VACCINATION ET ANTIBIORÉSISTANCE

Journées inter-DES sur la vaccination
12 juin 2026

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Chaire Prévention, Vaccination, Contrôle de l'Infection PRESAGE

Liens d’Intérêt

- Membre du groupe prévention vaccination de la SPILF et Ginger
- Membre du Copil du I-REIVAC
- Membre du Global Influenza initiative
- **Investigateur principal** essais vaccins académiques et industriels CIC 1408 Axe vaccinologie-I-REIVAC, Covireivac: Sanofi Pasteur; GSK, MSD, Pfizer, Janssen, Moderna….
- **Advisory Boards**: Pfizer, Moderna, Janssen, Sanofi Pasteur, GSK, MSD….
- Collaboration études précliniques (Sanofi Pasteur, Pfizer)
- **Oratrice** :congrès, journées scientifiques: Sanofi Pasteur; GSK, MSD, Pfizer, Moderna, Quiagen….

- ***Aucune rémunération à titre personnel***

Plan

- Vaccins et antibiorésistance (AMR): rationnel
- Vaccins et antibiorésistance (AMR): données sur les vaccins existants
  - Vaccins antibactériens
  - Vaccins antiviraux
- Vaccins et antibiorésistance (AMR):perspectives

Vaccins et antibiorésistance?

- **Vaccins reconnus depuis longtemps comme une stratégie pour lutter contre ATB**

Goal 1: Slow the Emergence of Resistant Bacteria and Prevent the Spread of Resistant Infections

Goal 2: Strengthen National One Health Surveillance Efforts to Combat Resistance

Goal 3: Advance Development and Use of Rapid and Innovative Diagnostic Tests for Identification and Characterization of Resistant Bacteria

Goal 4: Accelerate Basic and Applied Research and Development for New Antibiotics, Other Therapeutics, and Vaccines

Goal 5: Improve International Collaboration and Capacities for Antibiotic-resistance Prevention, Surveillance, Control and Antibiotic Research and Development.

HM Government

Tackling antimicrobial resistance 2019–2024

The UK's five-year national action plan

Published 24 January 2019

Fig. 1.1. The WHO core package of interventions to manage AMR in human health

Reduced and slower development of AMR
Reduced mortality and morbidity due to AMR

Pillar 1: Prevention	**Pillar 2: Access to essential health services**	**Pillar 3: Timely, accurate diagnosis**	**Pillar 4: Appropriate, qualityassured treatment**
6. Universal access to WASH and waste management to mitigate AMR **7.** Implementation of IPC components to mitigate AMR **8.** Access to vaccines and expanded immunization to manage AMR	**9.** AMR diagnosis and management health services are affordable for all **10.** Uninterrupted supply of quality-assured, essential antimicrobials and health products for AMR	**11.** Good-quality laboratory system and diagnostic stewardship to ensure clinical bacteriology and mycology testing	**12.** Up-to-date evidence-based treatment guidelines and programmes for antimicrobial stewardship **13.** Regulation to restrict sales of non-prescription antimicrobials

Foundational step: Strategic information through surveillance and research

3. National AMR surveillance network to generate good-quality data for patient care and action on AMR

4. Surveillance of antimicrobial consumption and use to guide patient care and action on AMR

5. AMR research and innovation including behavioural and implementation science

Foundational step: Effective governance, awareness and education

1. AMR advocacy, governance and accountability in the human health sector, in collaboration with other sectors

2. AMR awareness-raising, education and behaviour change of health workers and communities

AMR: antimicrobial resistance; IPC: infection prevention and control; WASH: water, sanitation and hygiene; WHO: World Health Organization.

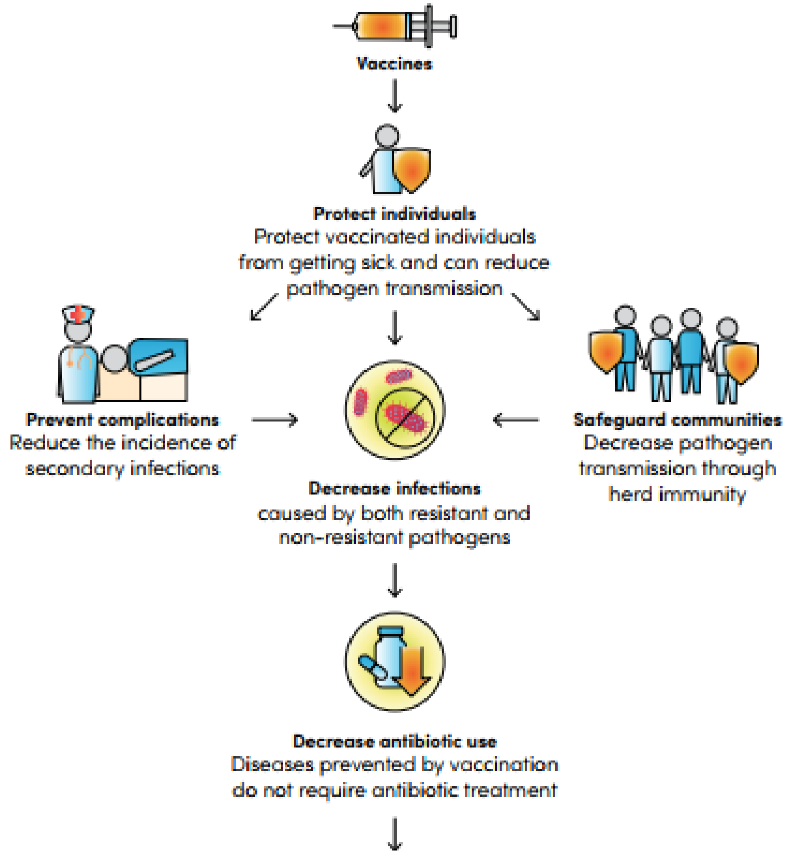
Source: Reproduced with permission from WHO, 2023 *(7)*.

https://www.who.int/publications/i/item/9789240098787
https://aspe.hhs.gov/sites/default/files/migrated_legacy_files//196436/CARB-National-Action-Plan-2020-2025.pdf

