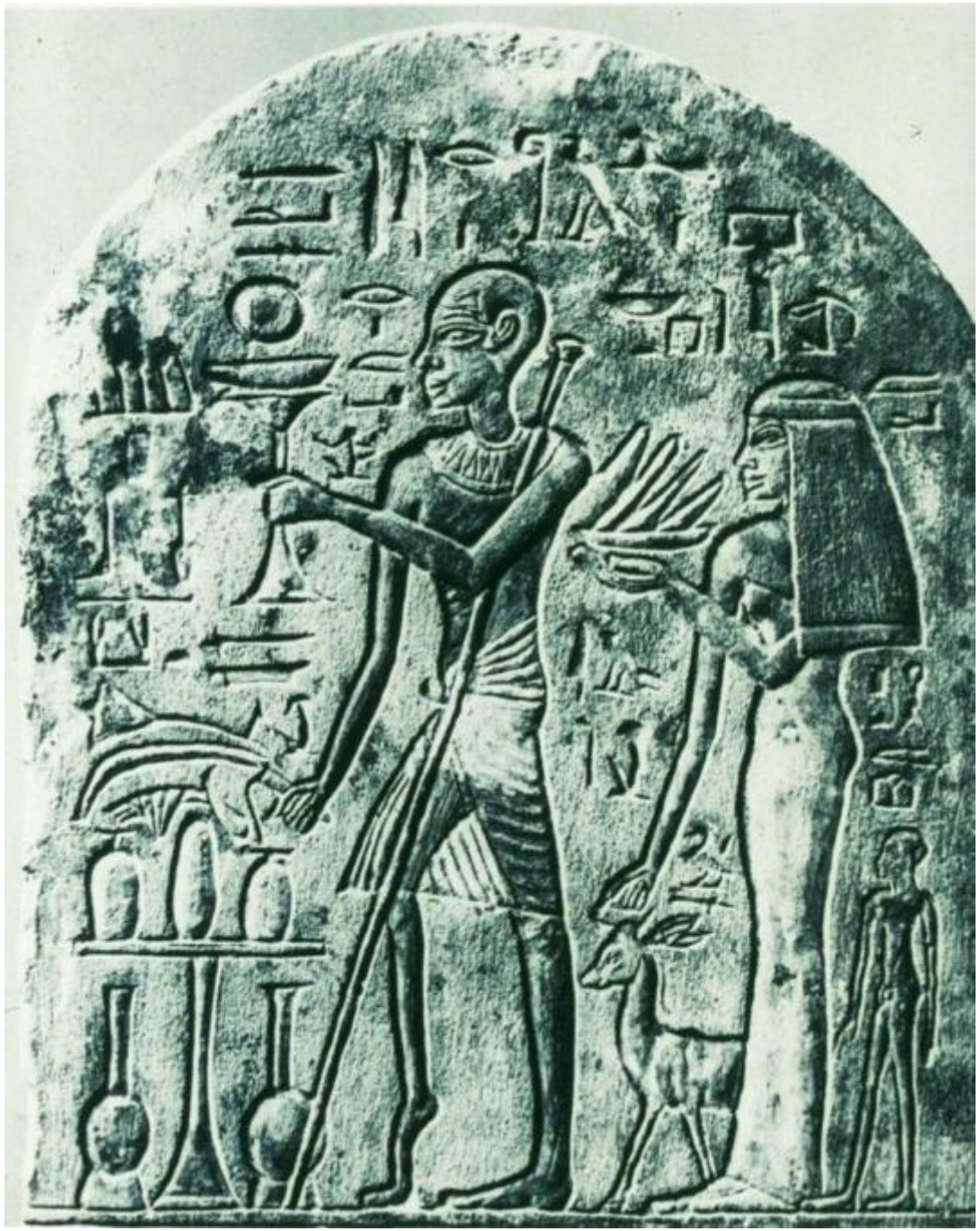
En conséquence, quand on voit un cas de poliomyélite paralytique, 100 ou 200 personnes autour sont en train de faire une forme asymptomatique et d'excréter du virus …

- 40% des personnes ayant développé une PPA développent à distance un **syndrome post-poliomyélitique**

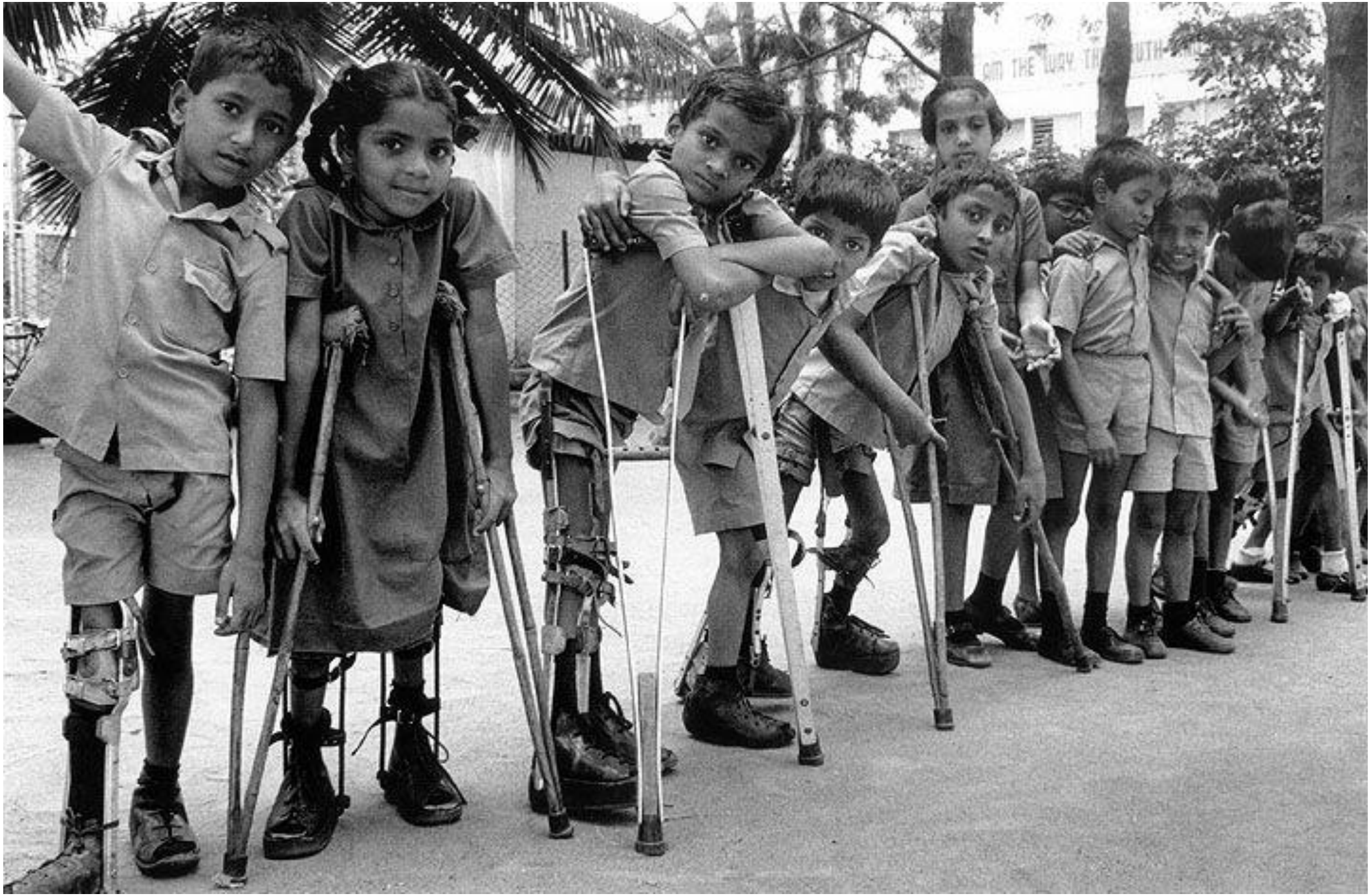
Viral and Rickettsial Infections of Man
1959

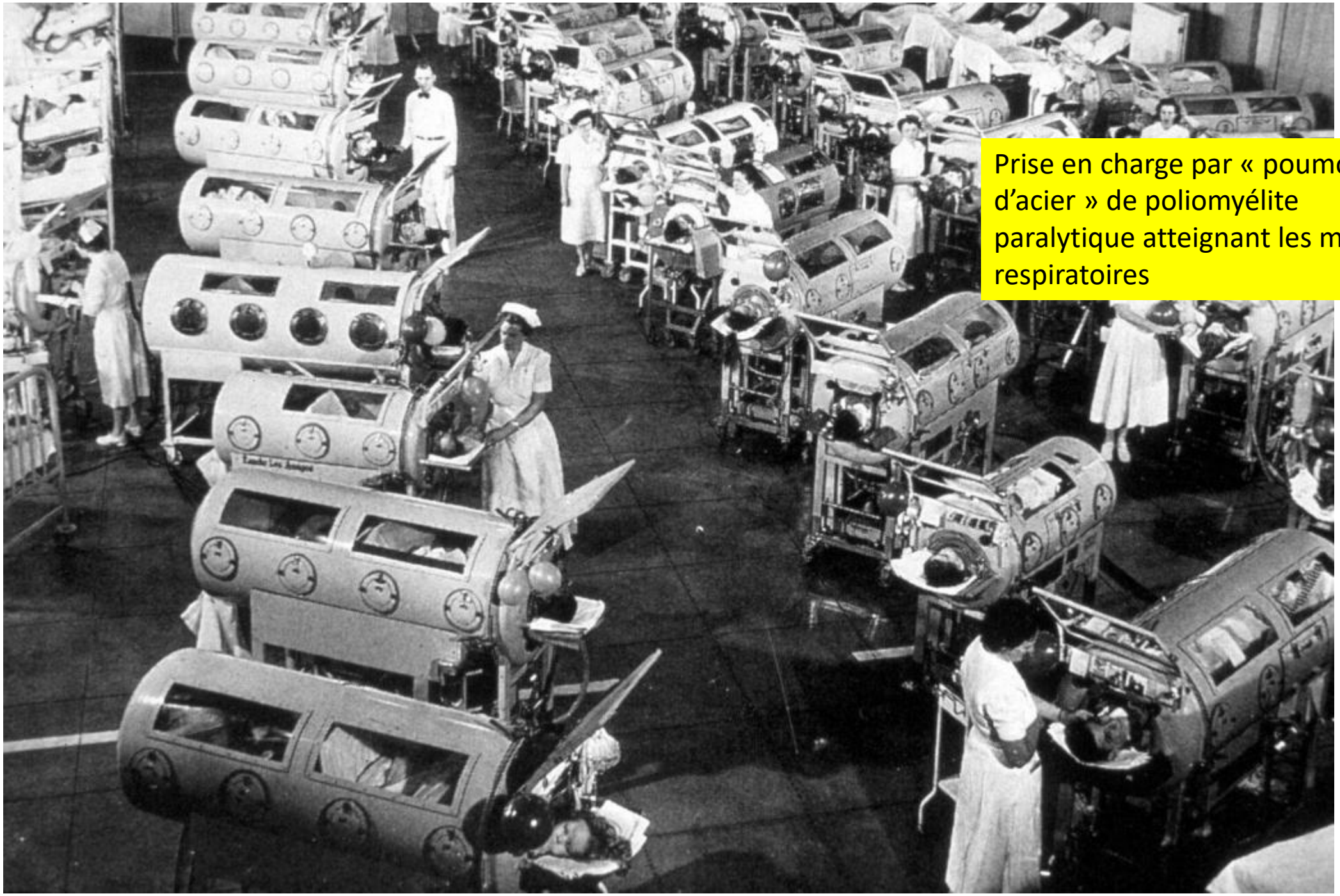






Stèle égyptienne, XVIII^{ème} dynastie
(1403-1365 av. J.-C.).





Prise en charge par « poumon d’acier » de poliomyélite paralytique atteignant les muscles respiratoires

https://www.youtube.com/watch?v=AGE6iVay4jg&list=PLqqqqZrD37h6OuF5890UsiQ5ORcIAf-T9

4mn et suivantes

1991 : last case of polio in the Americas (Peru)

D’autres entérovirus sont neuroinvasifs …

DISPATCHES

Acute Flaccid Paralysis Associated with Novel Enterovirus C105

Liana M. Horner, Melinda D. Poulter, J. Nicholas Brenton, Ronald B. Turner

An outbreak of acute flaccid paralysis among children in the United States during summer 2014 was tentatively associated with enterovirus D68 infection. This syndrome in a child in fall 2014 was associated with enterovirus C105 infection. The presence of this virus strain in North America may pose a diagnostic challenge.

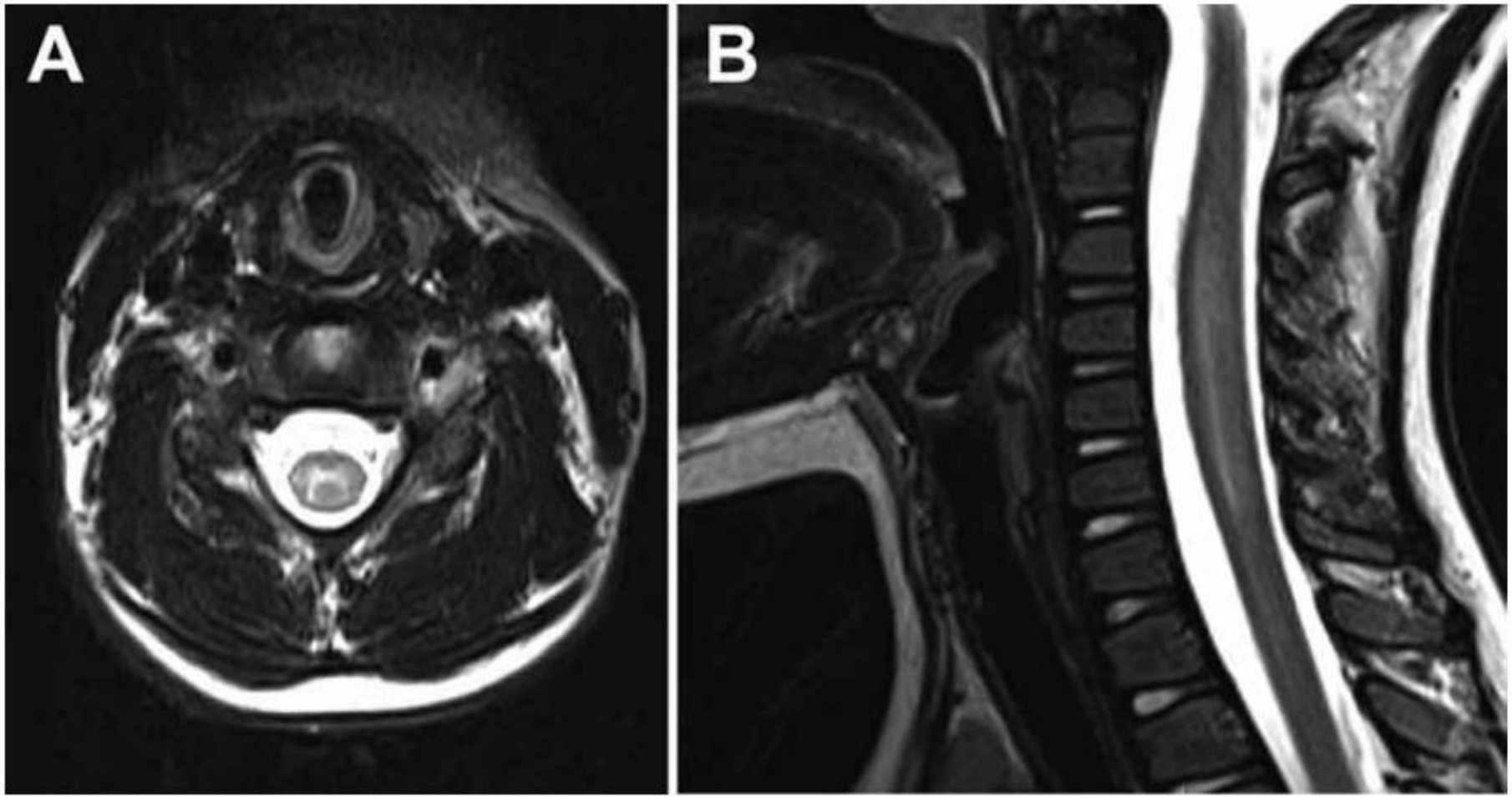
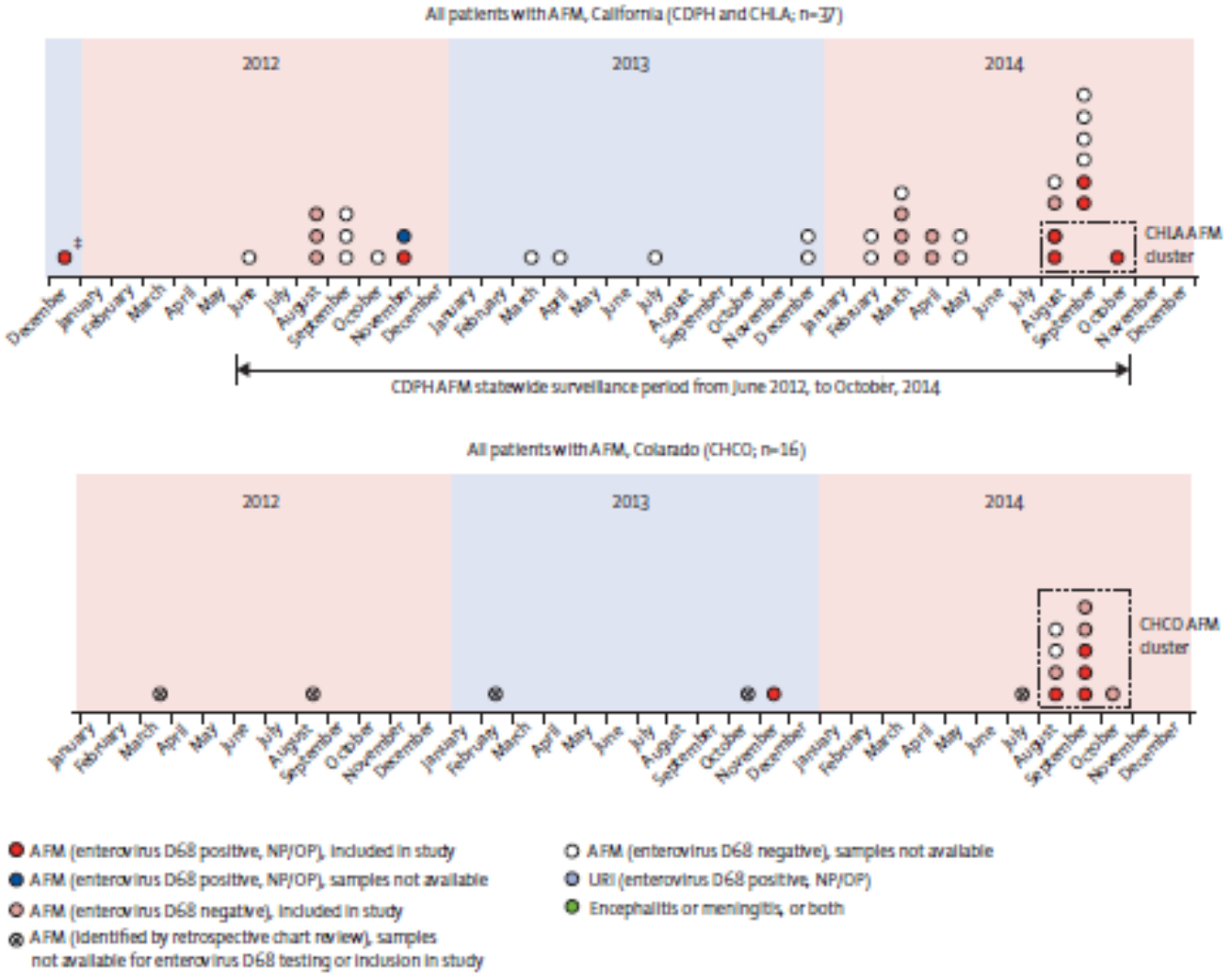


Figure. Magnetic resonance imaging of 6-year-old girl with flaccid paralysis and enterovirus C105 infection, Virginia, USA, October 2014. A) Axial T2-weighted image of the cervical spine demonstrating abnormal hyperintensity of the central gray matter (right to left). B) Sagittal T2-weighted image of the cervical spinal cord demonstrating faint longitudinally extensive central hyperintensity and associated cord edema.

2015

A novel outbreak enterovirus D68 strain associated with acute flaccid myelitis cases in the USA (2012–14): a retrospective cohort study

Alexander L Greninger, Samia N Naccache*, Kevin Messacar, Anna Clayton, Guixia Yu, Sneha Somasekar, Scot Federman, Doug Stryke, Christopher Anderson, Shigeo Yagi, Sharon Messenger, Debra Wadford, Dongxiang Xia, James P Watt, Keith Van Haren, Samuel R Dominguez, Carol Glaser, Grace Aldrovandi, Charles Y Chiu*



1918

ACTIVE IMMUNITY IN EXPERIMENTAL POLIOMYELITIS[1]

H. L. ABRAMSON AND HERMAN GERBER

From the Bureau of Laboratories, Department of Health, New York

Received for publication March 29, 1918

Des tentatives d'inactivation virale (en particulier par le formaldéhyde) ont eu lieu il y a plus d'un siècle, mais avec des conséquences dramatiques par inactivation insuffisante …

MODIFICATION OF POLIO VIRUS BY CONTACT WITH 0.5 PER CENT FORMALDEHYDE

Cummings devised a method of anti-rabic treatment in which he put a 2 per cent emulsion of fixed rabic virus in contact with 0.5 per cent formaldehyde for four hours in the ice-box. At the end of this time, he dialyzed the formalin from the mixture through collodion sacs into distilled water until the cord emulsion failed to give test for formalin. The material was then inoculated daily into the rabbits to be protected in increasing doses.

We applied this method in our attempt to chemically modify polio virus. We used a 10 per cent emulsion of the cords and brains of monkeys dead of highly virulent poliomyelitis virus and made it up fresh for each injection. This 10 per cent emulsion was kept in contact with 0.5 per cent formaldehyde for four hours. It was assumed that this contact would kill the polio virus. However, our experience proved to us without any chance for doubt, that it did not kill the virus. The protocol follows:

Active Immunization Against Poliomyelitis*

1935

MAURICE BRODIE, M.D.

Bureau of Laboratories, Department of Health, City of New York, and Department Bacteriology, New York University and Bellevue Hospital Medical School, New York, N. Y.

… en particulier, des cas de poliomyélite paralytique parfois mortelle après inoculation d'un virus insuffisamment inactivé

1936

POLIOMYELITIS FOLLOWING VACCINATION AGAINST THIS DISEASE†

By J. P. LEAKE, M.D.*

During the past year in the United States, several thousand individuals, mostly children, have received subcutaneous and intracutaneous injections of treated poliomyelitis virus in the hope of acquiring immunity against the natural disease. The two different forms of treatment to which the virus was subjected were intended to render it innocuous when thus used as a vaccine. Through those responsible for the production of these vaccines, through several health officers and through others, word has come

1. A boy, aged five years, had his first symptoms of poliomyelitis six days after receiving the second dose of vaccine A in the left arm, the first dose having been given in the same arm twenty-seven days before the second. Paralysis began in the left arm the day after onset, and death occurred after an illness of three days.

2. A girl, aged twenty-one months, received the second dose of vaccine A in the right arm twelve days after the first dose, and the onset of poliomyelitis occurred six days after the second dose. Paralysis began in the right arm three days later, and death occurred five days after the onset.

3. A boy, aged four years, had his onset of poliomyelitis eight days after the first dose of vaccine A in the left buttock, and one day after the second dose at the same site. Paralysis began in his right leg two days later and is at present, after three months, confined to that extremity, though there is hope of ultimate nearly complete recovery.

4. A girl, aged eight years, had her onset of poliomyelitis eight days after the first dose of vaccine A in the left arm, and one day after the second dose in the same arm. Paralysis began in the arm two days later, and death occurred after an illness of three days.

Leake 1936

Salk inactivated vaccine (injected)

Vaccin inactivé de Salk

- Inactivation par le formaldéhyde
- Protection très élevée contre la virémie et les formes neurologiques
- Pas d'effet sur l'immunité au niveau de la muqueuse digestive : pas de protection contre l'infection, ou contre l'excrétion de virus
  - Empêche la maladie (neurologique)
  - N'empêche pas la circulation du virus

1914-1995

EVALUATION OF THE 1954 POLIOMYELITIS VACCINE FIELD TRIAL

FURTHER STUDIES OF RESULTS DETERMINING THE EFFECTIVENESS OF POLIOMYELITIS VACCINE (SALK) IN PREVENTING PARALYTIC POLIOMYELITIS

Thomas Francis Jr., M.D., Ann Arbor, Mich.

TABLE 2.—*Distribution of Study Population, by Participation Status and Vaccination Status—Placebo Areas*

Study Population	No.	%
Total in grades 1, 2, and 3	749,236	100.0
Total requests to participate	455,474	60.8
Complete series of injections		
Vaccine	200,745	26.8
Placebo	201,229	26.9
Incomplete injections		
Vaccine	8,484	1.1
Placebo	8,577	1.1
Absent at first clinic or withdrew	36,439	4.9
Number not requesting participation	280,868	37.5
Participation status not recorded	12,894	1.7

TABLE 3.—*Summary of Study Cases by Diagnostic Class and Vaccination Status, Rate per 100,000*

Study Group	Study Population	All Reported Cases		Poliomyelitis Cases						Doubtful or Not Poliomyelitis	
				Total		Paralytic		Nonparalytic			
		No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate
All areas, total	1,829,916	1,013	55	863	47	685	37	178	10	150	8
Placebo areas, total	749,236	428	57	358	48	270	36	88	12	70	9
Vaccinated	200,745	82	41	57	28	33	16	24	12	25	12
Placebo	201,229	162	81	142	71	115	57	27	13	20	10
Not inoculated *	338,778	182	54	157	46	121	36	36	11	25	7
Incomplete vaccinations	8,484	2	24	2	24	1	12	1	12	..	..
Observed areas, total	1,080,680	585	54	505	47	415	38	90	8	80	7
Vaccinated	221,998	76	34	56	25	38	17	18	8	20	9
Controls †	725,173	439	61	391	54	330	46	61	8	48	6
2nd grade not inoculated	123,605	66	53	54	44	43	35	11	9	12	10
Incomplete vaccinations	9,904	4	40	4	40	4	40	..	..	..	..

* Includes 8,577 children who received one or two injections of placebo. † 1st and 3rd grade total population.

Effectiveness of Salk Vaccine

1961

Analysis of Virologically Confirmed Cases of Paralytic and Nonparalytic Poliomyelitis

Joseph L. Melnick, Ph.D., Matilda Benyesh-Melnick, M.D., Ramiro Peña, B.A., and Martha Yow, M.D., Houston

Table 5.—Relationship of Vaccination Status to Laboratory-Confirmed Paralytic Poliomyelitis

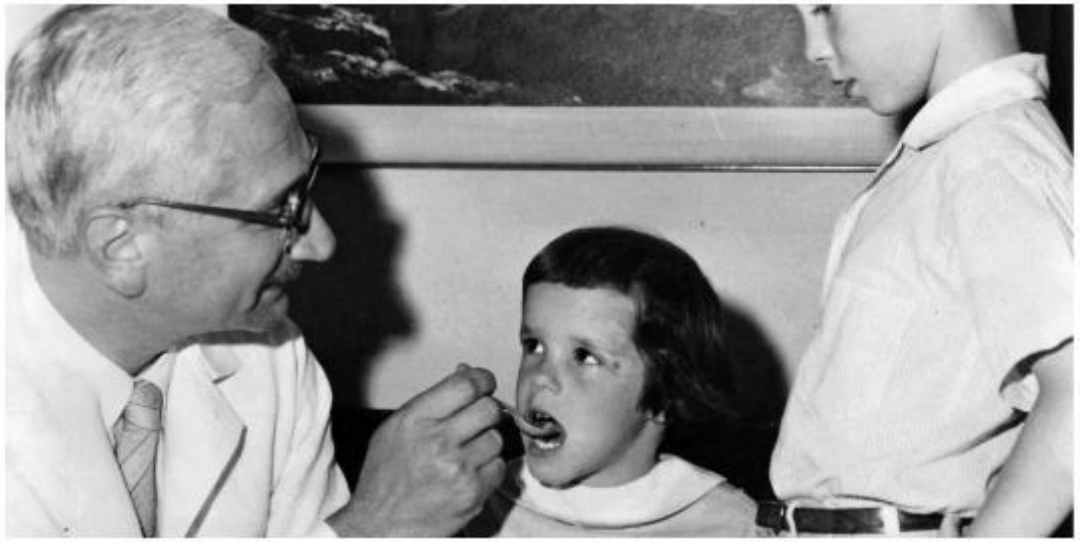
No. of Vaccine Inoculations	No. of Cases in 1958	No. of Cases in 1959	No. of Cases Both Years
0	45	42	87
1 or 2	6	4	10
3 or more	1	2	3
Total	**52**	**48**	**100**

On April 12, 1955, Edward R. Murrow asked Jonas Salk who owned the patent to the polio vaccine.

“*Well, the people, I would say*,” Salk responded.

“*There is no patent. Could you patent the sun?*”

Sabin attenuated vaccine (orally administered)



Abram Saperstejn / Albert Sabin
1906-1993

Albert Sabin élabore des souches atténuées des 3 sérotypes par cultures successives sur différents milieux

Bessaud 2021

Voici le détail de ces cultures successives, débouchant sur un virus inapte à la réplication chez l'humain

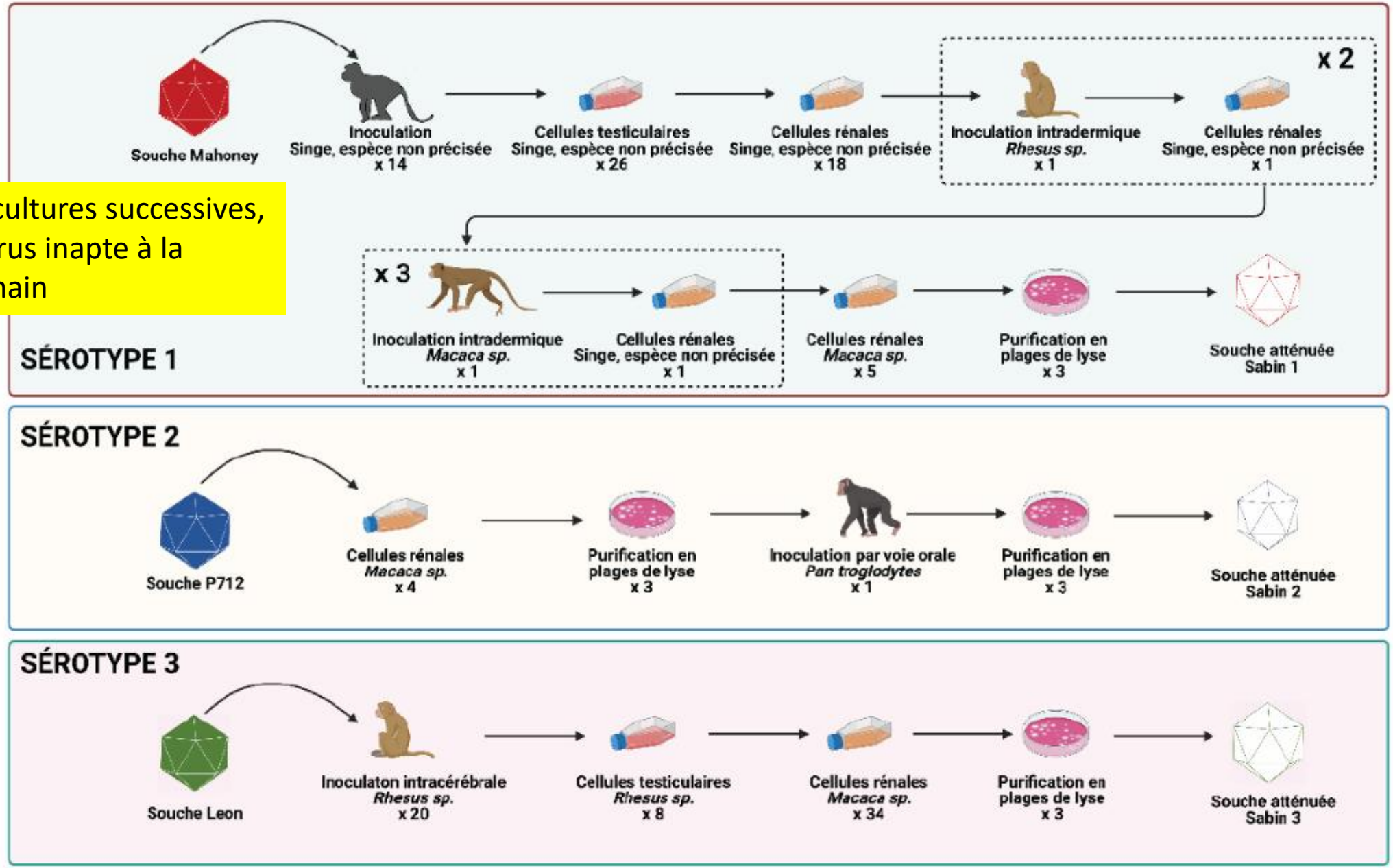


Figure 2 : Processus ayant permis d'obtenir les 3 souches atténuées Sabin à partir d'une souche sauvage de chacun des sérotypes. Figure réalisée en utilisant le logiciel BioRender *(https://biorender.com)*