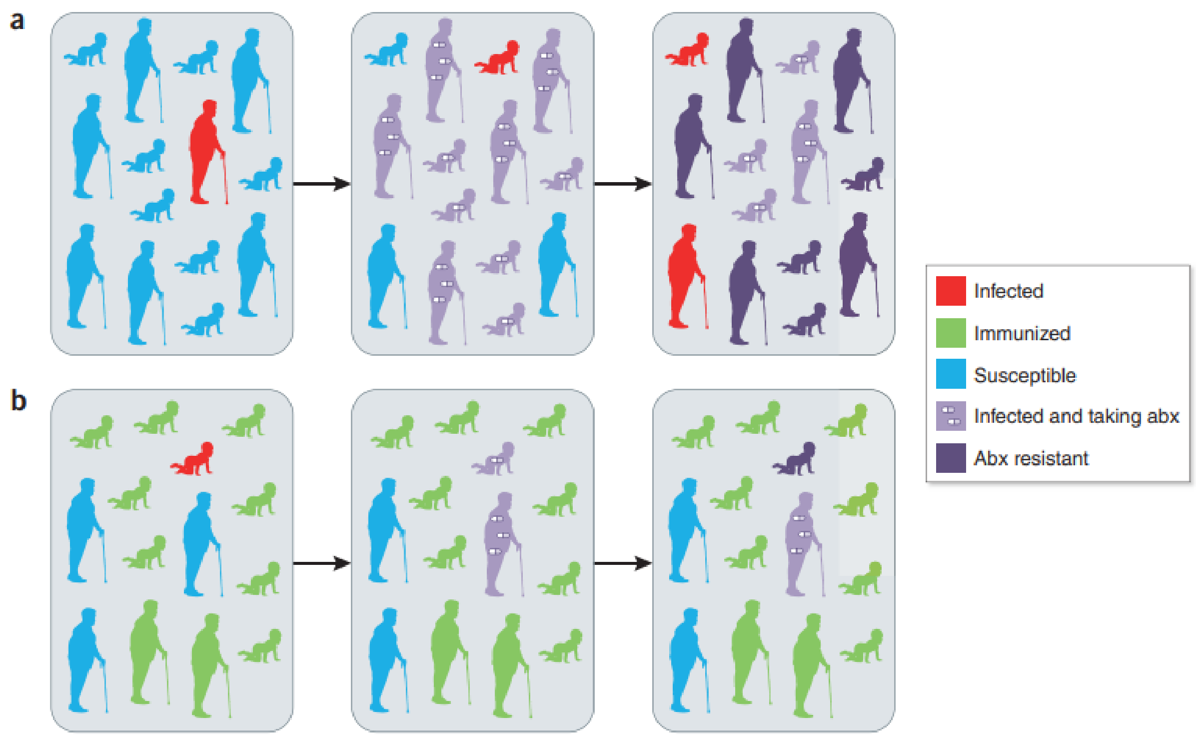
Vaccins et antibiorésistance?

- Double impact des vaccins pour diminuer l'antibiorésistance:
  - ***Impact DIRECT***: réduction des infections bactériennes et donc de la consommation d'ATB
  - ***Impact DIRECT'*:** réductions des infections virales et donc diminution de la consommation d'ATB utilisés du fait des surinfections bactériennes mais aussi du fait d'un mésusage d'ATB en cas d'Infection virale
  - ***Impact INDIRECT***: rôle de l'immunité de groupe, diminution de la transmission d'infections dont BMR

Fig. 1.2. Impact of vaccines on AMR in humans: a schematic pathway



https://www.who.int/publications/i/item/9789240098787



ATB donnés à raison: infection ou surinfection bactérienne
ATB donnés à tort+++

DOI: [10.1038/s41579-020-00506-3](https://doi.org/10.1038/s41579-020-00506-3)

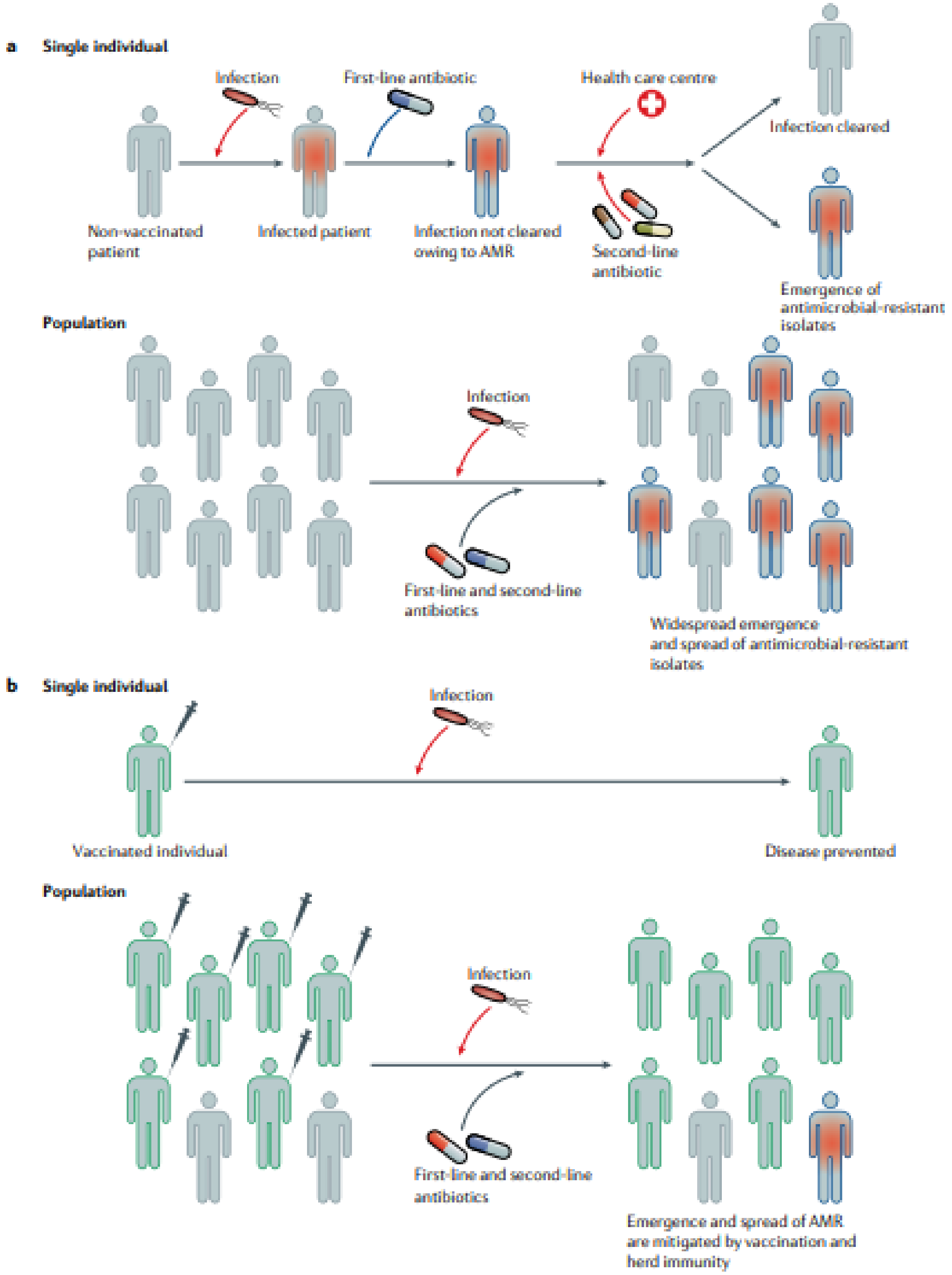


Fig. 1 | **Effects of vaccines on antimicrobial resistance. a** | Antimicrobial-resistant bacterial pathogens can cause serious,