PRESENT STATUS OF ATTENUATED LIVE-VIRUS POLIOMYELITIS VACCINE

Albert B. Sabin, M.D., Cincinnati

1956

TABLE 5.—*Screening of Thirteen Attenuated Strains of Poliovirus by Tests in Alimentary Tract of Chimpanzees and Men*

Type	Strain	Spinal Activity in Monkeys	No. Tested		Results of Alimentary Infection				Preference for Orally Given Vaccine
			Chimpanzees	Men	Antibody	Viremia	Alimentary Multiplication	Stability of Virus	
1	Brunhilde-Enders	(High)†	4	...	+++	0	+++	Yes	No
	Mahoney-LSa-mouse-Cinci	Low	3	...	(0 to +)	0	+	Yes	No
	Mahoney-KP 33	(High)	8	10	+++	0	+++	(No)	No
	Mahoney-L Sc-Cinci	Lowest	3	33	++	0	++	Yes	Yes!
	Cleveland 80-4*	Intermediate	3	—	+++	Slight	+++	(No)	No
	New Orleans P 1553*	Intermediate	3	—	+++	Slight	+++	(No)	No
	New Orleans P 2226*	Intermediate	—	6	++++	Slight	+++	(No)	No
	New Orleans P 2149*	Low	—	14	++++	Slight	+++	(No)	No
2	Y-SK-KP 51	Intermediate	14	14	+++	0	+++	(No)	No
	Cincinnati-FAF 117*	(High)	3	—	+++	Slight	+++	(No)	No
	New Orleans-P 712*	Low	—	38	+++	Trace-rare	+++	Yes	Yes!
3	Leon-KP 34 and 37	Low	8	44	++	0	+++	Yes	Yes!
	Cincinnati-Glenn*	High	3	13	++	0	+++	Yes	No

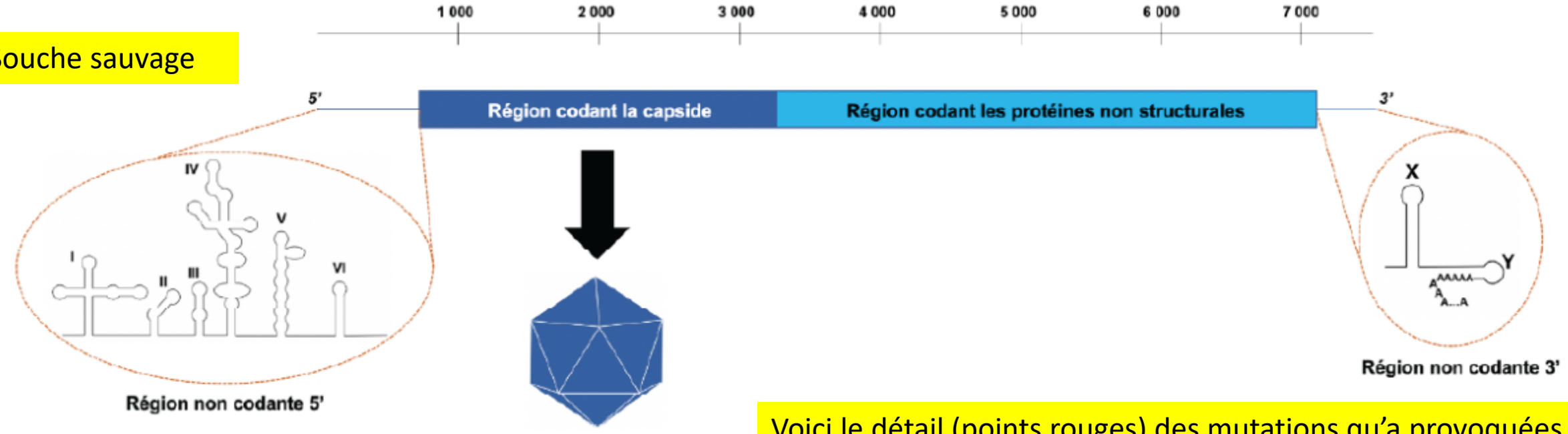
* Naturally occurring strains.

† Properties in parentheses eliminated strain.

TABLE 6.—*Isolation of Polioviruses with Varying Neurotropic Activity from Highly Attenuated Virus Populations Previously Purified by Terminal Dilution Technique*

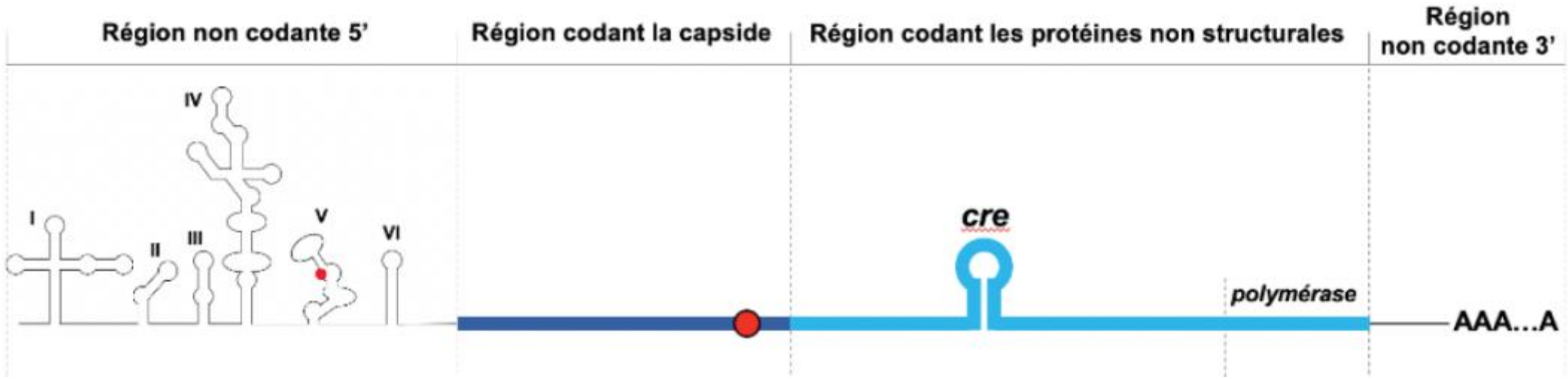
Type and Strain	Material Tested		Paralysis in Cynomolgus Monkeys Inoculated Intraspinally with Approximately Indicated No. of TCID*		
			1,000,000	100,000	10,000
3 Leon	Kidney passage 34		3/4	1/4	1/4
		36†	6/9	5/17	0/17
	Progeny of 9 triply purified plaques from kidney passage 34	Plaque 1†	0/29	0/14	0/14
		2†	0/15	0/15	0/15
		Plaques 3, 4, 5, 6	3/5 or 4/5	2/5 or 3/5	
		Plaques 7, 8, 9	4/5 or 5/5	5/5 or 4/5	
2 P 712	Kidney passage 4		2/4	0/8	0/4
		6†	6/17	5/17	4/17
	Progeny of 9 triply purified plaques from kidney passage 4	Plaque 1†	2 sl‡/24	0/19	1 sl/19
		Plaque 2	5/10	2/5	4/5
		3 to 9	3, 4 or 5/5	2, 3 or 4/5	
1 L Se Cincinnati	Kidney passages 1 to 5†		4/20	0/8	0/10
		7†	5 sl/17	2/17	1/17
	Progeny of 10 triply purified plaques from kidney passage 5	Plaque 1†	3 tr§/15	0/15	0/10
		2	1 tr/10	2/10	1 tr/5
		3	1 sl/10	0/5	2/5
		4	0/10	2/5	3/5
		Plaques 5, 6, 7	1/5	2/5	
		8, 9	2 or 3/5	1 or 2/5	
		Plaque 10	3/5	3/5	

Souche sauvage



Souche Sabin 2

Voici le détail (points rouges) des mutations qu'a provoquées (au hasard) A. Sabin en cultivant le sérotype 2



Bessaud 2021

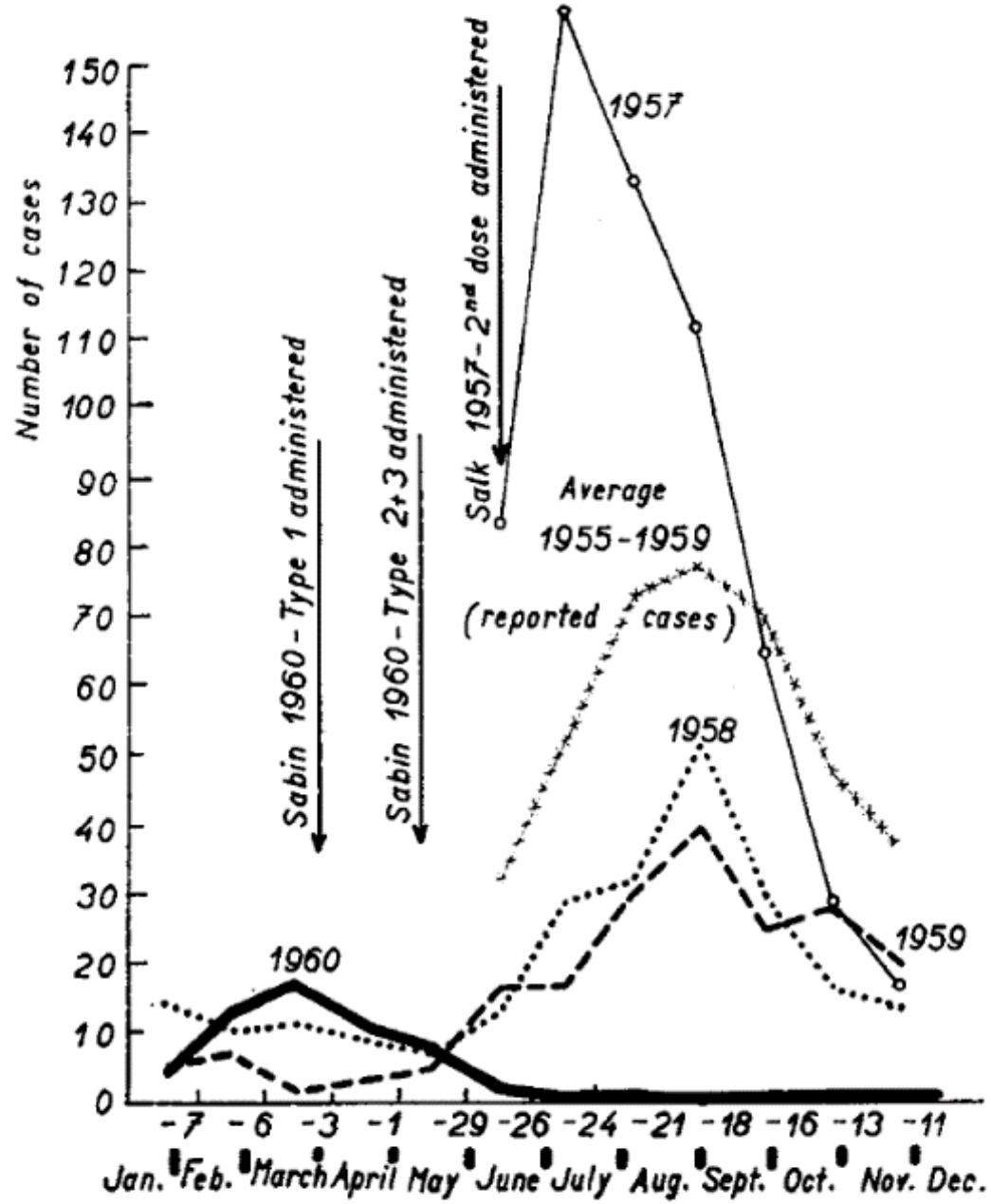
Clinical Notes

Oral Poliovirus Vaccine (Sabin) in Czechoslovakia

Effectiveness of Nation-Wide Use in 1960

Vilém Škovránek, M.D., and Karel Žáček, M.D., Prague, Czechoslovakia

Comparaison de différents pics épidémiques sur différentes années : l'impact du vaccin est majeur



Paralytic Poliomyelitis in Czechoslovakia 1957-1960 (Confirmed Cases).

Souches atténuées de Sabin

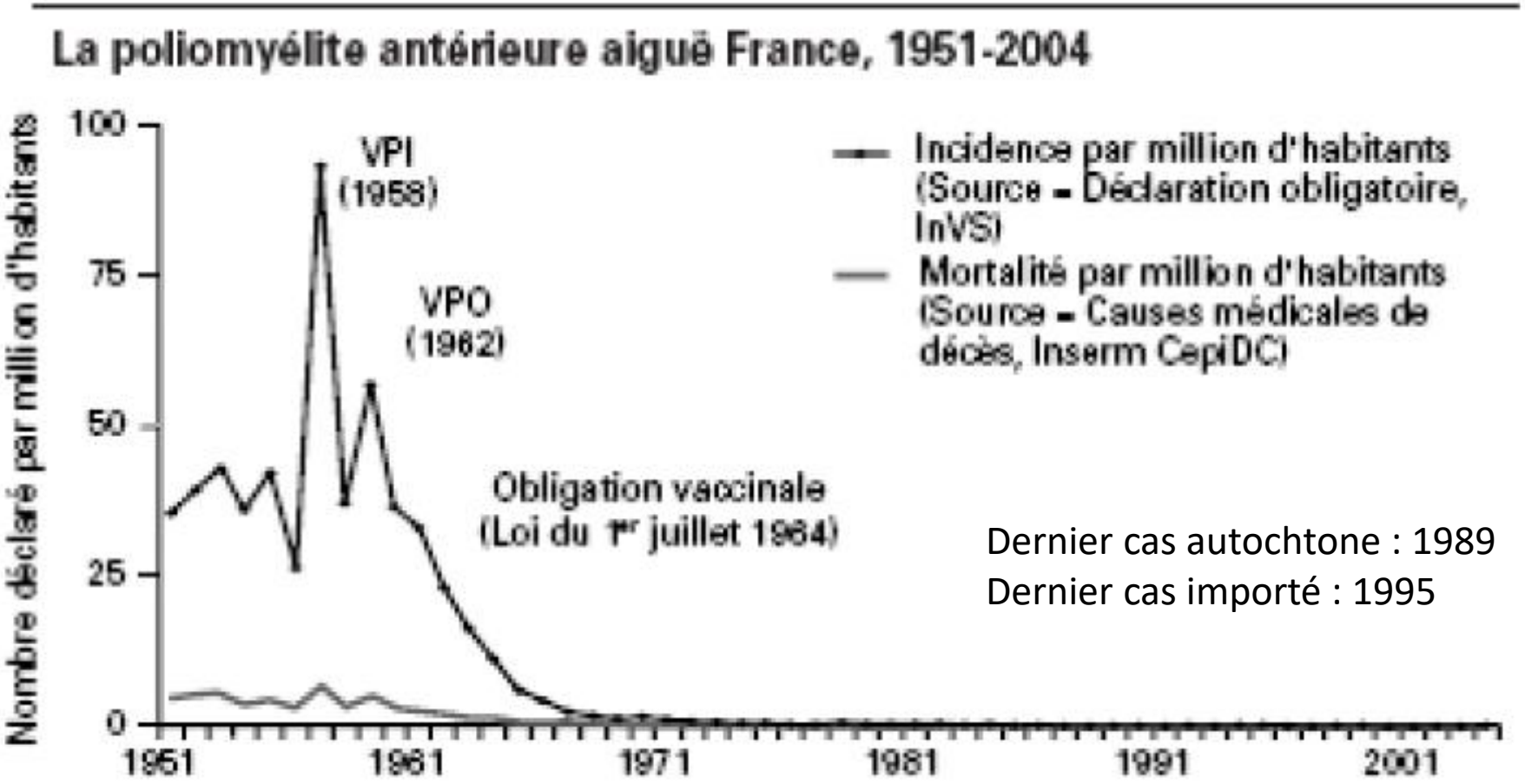
- Réplication dans le tractus digestif
  - Génération d'une immunité muqueuse efficace
- Pas de réplication dans les neurones
  - Pas de maladie vaccinale
- Protection contre l'infection (digestive) ET la maladie (neurologique)
- Après ingestion : excrétion dans les selles le temps que l'immunité apparaisse
  - Possibilité d'infection (sans risque neurologique) d'autres sujets non vaccinés
- Principal inconvénient : des souches vaccinales excrétées peuvent circuler et parfois récupérer une neurovirulence
  - Par ré-assortiment avec des entérovirus de l'environnement

DIFFERENCE BETWEEN IPV AND OPV

IPV	OPV
Killed formolised virus	Live attenuated virus
Given IM/SC	Given orally
Induces circulating antibody; no local immunity	Both humoral and intestinal immunity
Prevents paralysis; does not prevent reinfection by wild polio viruses	Prevents paralysis and intestinal reinfection
Not useful in epidemics	Effective in controlling epidemics
Content is 10,000 times more than OPV; Costlier	Cheaper
Does not require stringent conditions during storage and transportation	Requires to be stored and transported at sub-zero temperature, unless stabilised

IPV : inactivé, voie injectable ; OPV : atténué, voie orale

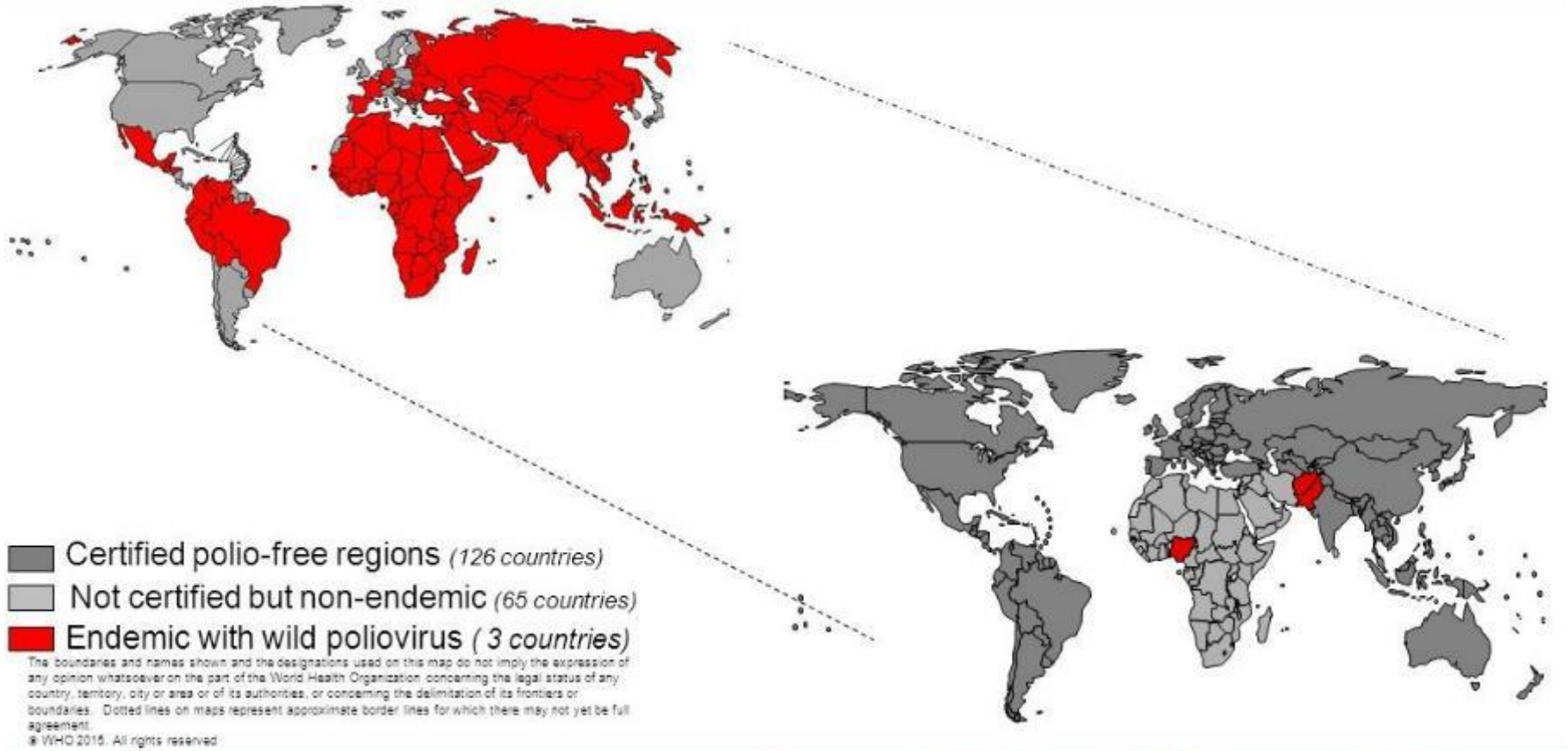
Poliomyélite : épidémiologie française avant et après l'introduction du vaccin



Dernier cas autochtone : 1989
Dernier cas importé : 1995

VPI / VPO : vaccin anti-poliomyélitique injectable / oral

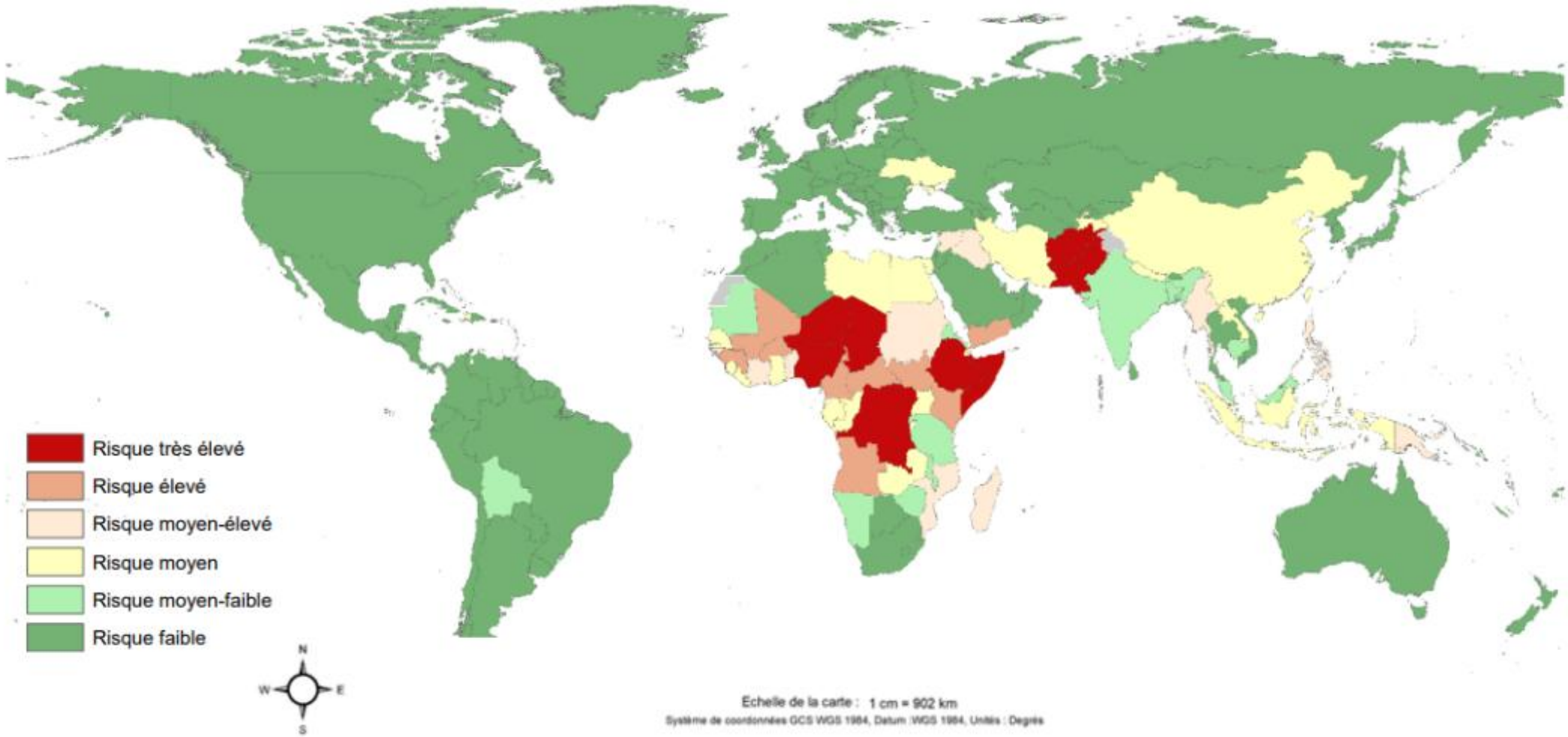
La poliomyélite dans le monde, 1988-2014



urce: WHO/POLIO database, as of Jul 2015

unicef World Health Organization

Fig. 1. Évaluation des risques au niveau pays (Depuis janvier 2022)



Global polio surveillance action plan, WHO

La poliomyélite dans le monde, 1988-2022

- **Diminution de 99,9% des cas entre 1988 et 2020**

- **Deux souches de poliovirus sauvage sur trois éradiquées**
  - Sérotype 3 : 2015 (dernier cas : Soudan, 2012)
  - Sérotype 2 : 2019

- **2020 : l'Afrique est déclarée indemne de tout virus polio sauvage**
  - Dernier cas : 2016
  - Mais nouveau cas positif au Malawi en 2022 (souche d'origine pakistanaise)

POLIO GLOBAL ERADICATION INITIATIVE every fast child

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2023 – zero-dose children in seven subnational consequential geographies hold key to success

Polio programme must keep clear focus in 2023 on adapting operations amid broader humanitarian emergencies

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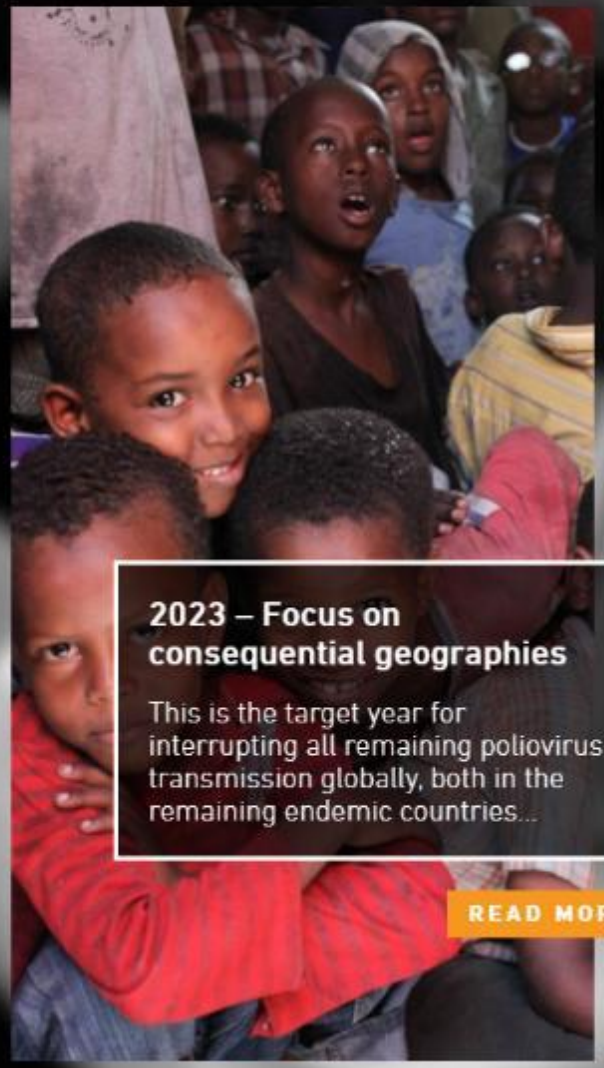


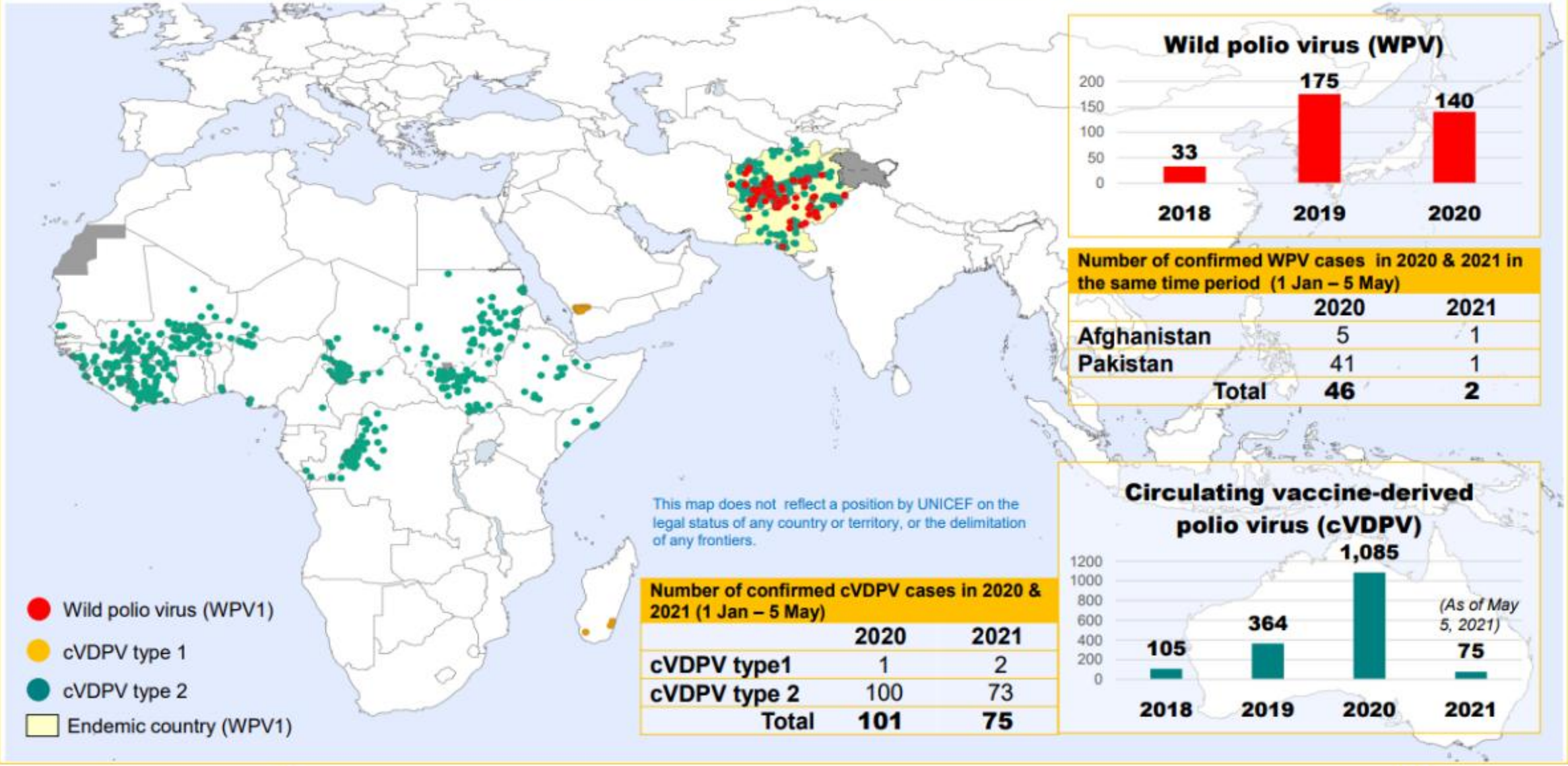
2023 – Focus on consequential geographies

This is the target year for interrupting all remaining poliovirus transmission globally, both in the remaining endemic countries...