Changing Priorities in Vaccinology: Antibiotic Resistance Moving to the Top

Aldo Tagliabue[1] and Rino Rappuoli[2]*

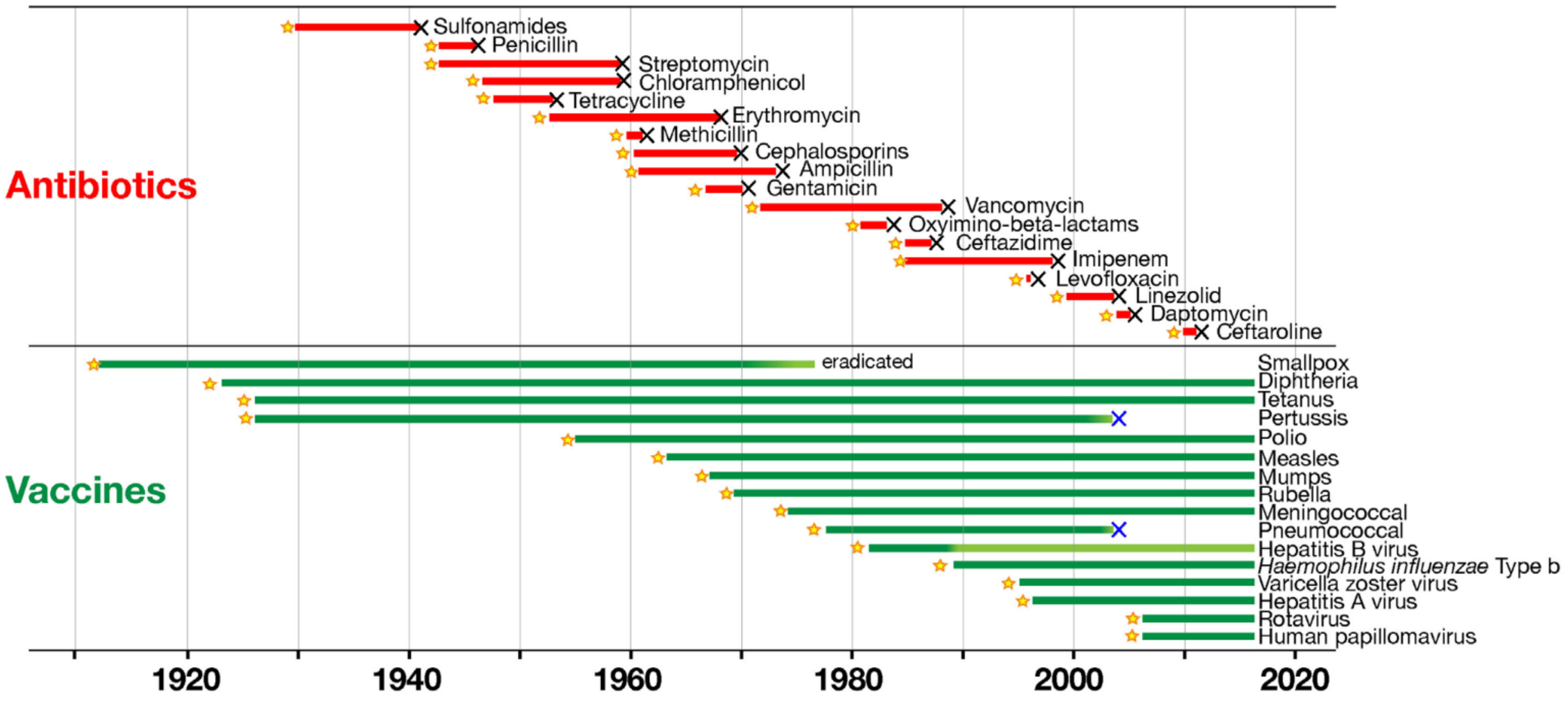
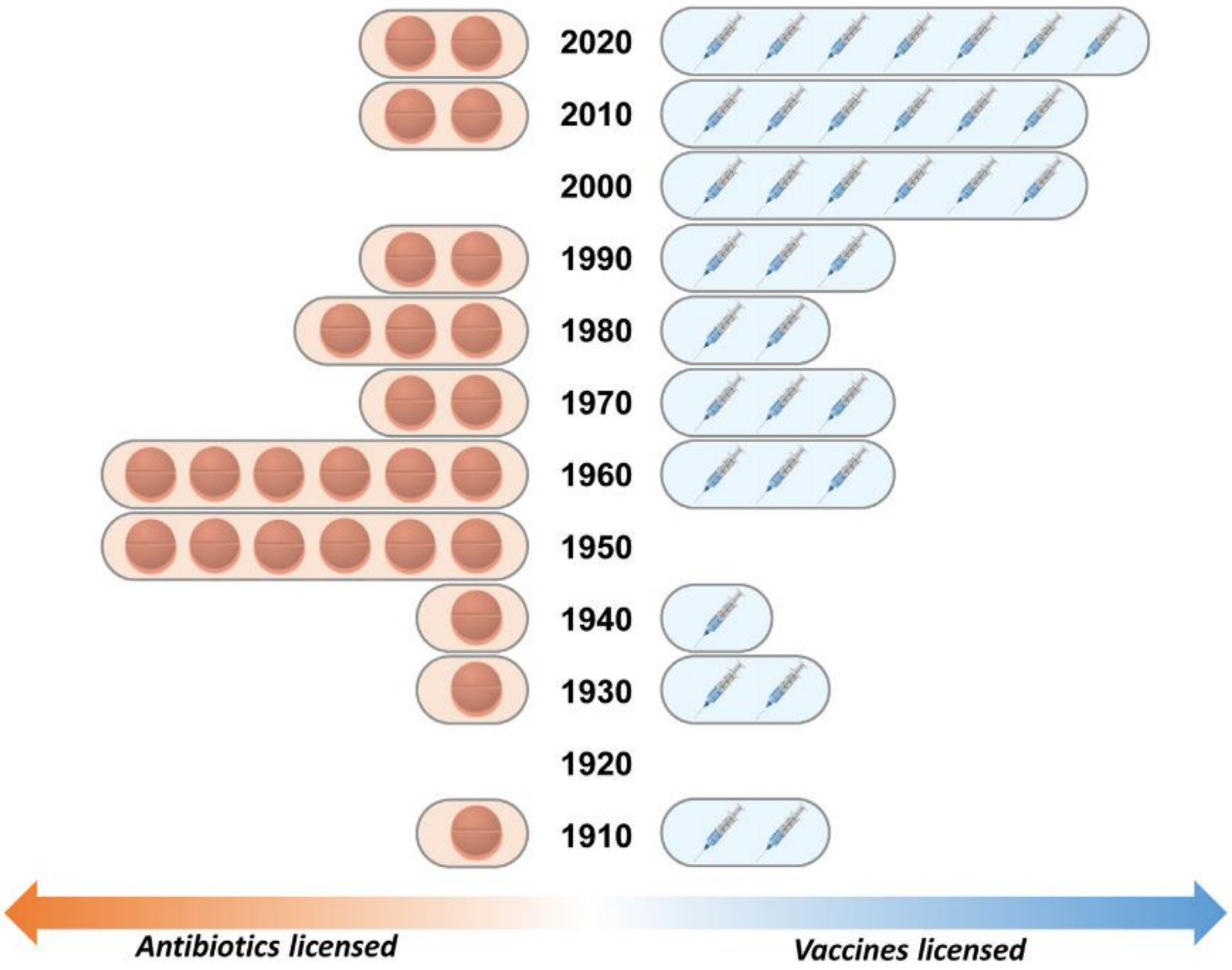


FIGURE 1 | Time to detection of resistance of human pathogens to antimicrobials (in red) and to vaccines (in green). Black X symbols indicate insurgence of resistance, with lines starting at product introduction (yellow stars; except for smallpox vaccination that began much earlier; with modifications from Ref. (14)