READ MORE

Children paralysed by polio: 2018–2021 (as at 5 May 2021)

POLIO GLOBAL ERADICATION INITIATIVE



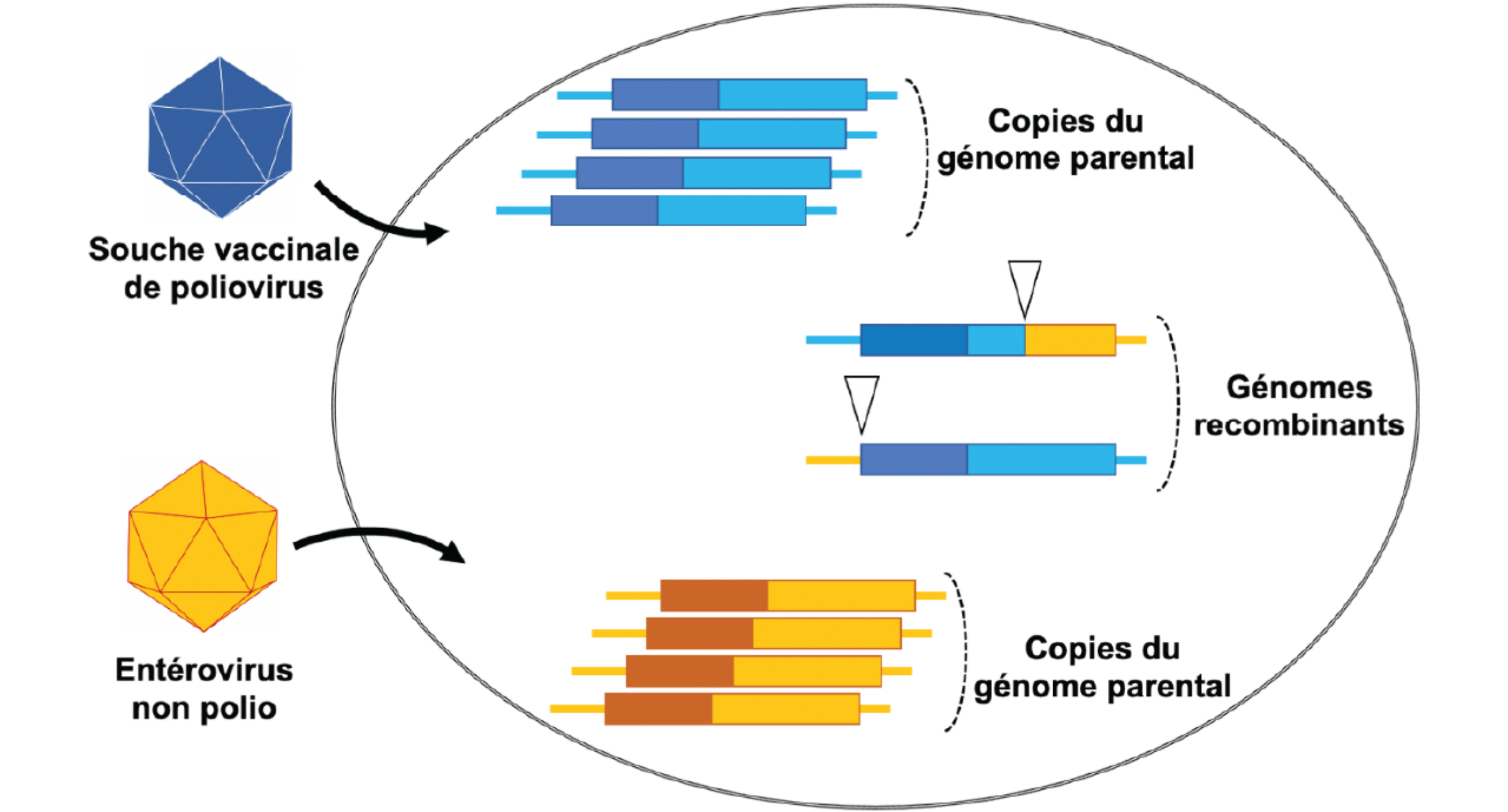
This map does not reflect a position by UNICEF on the legal status of any country or territory, or the delimitation of any frontiers.

Number of confirmed WPV cases in 2020 & 2021 in the same time period (1 Jan – 5 May)	2020	2021
Afghanistan	5	1
Pakistan	41	1
Total	**46**	**2**

Number of confirmed cVDPV cases in 2020 & 2021 (1 Jan – 5 May)	2020	2021
cVDPV type1	1	2
cVDPV type 2	100	73
Total	**101**	**75**

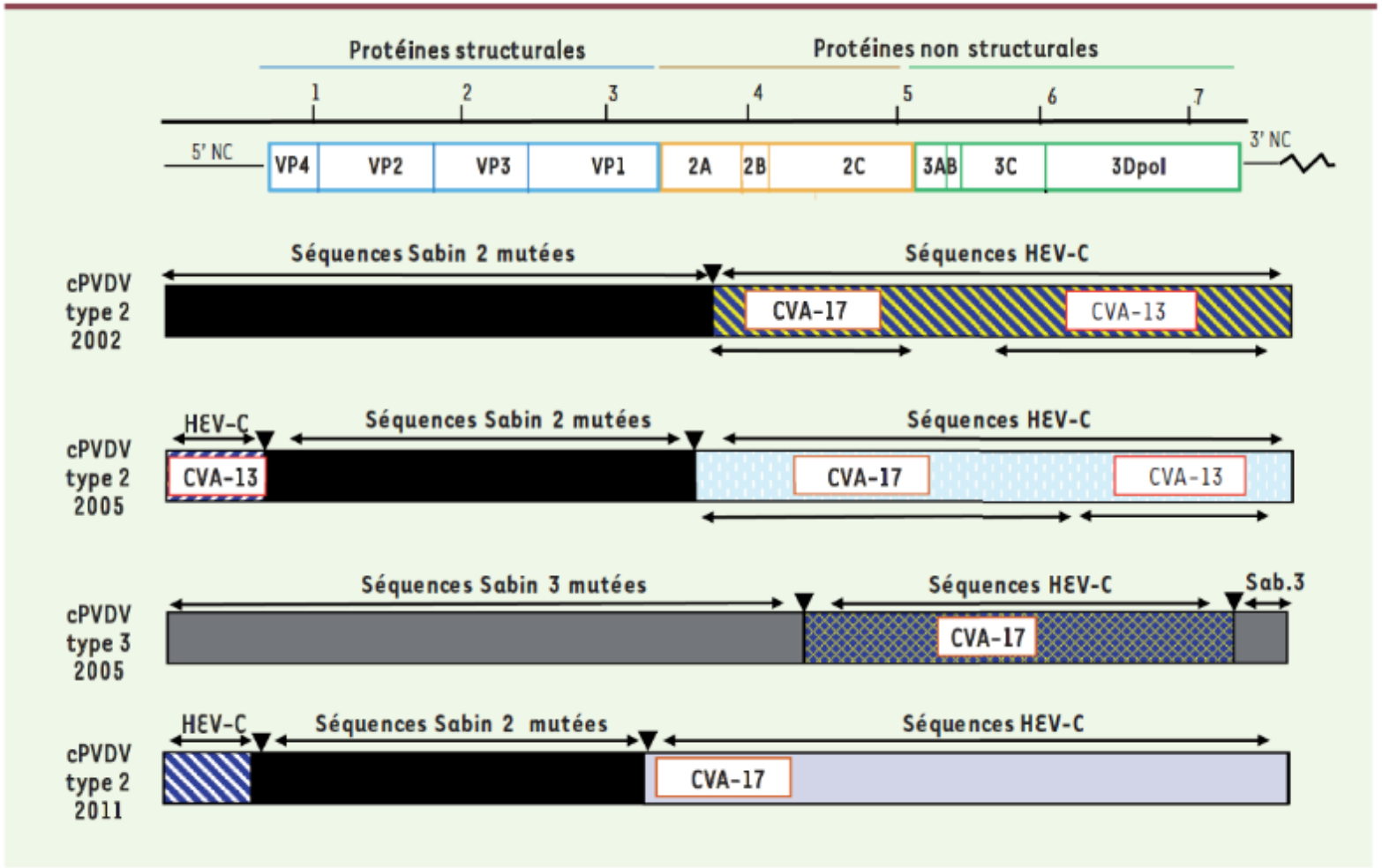
Conséquences de la nature « vivante » du vaccin oral

- Les souches vaccinales atténuées orales sont excrétées temporairement par les sujets vaccinés
- Elles se retrouvent dans l'environnement et peuvent infecter d'autres sujets s'ils ne sont pas vaccinés par le vaccin atténué
  - Sans déclencher à ce stade de maladie neurologique
- Leur circulation dans l'environnement et chez les sujets non vaccinées peut s'accompagner de modifications génomiques de regain de virulence
  - En particulier par recombinaison avec d'autres entérovirus
- Des épidémies liées à ces virus dérivés de vaccin peuvent alors se produire
  - Elles prédominent actuellement, car la circulation du virus sauvage a été presque éradiquée



Bessaud 2021

Recombinaison entre des souches vaccinales et d'autres entérovirus dans l'environnement



Delpeyroux 2013

RESEARCH ARTICLES

Molecular epidemiology of silent introduction and sustained transmission of wild poliovirus type 1, Israel, 2013

L M Shulman (lester.shulman@sheba.health.gov.il)[1,2,3], E Gavrilin[3,4], J Jorba[3,5], J Martin[3,6], C C Burns[3,5], Y Manor[1], J Moran-Gilad[7,8], D Sofer[1], M Y Hindiyeh[1], R Gamzu[2,7], E Mendelson[1,2], I Grotto[7,9], for the Genotype - Phenotype Identification (GPI) group[10]

1. Public Health Services, Israel Ministry of Health, Central Virology Laboratory (CVL), Sheba Medical Center, Tel Hashomer, Israel
2. School of Public Health, Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel
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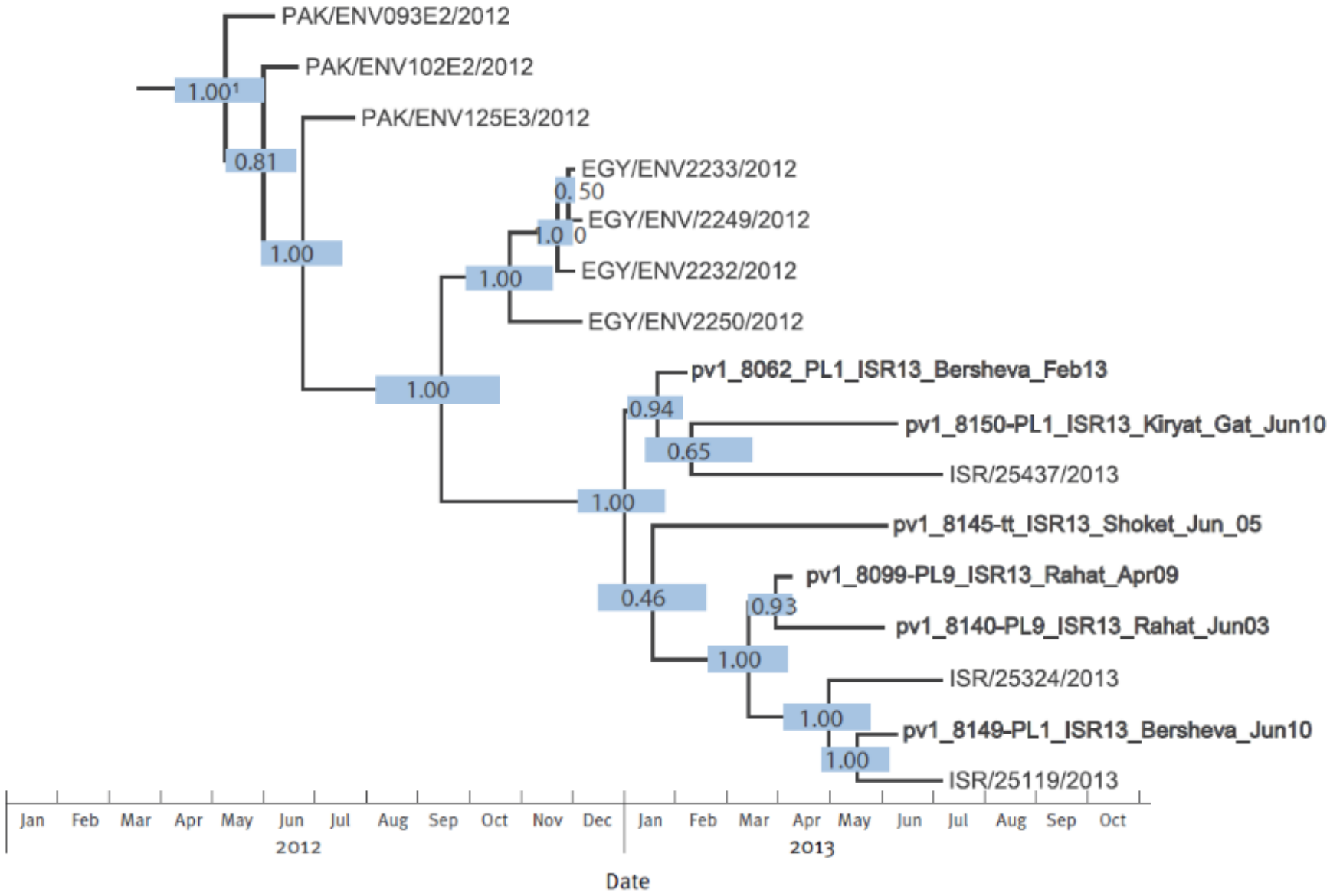
6. Division of Virology, National Institute for Biological Standards and Control, South Mimms, Potters Bar, United Kingdom
7. Israel Ministry of Health, Jerusalem, Israel
8. European Society of Clinical Microbiology and Infectious Diseases ESCMID Study Group for Molecular Diagnostics (ESGMD)
9. Department of Public Health, Faculty of Health Sciences, Ben Gurion University of the Negev, Beer Sheva, Israel
10. Members of the group are listed at the end of the article

Between February and July 2013 type 1 wild poliovirus (WPV1) was detected persistently in 10 and intermittently in 8 of 47 environmental surveillance sites in southern and central Israel and in 30 stool samples collected during July from healthy individuals in southern Israel.

Détection de poliovirus en Israël en 2013 : cela rappelle que le vaccin injectable protège contre la maladie, pas contre l'infection

FIGURE 1

Bayesian phylogenetic tree of P1 capsid sequences (2,634 nt) from WPV1-SOAS environmental samples from Pakistan (2012), Egypt (December 2013) and Israel (February to July, 2013)



Personal View

The Israeli public health response to wild poliovirus importation

Ehud Kaliner, Eran Kopel*, Emilia Anis, Ella Mendelson, Jacob Moran-Gilad, Lester M Shulman, Shepherd R Singer, Yossi Manor, Eli Somekh, Shmuel Rishpon, Alex Leventhal, Lisa Rubin, Diana Tasher, Mira Honovich, Larisa Moerman, Tamy Shohat, Ravit Bassal, Danit Sofer, Michael Gdalevich, Boaz Lev, Ronni Gamzu, Itamar Grotto*

Lancet Infect Dis 2015

Published Online
July 24, 2015
http://dx.doi.org/10.1016/
S1473-3099(15)00064-X

Cette haute circulation de poliovirus faisait courir un risque de poliomyélite aux non-vaccinés, et Israël a alors lancé une campagne de vaccination par le vaccin oral : il empêche la maladie, mais également l'infection, et donc limite la circulation du virus dans la population (si on est infecté, on excrète, même si on est asymptomatique …)

(Prof T Shohat, R Bassal); **and South District Health Office, Ministry of Health, Beer-Sheva, Israel**
(M Gdalevich)

Correspondence to:
Dr Eran Kopel, Public Health Services, Ministry of Health, Jerusalem 9101002, Israel
eran.kopel@mail.huji.ac.il

See Online for appendix

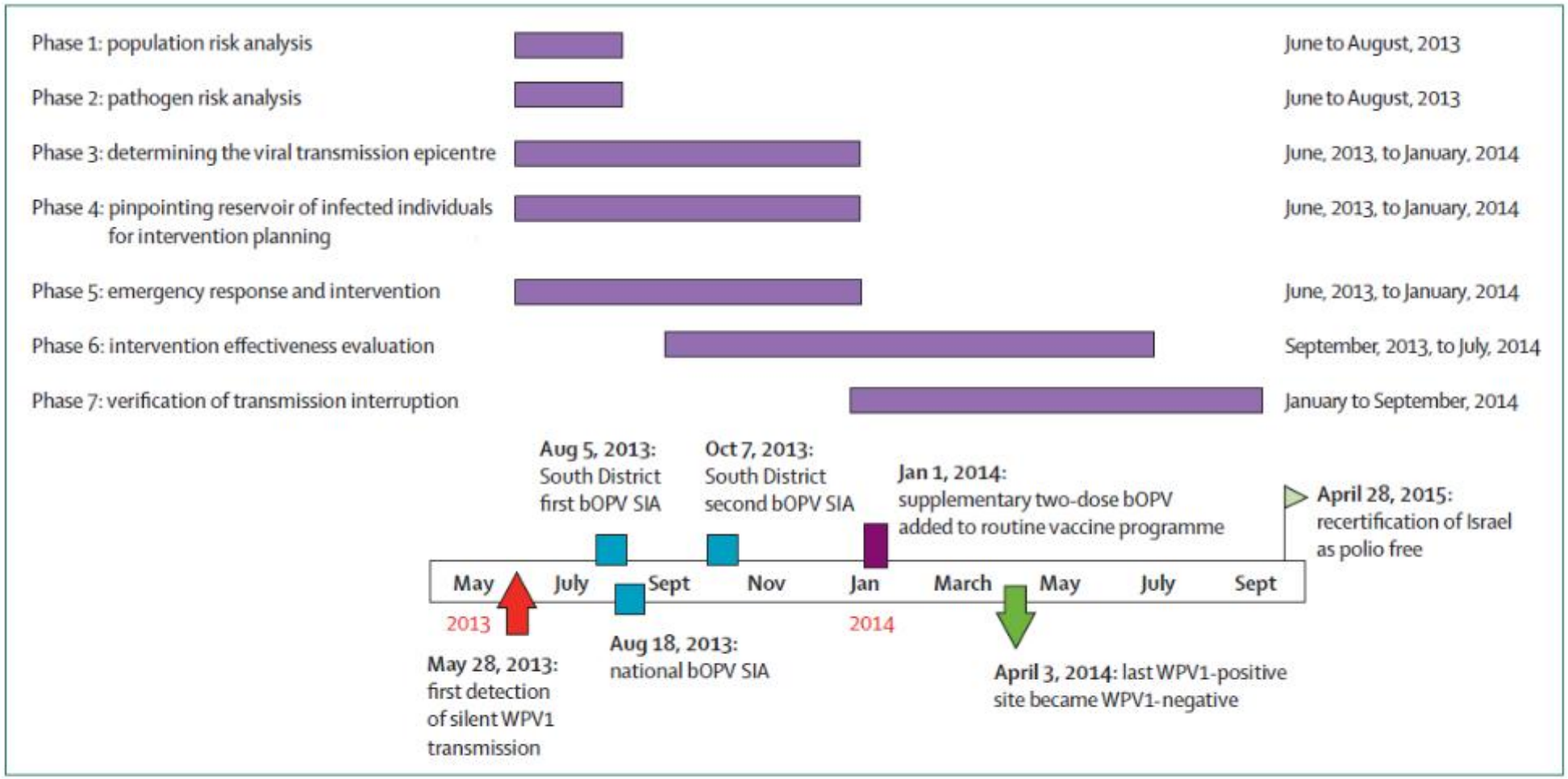


***Figure 1*: Timeline of key junctions, phases of evidence-based activities, and related public health decisions during the importation event of wild poliovirus type 1 to Israel, 2013–15**
bOPV=bivalent oral polio vaccine. SIA=supplementary immunisation activity. WPV1=wild poliovirus type 1.

Vaccination of 943 587 children younger than 10 years (79% of the eligible target population)

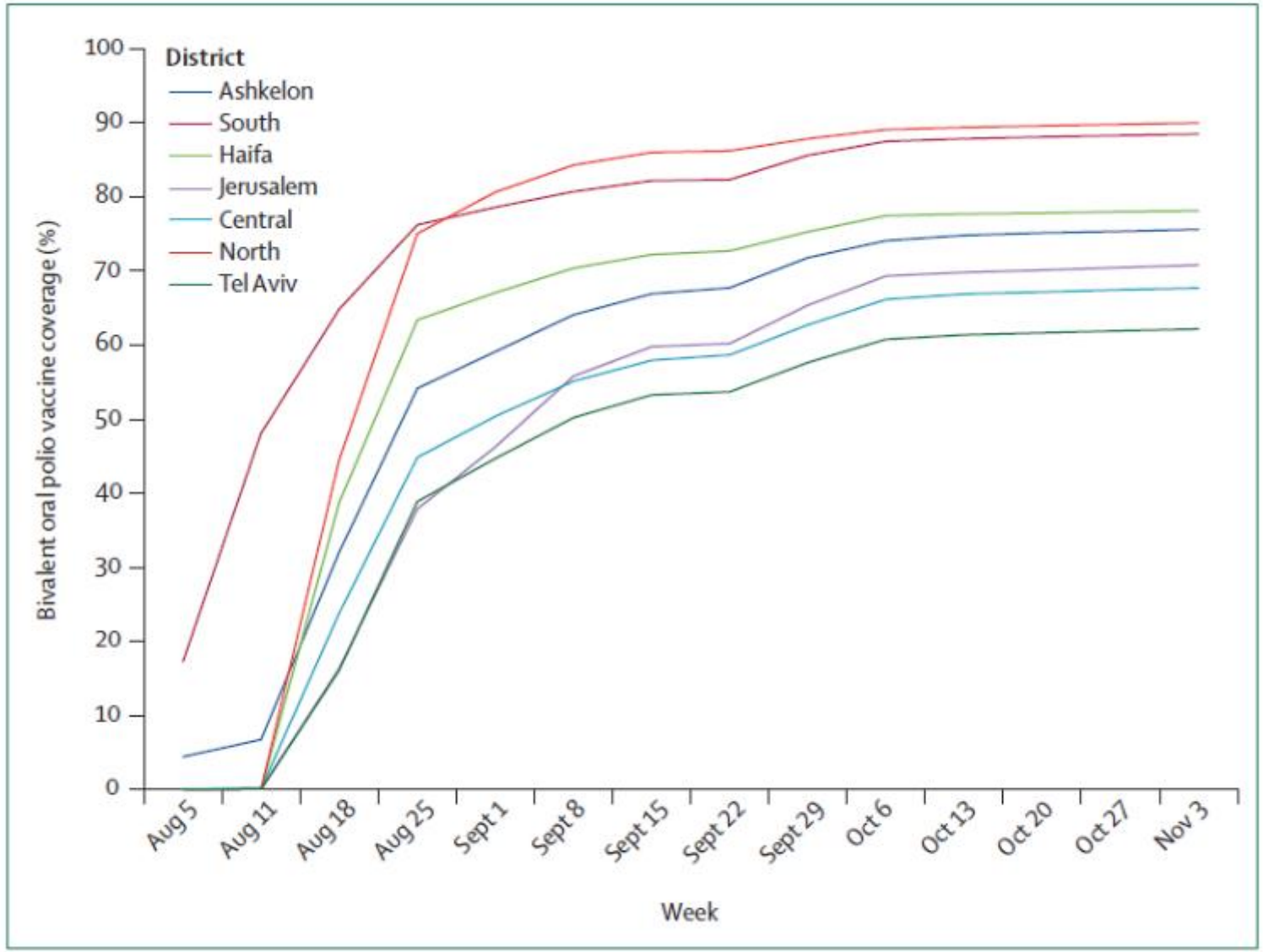


Figure 3: Vaccination coverage with bivalent oral polio vaccine during the supplementary immunisation activity in 2013, by district

RAPID COMMUNICATION

Emergence of genetically linked vaccine-originated poliovirus type 2 in the absence of oral polio vaccine, Jerusalem, April to July 2022

Neta S Zuckerman[1,*] , Itay Bar-Or[1,*] , Danit Sofer[1] , Efrat Bucris[1] , Hagar Morad[1] , Lester M Shulman[1] , Nofar Levi[1] , Leah Weiss[1] , Irina Aguvaev[1] , Zvi Cohen[1] , Klil Kestin[1] , Rinat Vasserman[1] , Michal Elul[1] , Ilana S Fratty[1,3] , Miranda Geva[1] , Marina Wax[1] , Oran Erster[1] , Ruth Yishai[4] , Lior Hecht-Sagie[5] , Sharon Alroy-Preis[5] , Ella Mendelson[1,2,] , Merav Weil[1,**]**

1. Central Virology Laboratory, Public Health Services, Ministry of Health, Chaim Sheba Medical Center, Ramat Gan, Israel
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3. The Israel Center for Disease Control, Israel Ministry of Health, Ramat-Gan, Israel
4. Department of Laboratories, Public Health Services, Ministry of Health, Jerusalem, Israel
5. Public Health Services, Ministry of Health, Jerusalem, Israel

* These authors contributed equally to this work and share first authorship
** These authors contributed equally to this work and share last authorship

Correspondence: Neta S. Zuckerman (neta.zuckerman@sheba.health.gov.il)

Israël a également été confronté en 2022 à une circulation de poliovirus dérivé du vaccin (par recombinaison avec des entérovirus environnementaux, cf diapos précédentes)

A. Poliovirus type 2 - positive sampling sites

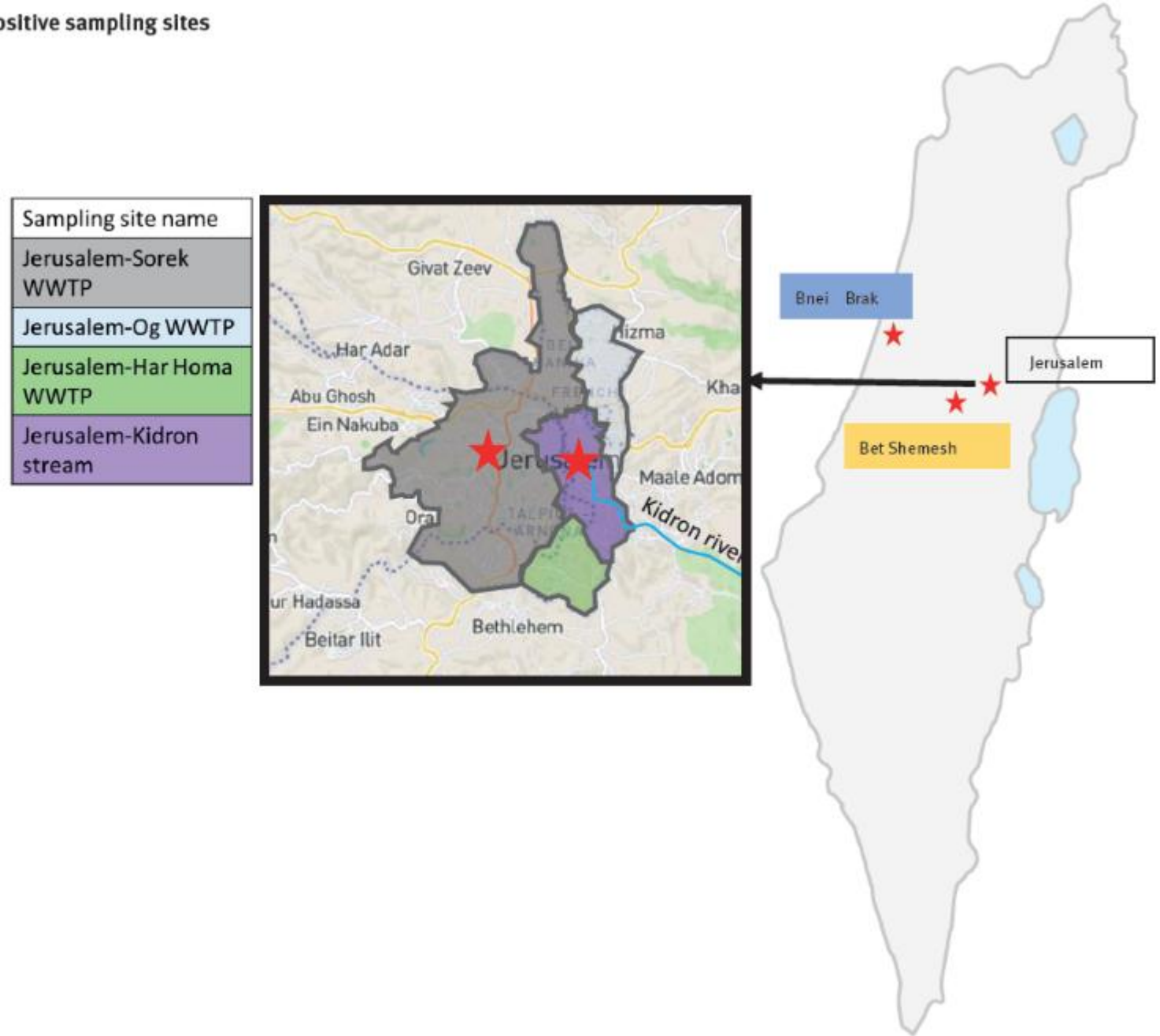
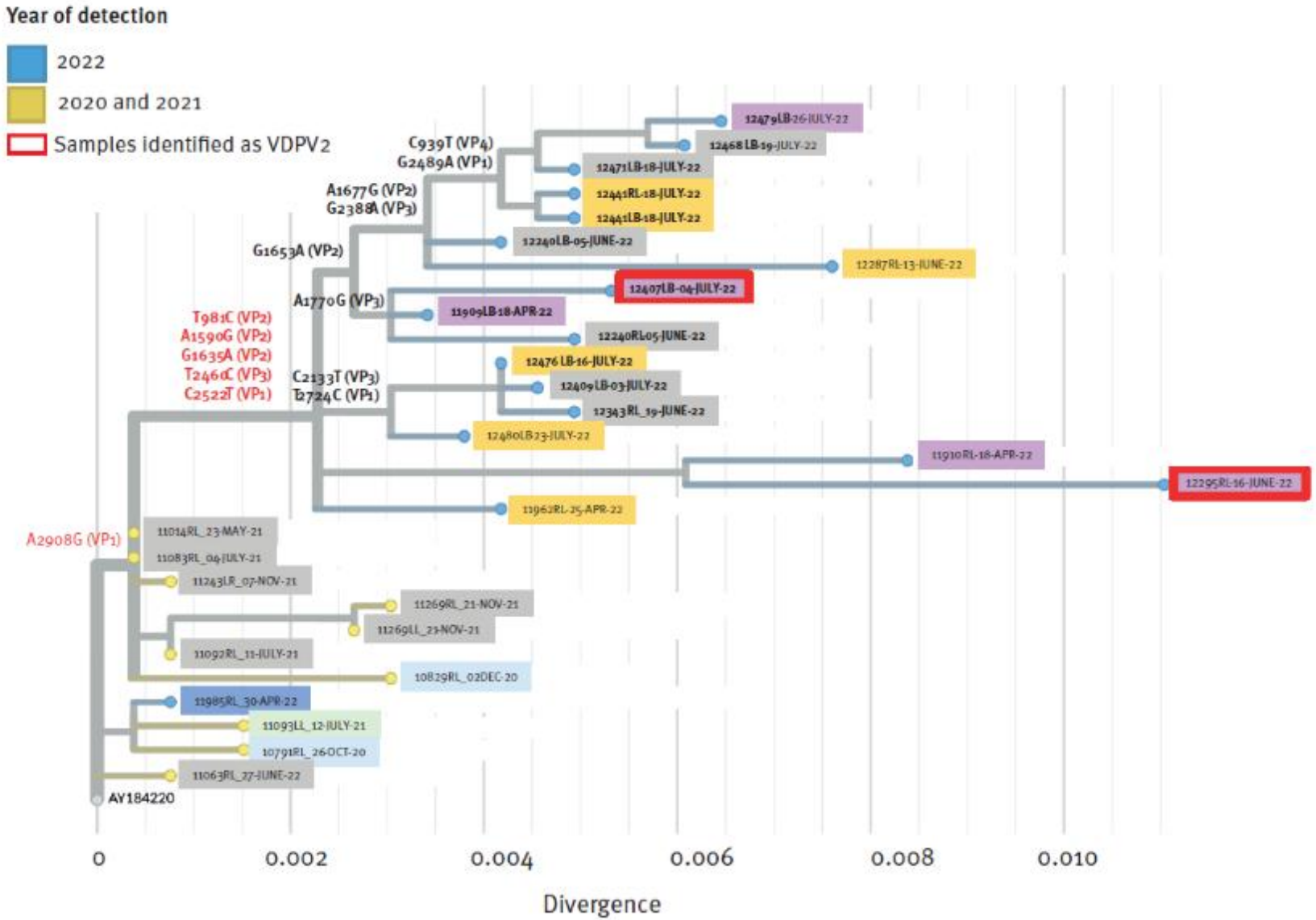