10.3389/fimmu.2018.01068

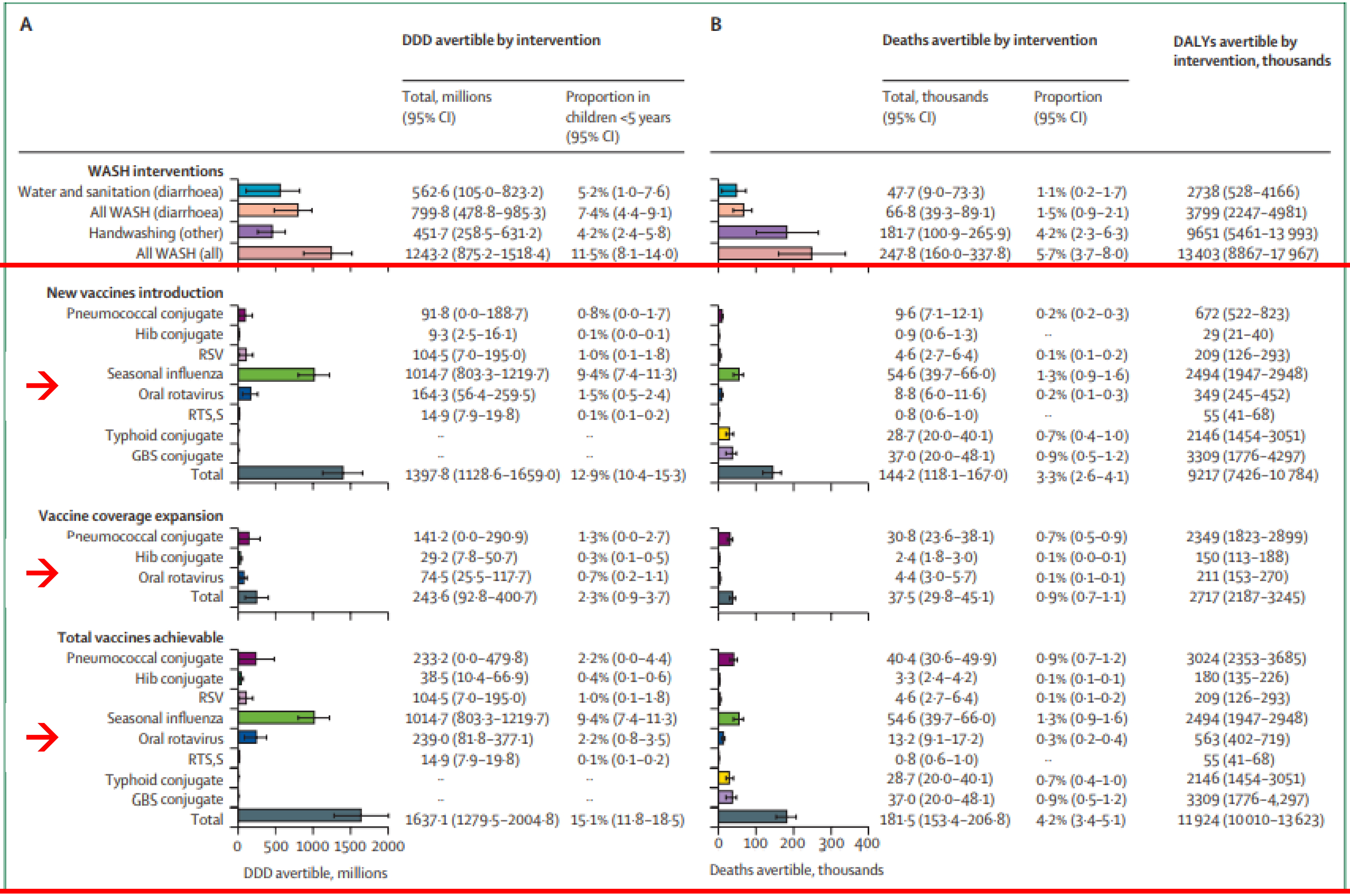


https://doi.org/10.1016/j.ijid.2019.10.005

Vaccins et antibiorésistance

Burden of bacterial antimicrobial resistance in low-income and middle-income countries avertible by existing interventions: an evidence review and modelling analysis

Joseph A Lewnard, Esmita Charani, Alec Gleason, Li Yang Hsu, Wasif Ali Khan, Abhilasha Karkey, Clare I R Chandler, Tapfumanei Mashe, Ejaz Ahmed Khan, Andre N H Bulabula, Pilar Donado-Godoy, Ramanan Laxminarayan



	A: DDD avertible by intervention – Total, millions (95% CI)	A: DDD avertible by intervention – Proportion in children <5 years (95% CI)	B: Deaths avertible by intervention – Total, thousands (95% CI)	B: Deaths avertible by intervention – Proportion (95% CI)	DALYs avertible by intervention, thousands
WASH interventions					
Water and sanitation (diarrhoea)	562·6 (105·0–823·2)	5·2% (1·0–7·6)	47·7 (9·0–73·3)	1·1% (0·2–1·7)	2738 (528–4166)
All WASH (diarrhoea)	799·8 (478·8–985·3)	7·4% (4·4–9·1)	66·8 (39·3–89·1)	1·5% (0·9–2·1)	3799 (2247–4981)
Handwashing (other)	451·7 (258·5–631·2)	4·2% (2·4–5·8)	181·7 (100·9–265·9)	4·2% (2·3–6·3)	9651 (5461–13 993)
All WASH (all)	1243·2 (875·2–1518·4)	11·5% (8·1–14·0)	247·8 (160·0–337·8)	5·7% (3·7–8·0)	13 403 (8867–17 967)
New vaccines introduction					
Pneumococcal conjugate	91·8 (0·0–188·7)	0·8% (0·0–1·7)	9·6 (7·1–12·1)	0·2% (0·2–0·3)	672 (522–823)
Hib conjugate	9·3 (2·5–16·1)	0·1% (0·0–0·1)	0·9 (0·6–1·3)	··	29 (21–40)
RSV	104·5 (7·0–195·0)	1·0% (0·1–1·8)	4·6 (2·7–6·4)	0·1% (0·1–0·2)	209 (126–293)
→ Seasonal influenza	1014·7 (803·3–1219·7)	9·4% (7·4–11·3)	54·6 (39·7–66·0)	1·3% (0·9–1·6)	2494 (1947–2948)
Oral rotavirus	164·3 (56·4–259·5)	1·5% (0·5–2·4)	8·8 (6·0–11·6)	0·2% (0·1–0·3)	349 (245–452)
RTS,S	14·9 (7·9–19·8)	0·1% (0·1–0·2)	0·8 (0·6–1·0)	··	55 (41–68)
Typhoid conjugate	··	··	28·7 (20·0–40·1)	0·7% (0·4–1·0)	2146 (1454–3051)
GBS conjugate	··	··	37·0 (20·0–48·1)	0·9% (0·5–1·2)	3309 (1776–4297)
Total	1397·8 (1128·6–1659·0)	12·9% (10·4–15·3)	144·2 (118·1–167·0)	3·3% (2·6–4·1)	9217 (7426–10 784)
Vaccine coverage expansion					
→ Pneumococcal conjugate	141·2 (0·0–290·9)	1·3% (0·0–2·7)	30·8 (23·6–38·1)	0·7% (0·5–0·9)	2349 (1823–2899)
Hib conjugate	29·2 (7·8–50·7)	0·3% (0·1–0·5)	2·4 (1·8–3·0)	0·1% (0·0–0·1)	150 (113–188)
Oral rotavirus	74·5 (25·5–117·7)	0·7% (0·2–1·1)	4·4 (3·0–5·7)	0·1% (0·1–0·1)	211 (153–270)
Total	243·6 (92·8–400·7)	2·3% (0·9–3·7)	37·5 (29·8–45·1)	0·9% (0·7–1·1)	2717 (2187–3245)
Total vaccines achievable					
Pneumococcal conjugate	233·2 (0·0–479·8)	2·2% (0·0–4·4)	40·4 (30·6–49·9)	0·9% (0·7–1·2)	3024 (2353–3685)
Hib conjugate	38·5 (10·4–66·9)	0·4% (0·1–0·6)	3·3 (2·4–4·2)	0·1% (0·1–0·1)	180 (135–226)
RSV	104·5 (7·0–195·0)	1·0% (0·1–1·8)	4·6 (2·7–6·4)	0·1% (0·1–0·2)	209 (126–293)
→ Seasonal influenza	1014·7 (803·3–1219·7)	9·4% (7·4–11·3)	54·6 (39·7–66·0)	1·3% (0·9–1·6)	2494 (1947–2948)
Oral rotavirus	239·0 (81·8–377·1)	2·2% (0·8–3·5)	13·2 (9·1–17·2)	0·3% (0·2–0·4)	563 (402–719)
RTS,S	14·9 (7·9–19·8)	0·1% (0·1–0·2)	0·8 (0·6–1·0)	··	55 (41–68)
Typhoid conjugate	··	··	28·7 (20·0–40·1)	0·7% (0·4–1·0)	2146 (1454–3051)
GBS conjugate	··	··	37·0 (20·0–48·1)	0·9% (0·5–1·2)	3309 (1776–4,297)
Total	1637·1 (1279·5–2004·8)	15·1% (11·8–18·5)	181·5 (153·4–206·8)	4·2% (3·4–5·1)	11 924 (10 010–13 623)