FIGURE 3

Phylogenetic analysis of the P1 region of polioviruses wastewater isolates, Israel, 2020–2022 (n = 28)



Morbidity and Mortality Weekly Report

Public Health Response to a Case of Paralytic Poliomyelitis in an Unvaccinated Person and Detection of Poliovirus in Wastewater — New York, June–August 2022

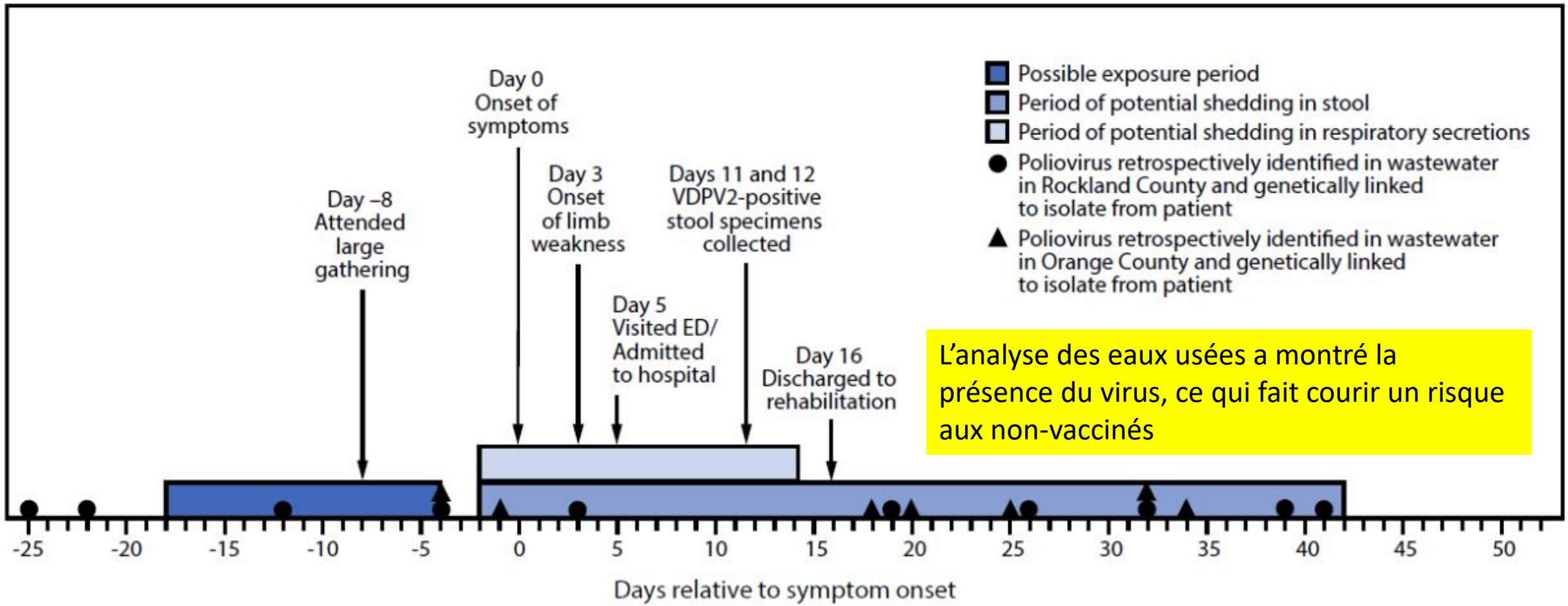
Ruth Link-Gelles, PhD[1]; Emily Lutterloh, MD[2,3]; Patricia Schnabel Ruppert, DO[4]; P. Bryon Backenson, MS[2,3]; Kirsten St. George, PhD[5,6]; Eli S. Rosenberg, PhD[2,3]; Bridget J. Anderson, PhD[2]; Meghan Fuschino, MS[5]; Michael Popowich[5]; Chitra Punjabi, MD[4]; Maria Souto, MPH[4]; Kevin McKay, MPH[4]; Samuel Rulli[4]; Tabassum Insaf, PhD[2]; Dustin Hill, PhD[7]; Jessica Kumar, DO[2]; Irina Gelman, DPM[8]; Jaume Jorba, PhD[1]; Terry Fei Fan Ng, PhD[1]; Nancy Gerloff, PhD[1]; Nina B. Masters, PhD[1]; Adriana Lopez, MHS[1]; Kathleen Dooling, MD[1]; Shannon Stokley, DrPH[1]; Sarah Kidd, MD[1]; M. Steven Oberste, PhD[1]; Janell Routh, MD[1]; 2022 U.S. Poliovirus Response Team

New York a également été confronté en 2022 à une circulation de poliovirus dérivé du vaccin, circulation révélée par un cas de poliomyélite paralytique chez une personne non vaccinée

On August 16, 2022, this report was posted as an MMWR *Early Release on the* MMWR *website (https://www.cdc.gov/mmwr).*

On July 18, 2022, the New York State Department of Health (NYSDOH) notified CDC of detection of poliovirus type 2 in stool specimens from an unvaccinated immunocompetent young adult from Rockland County, New York, who was experiencing acute flaccid weakness. The patient initially experienced fever, neck stiffness, gastrointestinal symptoms, and limb weakness. The patient was hospitalized with possible acute flaccid myelitis (AFM). Vaccine-derived poliovirus type 2 (VDPV2) was detected in stool specimens obtained on days 11 and 12 after initial symptom onset. To date, related Sabin-like type 2 polioviruses have been detected in wastewater* in the patient's county of residence and in neighboring Orange County up to 25 days before (from samples originally collected for SARS-CoV-2 wastewater monitoring) and 41 days after the patient's symptom onset. The last U.S. case of polio caused by wild poliovirus occurred in 1979, and the World Health Organization Region of the Americas was declared polio-free in 1994.

FIGURE. Timeline of patient activities, potential poliovirus exposures, shedding, and poliovirus-positive wastewater* samples† genetically linked to a patient with a case of type 2 vaccine-derived poliovirus — New York, May–August 2022



L'analyse des eaux usées a montré la présence du virus, ce qui fait courir un risque aux non-vaccinés

Abbreviations: ED = emergency department; VDPV2 = type 2 vaccine-derived poliovirus.

* Wastewater, also referred to as sewage, includes water from household or building use (e.g., toilets, showers, and sinks) that can contain human fecal waste and water from non-household sources (e.g., rain and industrial use).

† More than one positive wastewater sample might have been collected on the same day in Rockland County or Orange County.

According to the New York State Immunization Information System, 3-dose polio vaccination coverage among infants and children aged <24 months living in Rockland County was 67.0% in July 2020 and declined to 60.3% by August 2022, with zip code–specific coverage as low as 37.3%.[§§] National coverage for IPV by age 24 months was 92.7% among infants born during 2017–2018 (5). The Rockland County Department of Health launched a countywide catch-up vaccination effort on July 22, 2022. Although there was a brief increase in administration of polio-containing vaccines (IPV alone and combination vaccines including IPV), the number of doses administered at temporary and established clinics was not sufficient to meaningfully increase population IPV coverage levels.

Morbidity and Mortality Weekly Report

Wastewater Testing and Detection of Poliovirus Type 2 Genetically Linked to Virus Isolated from a Paralytic Polio Case — New York, March 9–October 11, 2022

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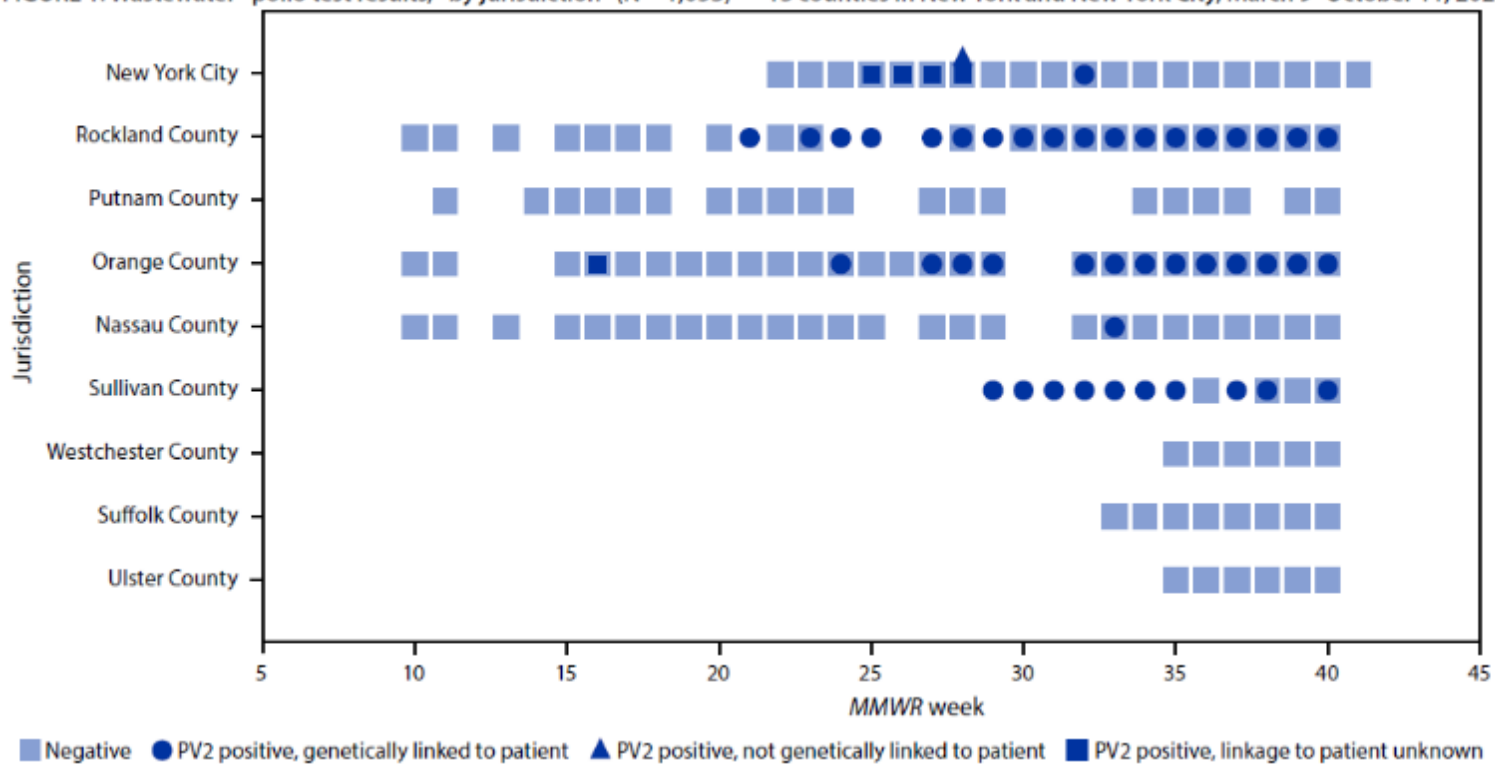
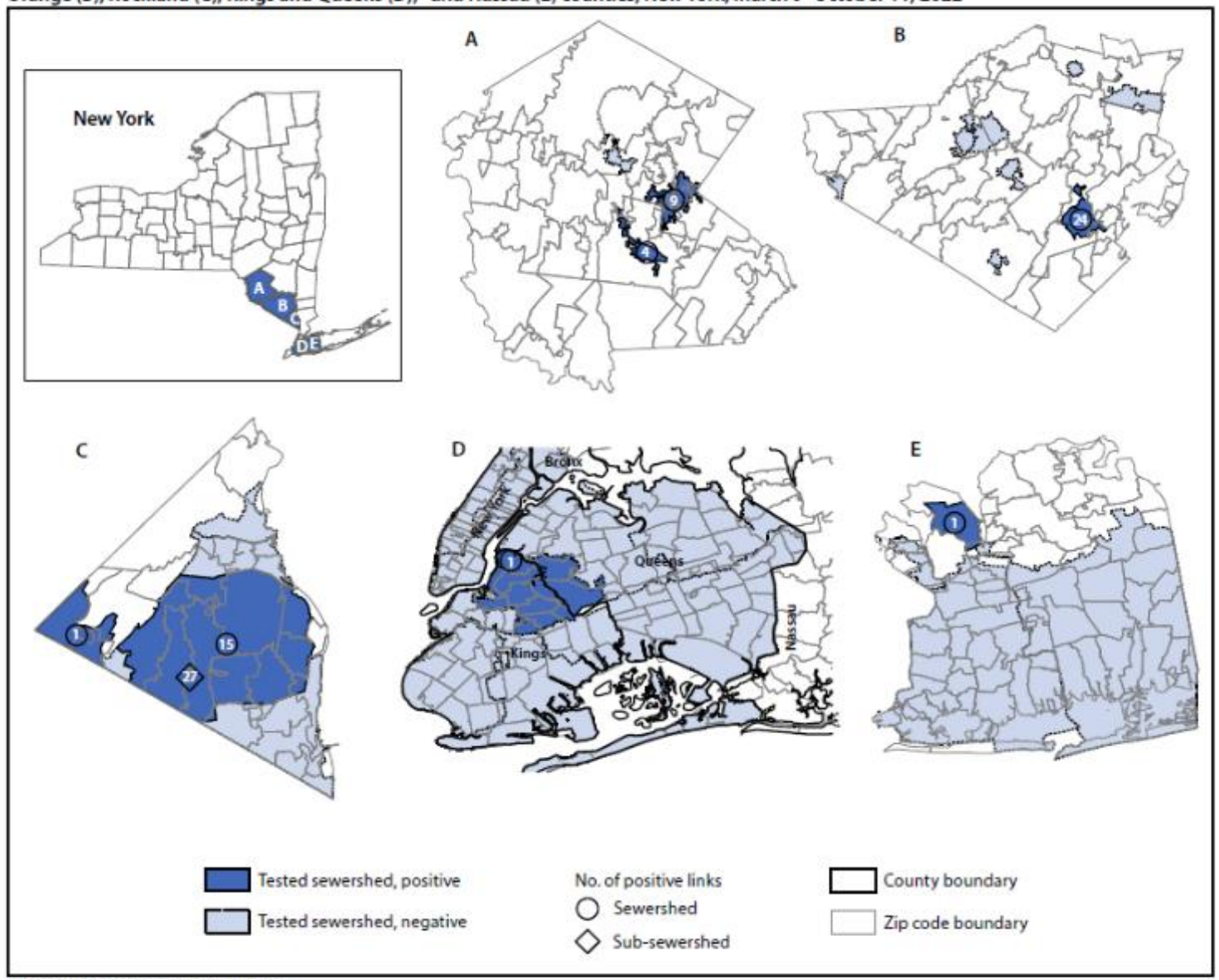
FIGURE 1. Wastewater* polio test results,† by jurisdiction§ (N = 1,053) — 13 counties in New York and New York City, March 9–October 11, 2022



L'analyse des eaux usées a montré que de nombreux bassins de populations voyaient circuler le virus

FIGURE 2. Sewersheds* with detections of poliovirus type 2 genetically linked to the virus isolated from a paralytic polio patient† — Sullivan (A), Orange (B), Rockland (C), Kings and Queens (D),§ and Nassau (E) counties, New York, March 9–October 11, 2022



Abbreviation: PV2 = poliovirus type 2.