Figure 4: **Burden of bacterial AMR avertible by direct prevention of acute infections and reduction in antibiotic use through WASH and vaccine interventions**

DOI: 10.1016/S0140-6736(24)00862-6

Vaccins et antibiorésistance

- Passer de la théorie à la pratique+++
  - Seuls 13% (14/108) des plans d'actions nationaux intègre la vaccination comme un élément clé.
  - Même si tous reconnaissent le besoin de prévention et de contrôle des infections

Other recognised priorities in NAPs		
Vaccination as an important measure in preventing infections (included in 14 NAPs)	Vaccination programme strengthening was recognised as an intervention to support efforts tackling AMR; a need for implementing campaigns supporting vaccination uptake; a need for research and development into new vaccines and alternatives	Investigate how to develop a strategy for implementing sustainable vaccination campaigns that target those least likely to be vaccinated; conduct research to investigate how to increase vaccine uptake in health-care worker populations as well as populations with socioeconomic disadvantages

  - Les programmes de lutte contre l'AMR et ceux de vaccination évoluent souvent en silo
  - L'effet des vaccins sur l'AMR est peu surveillé+++
  - Difficulté de financement des programmes de vaccination dans les LMICs
  - Rôle de l'hésitation vaccinale

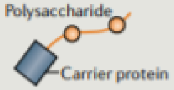
https://doi.org/10.1016/ S2214-109X(23)00019-0
https://www.sabin.org/resources/vaccines-as-a-critical-yet-underutilized-tool-in-the-fight-against-antimicrobial-resistance/

Plan

- Vaccins et antibiorésistance (AMR): rationnel
- Vaccins et antibiorésistance (AMR): données sur les vaccins existants
    - Vaccins antibactériens
    - Vaccins antiviraux
- Vaccins et antibiorésistance (AMR):perspectives

Vaccins antibactériens

Vaccin anti-*Haemophilus influenzae* b

Protein–polysaccharide conjugate		*Haemophilus influenzae* type B, pneumococcal, meningococcal, typhoid	1987 (*H. influenzae* type b)

ANTIMICROBIAL AGENTS AND CHEMOTHERAPY, June 2005, p. 2561–2564 Vol. 49, No. 6
0066-4804/05/$08.00+0 doi:10.1128/AAC.49.6.2561–2564.2005

Decreasing Prevalence of β-Lactamase Production among Respiratory Tract Isolates of *Haemophilus influenzae* in the United States

Kris P. Heilmann, Cassie L. Rice, Ashley L. Miller, Norma J. Miller, Susan E. Beekmann, Michael A. Pfaller, Sandra S. Richter, and Gary V. Doern*

TABLE 3. Comparison of resistant rates with *Haemophilus influenzae* during five study periods between 1994–1995 and 2002–2003

Antimicrobial agent or resistance factor	Percentage resistant in				
	1994–1995[a]	1997–1998[b]	1999–2000[c]	2000–2001[d]	2002–2003[e]
β-Lactamase positive	36.4	31.1	30.8	28.9	26.2
BLNAR[f]	1.3	1.9	2.0	0.7	0.1
BLPACR[g]	3.0	2.0	0.2	0.7	0.4
Ampicillin	36.6	32.4	34.6	29.4	26.3
Amoxicillin-clavulanate	5.0	2.4	0.3	0.5	0.1
Cefprodoxime	0.1	0.0	0.1	0.1	0.0
Cefuroxime	1.5	1.0	1.1	0.5	0.1
Clarithromycin	1.8	4.2	6.8	6.3	1.7
Azithromycin	0.5	1.9	2.9	2.4	1.0
TMP-SMX	9.0	18.3	14.6	17.6	14.6
Chloramphenicol	0.5	0.5	0.5	0.6	0.4
Tetracycline	1.3	1.0	0.7	1.1	0.4

- Avant l'introduction des vaccins, augmentation des souches R aux betalactamines
- Introduction vaccin Vaccin anti-Haemophilus influenza conjugué aux USA en 1987.
- Reduction massive des infections à Hib: méningites, épiglotites, bactériemies

- Mêmes données en Italie et en Espagne

DOI: 10.1128/AAC.49.6.2561-2564.2005
doi:10.1016/j.vaccine.2011.03.059
DOI: 10.1128/AAC.01674-07

Antibiorésistance

Global burden of bacterial antimicrobial resistance 1990–2021: a systematic analysis with forecasts to 2050

*GBD 2021 Antimicrobial Resistance Collaborators**

- Parmi les pathogènes les plus associés à de la mortalité attribuée à de l'AMR, le pneumocoque *S. pneumoniae* reste une cause importante et <u>stable</u> , notamment chez les > 5 ans

- Il existe des vaccins contre le pneumocoque!