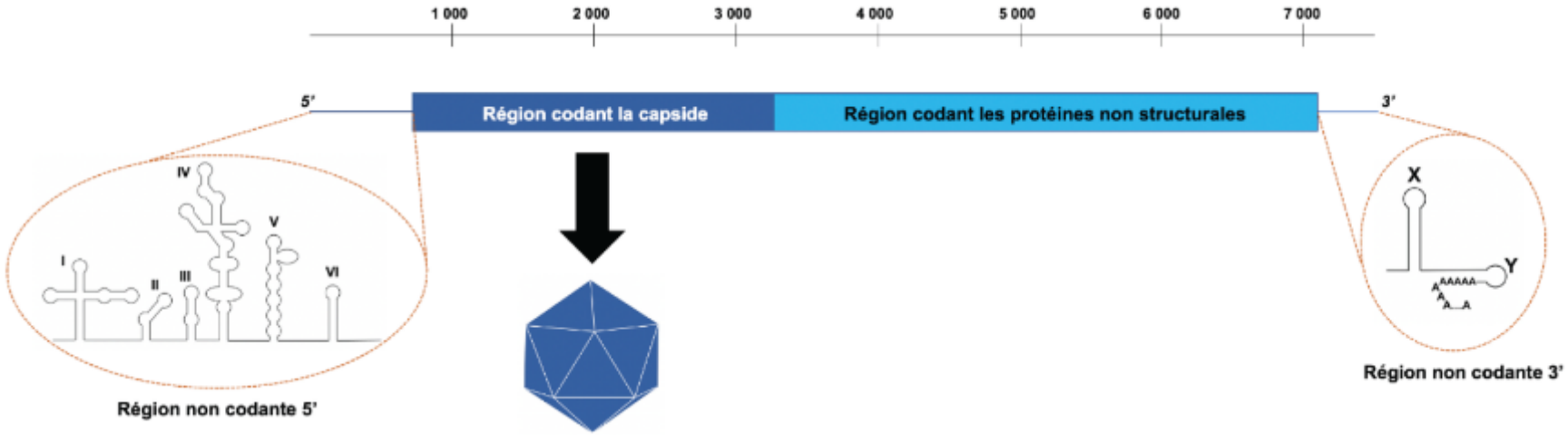
* Sampling sites are sewersheds defined as the community area served by a wastewater collection system. Sub-sewersheds are upstream sampling locations within a larger sewershed.

† In July 2022, paralytic poliomyelitis resulting from infection with vaccine-derived PV2 was confirmed in an unvaccinated adult resident of Rockland County, New York.

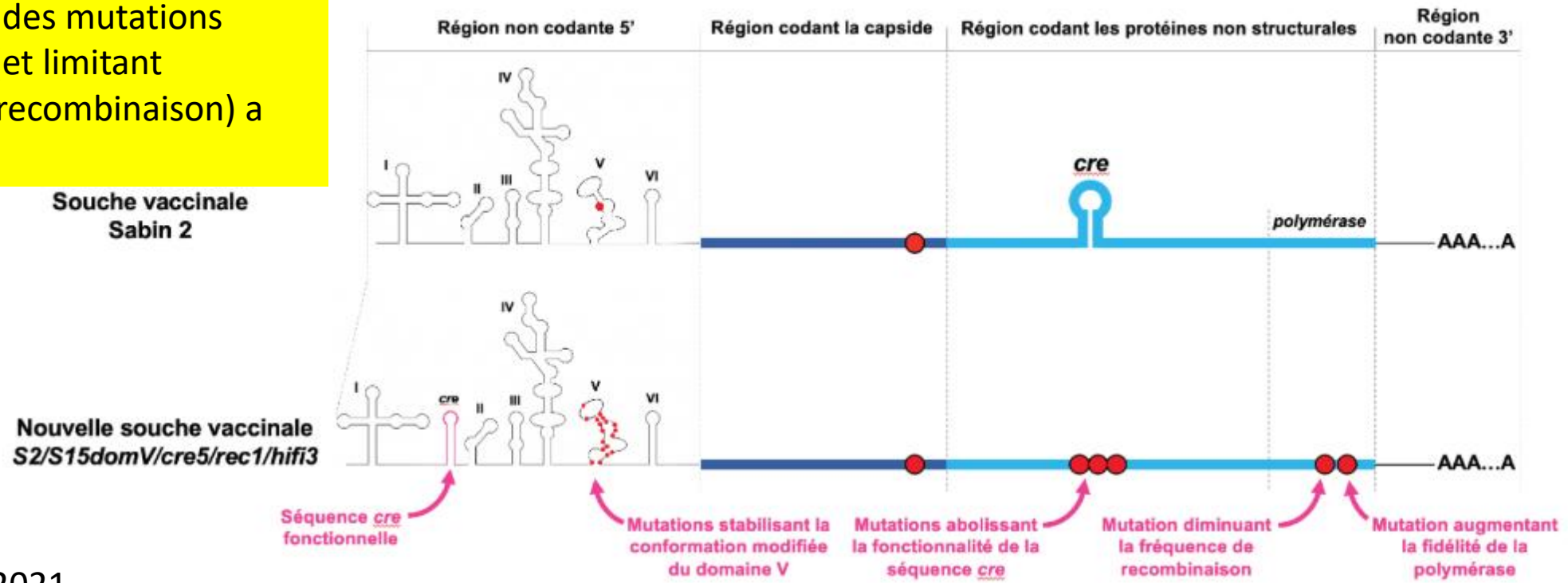
§ A single large-volume sample from a sub-sewershed serving parts of Kings and Queens counties tested positive for the PV2 genetically linked to the virus isolated from the patient.

Un nouveau vaccin atténué

Souche sauvage



Pour prévenir toute recombinaison, une souche atténuée par des mutations irréversibles (et limitant justement la recombinaison) a été élaborée

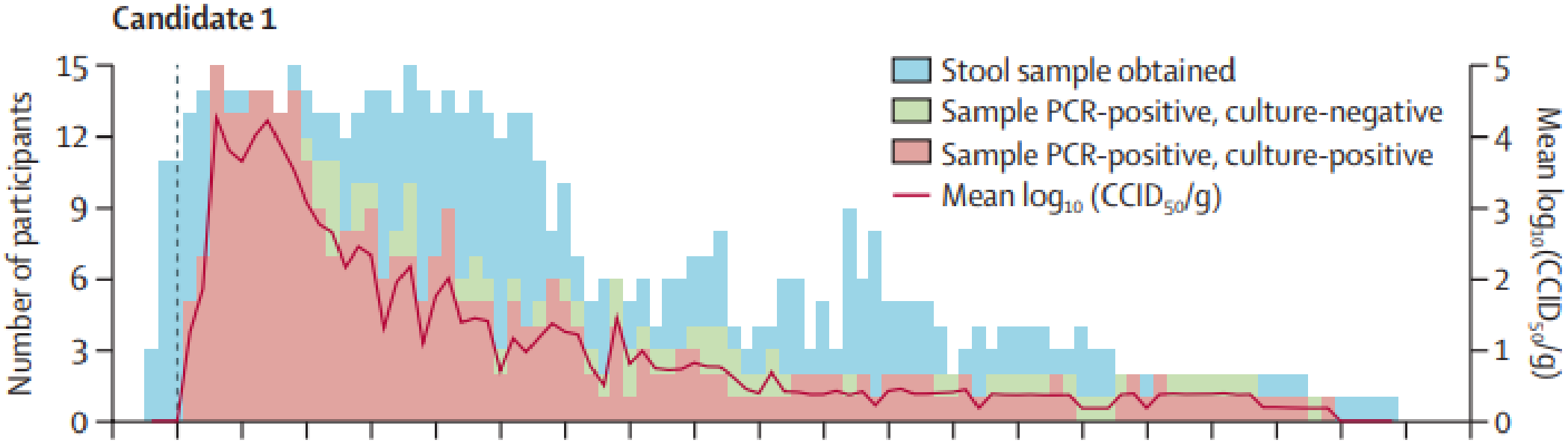


Bessaud 2021

2019

The safety and immunogenicity of two novel live attenuated monovalent (serotype 2) oral poliovirus vaccines in healthy adults: a double-blind, single-centre phase 1 study

Pierre Van Damme, Ilse De Coster*, Ananda S Bandyopadhyay, Hilde Revets, Kanchanamala Withanage, Philippe De Smedt, Leen Suykens, M Steven Oberste, William C Weldon, Sue Ann Costa-Clemens, Ralf Clemens, John Modlin, Amy J Weiner, Andrew J Macadam, Raul Andino, Olen M Kew, Jennifer L Konopka-Anstadt, Cara C Burns, John Konz, Rahnuma Wahid, Christopher Gast*



	Candidate 1 (n=15)	Candidate 2 (n=15)
Geometric mean titre (95% CI)		
Day 0	93·3 (55·3–170·0)	52·8 (25·2–123·1)
Day 28	680·9 (367·8–1098)	575·0 (330·1–871·9)
Geometric mean fold change in titre (95% CI)		
Day 28	7·3 (3·8–13·5)	10·9 (4·5–24·6)
Median titre (IQR; Q1–Q3), (95% CI)		
Day 0	56·9 (40·6–147·4; 106·7), (36·0–181·0)	36·0 (22·6–81·3; 58·6), (22·6–90·5)
Day 28	1152 (650–1448; 798), (576·0–1448)	724·1 (408·6–1152·1; 743·5), (362·0–1152)
Median fold change in titre (IQR; Q1–Q3), (95% CI)		
Day 28	8·00 (2·6–22·8; 20·2), (2·00–20·1)	12·73 (4·1–38·2; 34·1), (3·18–25·5)
Seroprotection, n (%), 95% CI		
Day 0	15 (100%), 78·2–100	14 (93%), 68·1–99·8
Day 28	15 (100%), 78·2–100	15 (100%), 78·2–100
Seroconversion, n (%), 95% CI		
Day 28*	10 (83%), 51·6–97·9	11 (85%), 54·6–98·1

95% CIs were calculated with the Clopper-Pearson method. *Three participants given candidate 1 and two participants given candidate 2 had baseline titres close to the upper limit of quantitation so it was not possible to measure a 4-fold increase.

Table 5: **Immune responses as poliovirus type-2 neutralising antibody titres in the total study population**

Ce nouveau vaccin atténué a une immunogénicité satisfaisante

PLOS GLOBAL PUBLIC HEALTH

Cette nouvelle souche de vaccin atténuée est maintenant largement utilisée, et devrait empêcher à l'avenir l'émergence de souches pathogènes résultant de la recombinaison des « vieux » vaccins atténués

OPINION

One billion doses and WHO prequalification of nOPV2: Implications for the global polio situation and beyond

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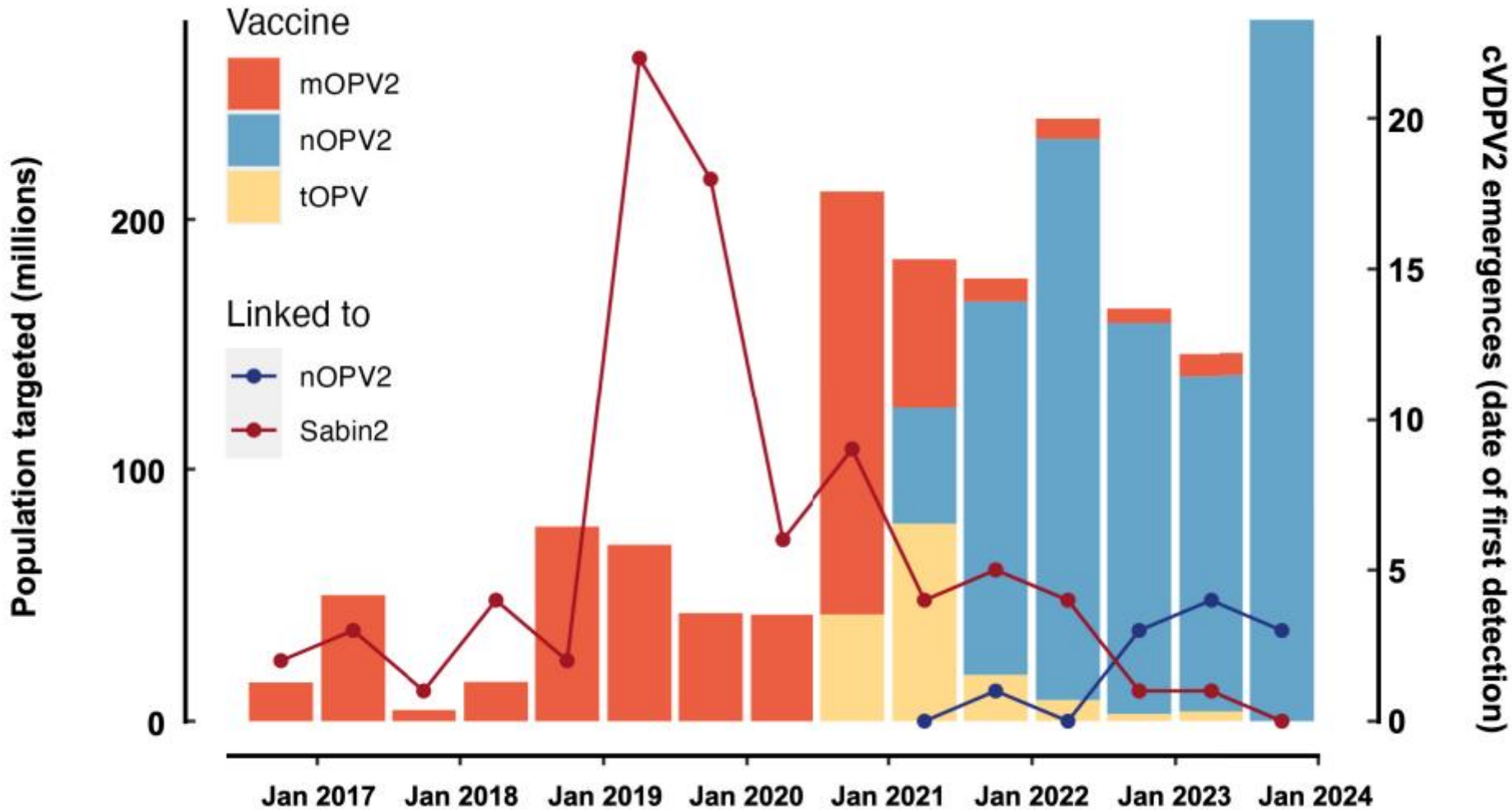

Fig 1. Use of type 2-containing OPV in campaigns linked to emergence of cVDPV linked to Sabin OPV (red line) and nOPV2 (blue line) by six-month periods since the global cessation of the routine use of type 2 OPV, from July 1, 2016 to December 31, 2023 (WHO data on file).

Article https://doi.org/10.1038/s41564-025-02219-w

Higher stability of novel live-attenuated oral poliovirus type 2 (nOPV2) despite the emergence of a neurovirulent double recombinant strain in Uganda

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Vigilance cependant : des souches résultant de recombinaison de ce nouveau vaccin atténué et possédant une neurovirulence en modèle animal ont été isolées en Ouganda après des campagnes de vaccination …

Table 3 | Neurovirulence of the double recombinant nOPV2 strain from Kabarole in transgenic mice compared with type 2 vaccine, revertant and wild-type poliovirus strains

Virus strain	PD_{50} (log_{10})
nOPV2 (vaccine strain)	>8.4
Sabin 2 (vaccine strain)	5.8 (5.1–6.4)
S2/481G (Sabin 2 revertant strain)	1.8 (1.4–2.2)
ENV-UGA-KAB-KAB-KIS-22-004 (Kabarole double recombinant strain)	1.1 (0.6–1.6)
MEF-1 (wild-type 2 strain)	0.7 (0.2–1.2)

Transgenic mice expressing the poliovirus receptor (minimum $n = 8$ biologically independent mice per dilution) were inoculated intraspinally with stocks of representative poliovirus strains. The PD_{50} was calculated using the Spearman–Karber method. Data are presented as PD_{50} values with 95% CI.