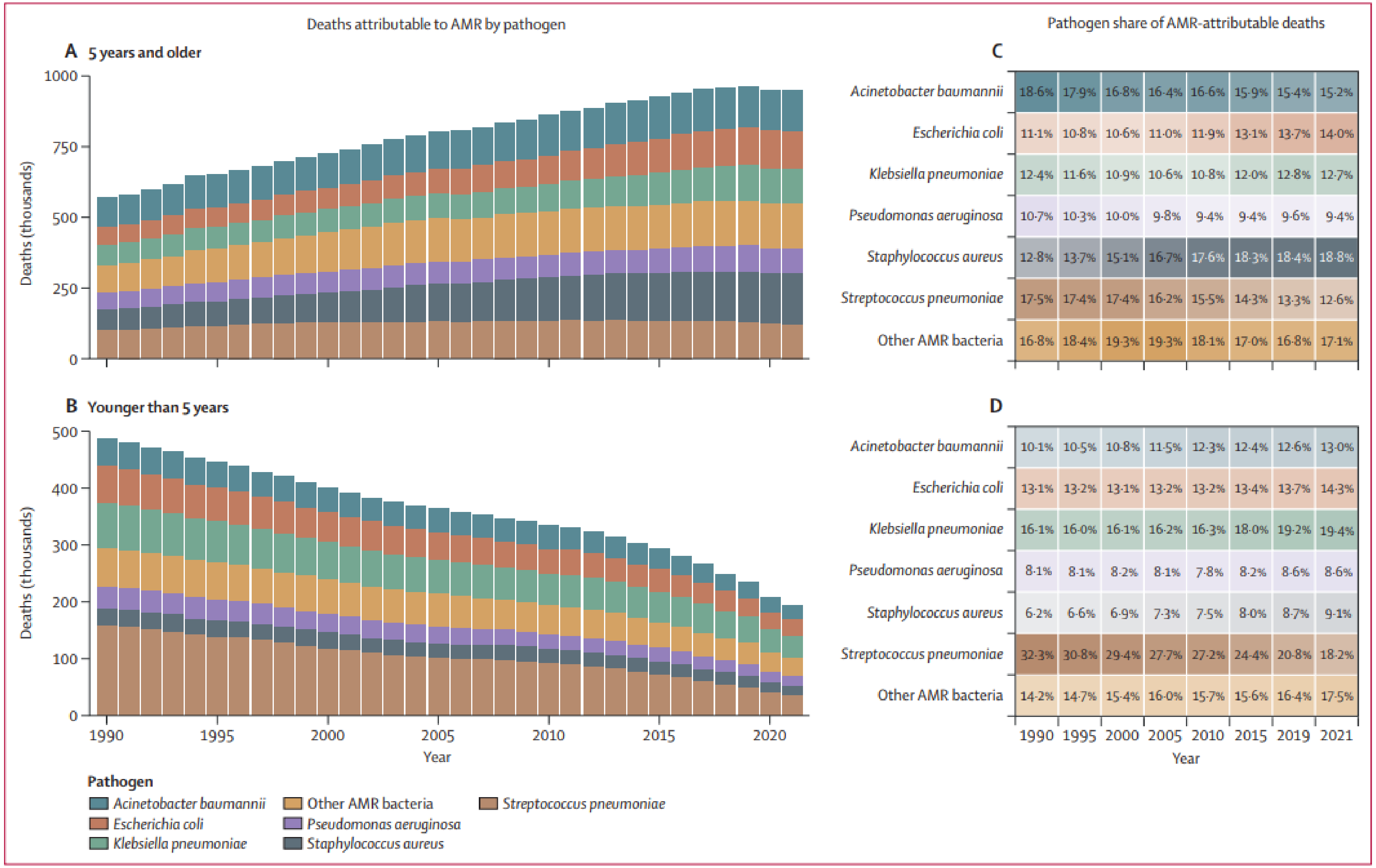
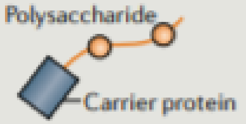


Figure 4: **Deaths attributable to AMR by pathogen, global, 1990–2021, for people 5 years and older and those younger than 5 years**

https://doi.org/10.1016/ S0140-6736(24)01867-1

Streptococcus pneumoniae

- Vaccins polysaccharidiques conjugués

Protein–polysaccharide conjugate		*Haemophilus influenzae* type B, pneumococcal, meningococcal, typhoid	1987 (*H. influenzae* type b)

Serotype Composition

PCV 7

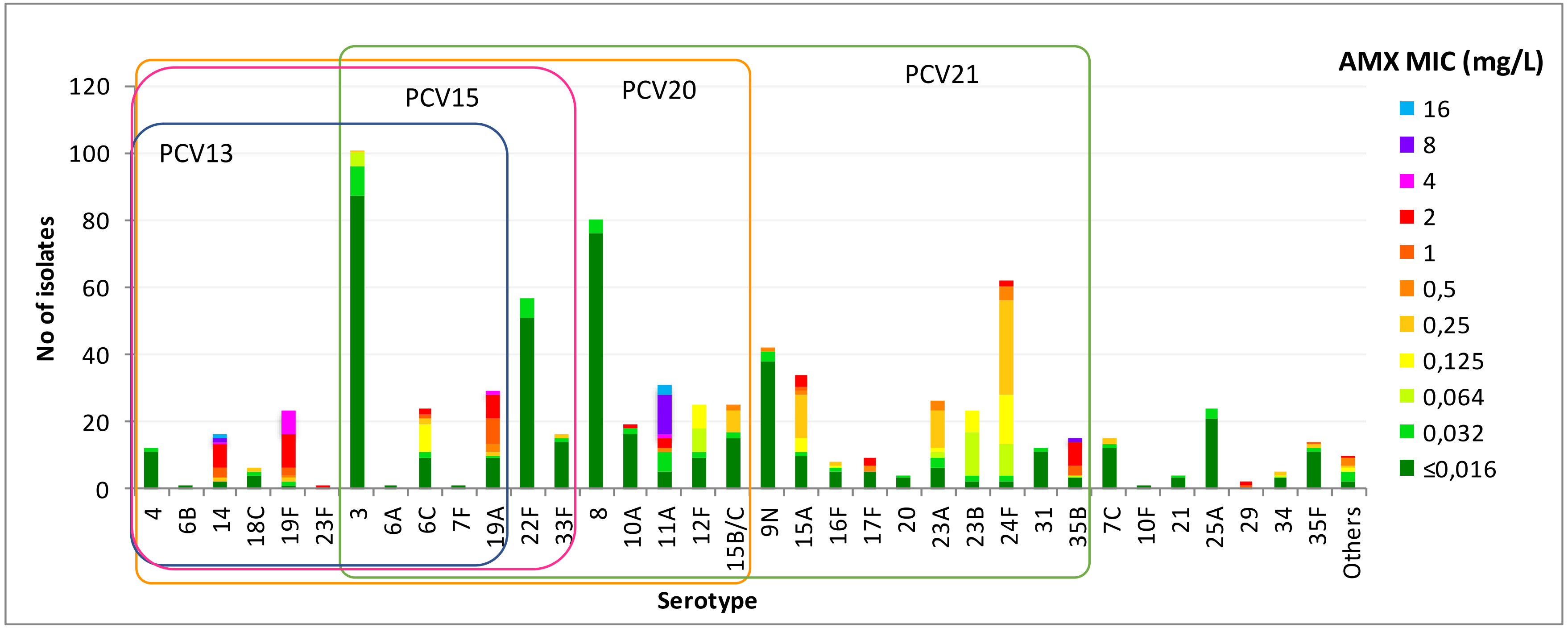
PCV13	4	6B	9V	14	18C	19F	23F	1	3	5	6A	7F	19A																			
PCV15	4	6B	9V	14	18C	19F	23F	1	3	5	6A	7F	19A	22F	33F																	
PPSV23	4	6B	9V	14	18C	19F	23F	1	3	5		7F	19A	22F	33F	2	8	9N	10A	11A	12F	15B	17F	20								
PCV20	4	6B	9V	14	18C	19F	23F	1	3	5	6A	7F	19A	22F	33F		8		10A	11A	12F	15B										
PCV21									3		6A	7F	19A	22F	33F		8	9N	10A	11A	12F		17F	20A	15A	15C*	16F	23A	23B	24F	31	35B

*Serotype 15C represents the immune response to the deOAc15B polysaccharide as the molecular structures for deOAc15B and 15C are similar.

IPD, invasive pneumococcal disease; PCV, pneumococcal conjugate vaccine; PCV13, pneumococcal conjugate vaccine, 13-valent; PCV15 pneumococcal conjugate vaccine, 15-valent, PCV20, pneumococcal conjugate vaccine, 20-valent.

Bacteremia (n=778) : susceptibility to amoxicillin in 2024

AMX R : 3,6%
PCV13&15 : 1,4%
PCV20 : 3,5%
PCV21 : 2,3%
PCV20non21 : 1,3%

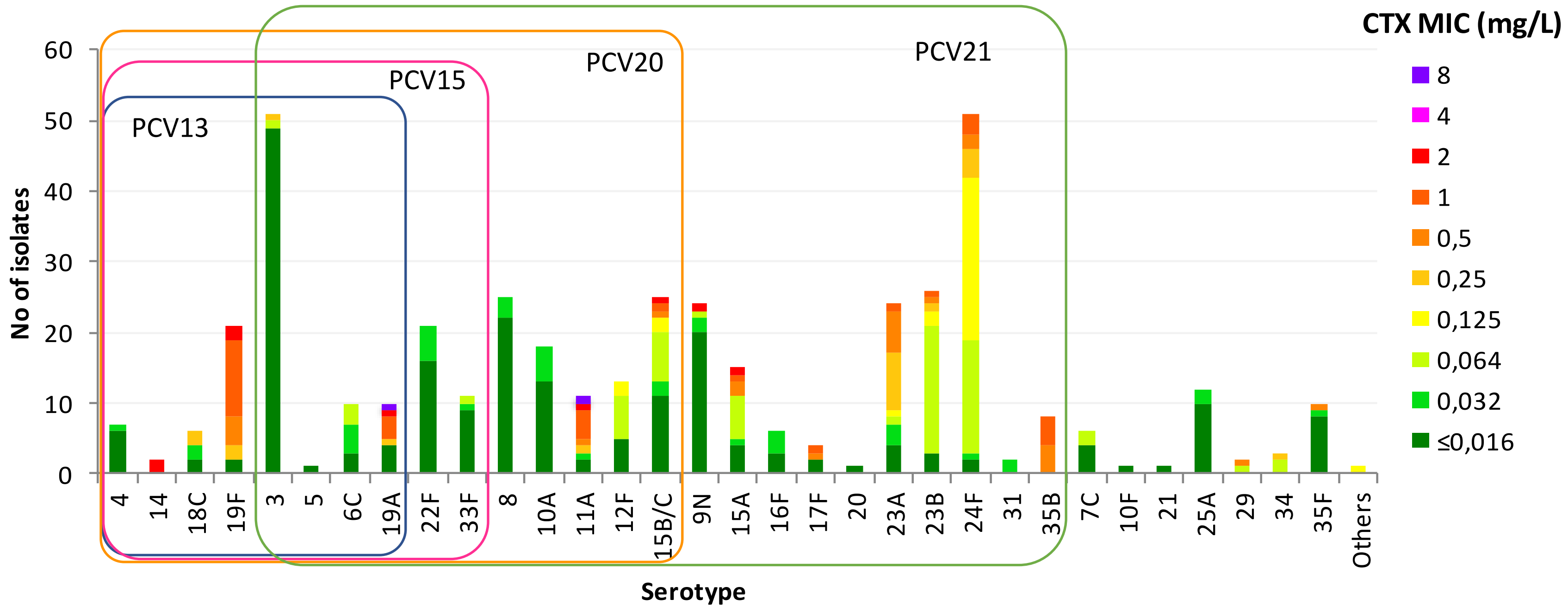


96,4% of bacteremia isolates are susceptible to amoxicillin (MIC ≤ 2 mg/L) when considering non-meningitis IPD (CA-SFM EUCAST)

Varon, CNRP-ORP année 2024, unpublished data

Meningitis (n=429) : susceptibility to cefotaxime in 2024

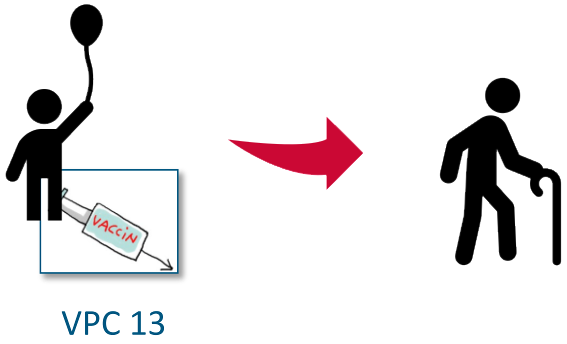
CTX-R
PCV13&15 : 4,7%
PCV20 : 6,5%
PCV21 : 6%
PCV20non21 : 3,5%



9,6% of meningitis isolates are resistant to cefotaxime (MIC > 0.5 mg/L) when considering meningitis (CA-SFM EUCAST)

Varon, CNRP-ORP année 2024, unpublished data

Vaccination anti-pneumococcique des enfants protège les adultes



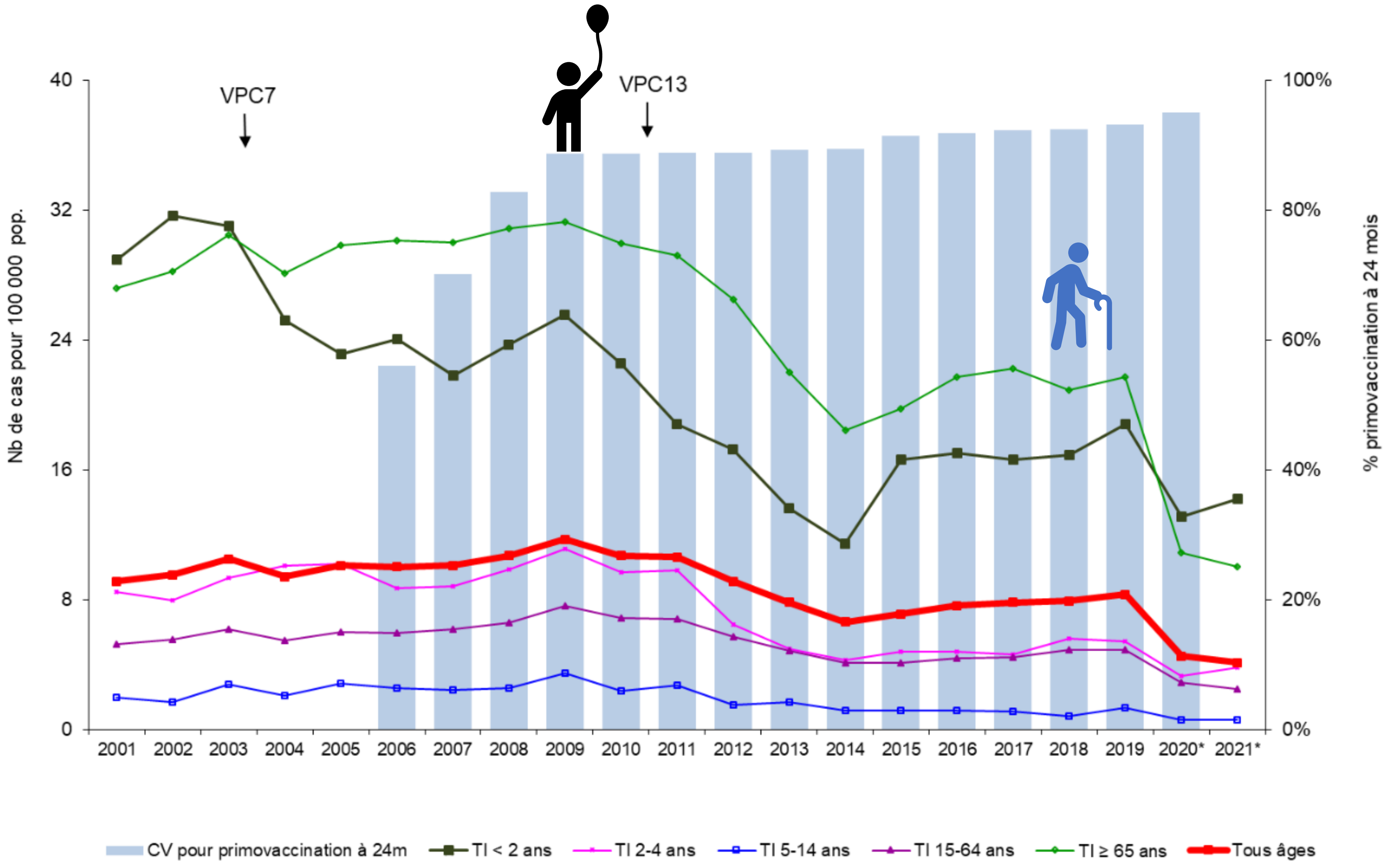


Figure 1 : Taux d'incidence des IIP selon l'âge et couverture vaccinale chez les 24 mois entre 2001 et 2021. Source : Santé publique France, 2022 (3)

Vaccins antipneumococciques

The NEW ENGLAND JOURNAL of MEDICINE
ESTABLISHED IN 1812 APRIL 6, 2006 VOL. 354 NO. 14

Effect of Introduction of the Pneumococcal Conjugate Vaccine on Drug-Resistant *Streptococcus pneumoniae*

Moe H. Kyaw, Ph.D., M.P.H., Ruth Lynfield, M.D., William Schaffner, M.D., Allen S. Craig, M.D., James Hadler, M.D., M.P.H., Arthur Reingold, M.D., Ann R. Thomas, M.D., M.P.H., Lee H. Harrison, M.D., Nancy M. Bennett, M.D., Monica M. Farley, M.D., Richard R. Facklam, Ph.D., James H. Jorgensen, Ph.D., John Besser, M.S., Elizabeth R. Zell, M.Stat., Anne Schuchat, M.D., and Cynthia G. Whitney, M.D., M.P.H., for Active Bacterial Core Surveillance of the Emerging Infections Program Network

2006

US
Cas d'infections invasives à pneumocoques identifiées entre Janvier 1, 1996, à Décembre 31, 2004

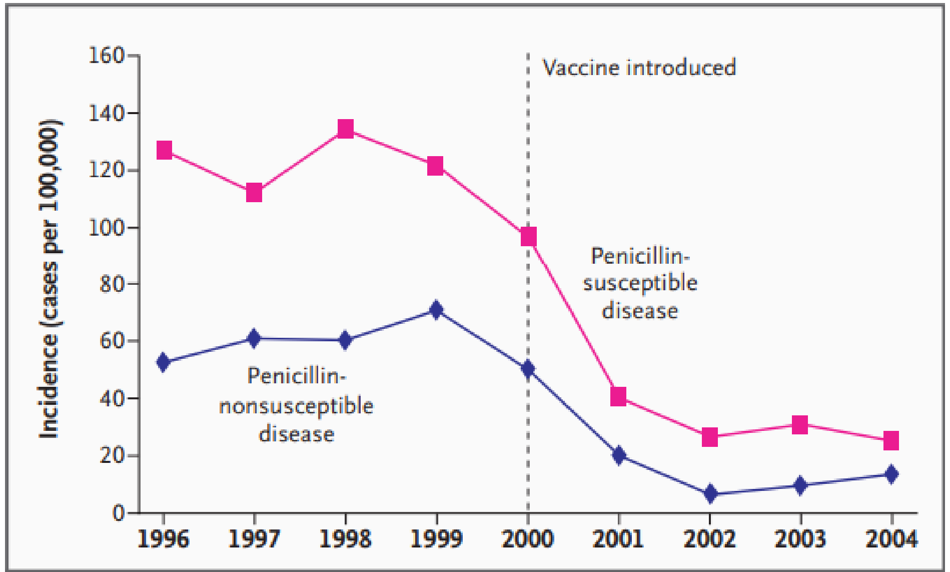


Figure 1. Annual Incidence of Invasive Disease Caused by Penicillin-Susceptible and Penicillin-Nonsusceptible Pneumococci among Children under Two Years of Age, 1996 to 2004.

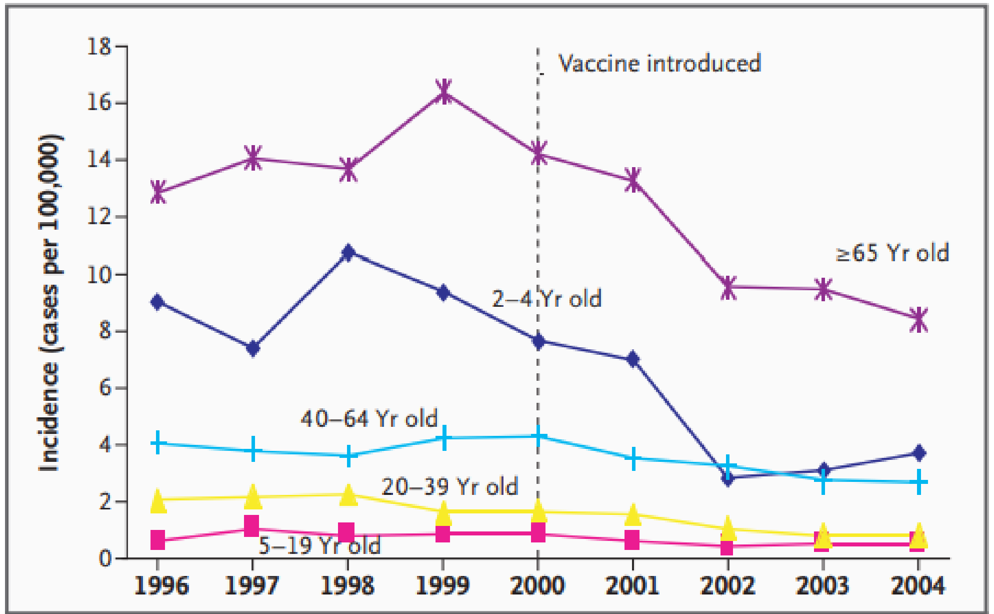


Figure 2. Annual Incidence of Invasive Disease Caused by Penicillin-Nonsusceptible Pneumococci in Persons Two Years of Age or Older, 1996 to 2004.

28 336 cas de 1996 à2004; isolats étaient disponibles pour 24 825 (87,6%)

https://doi.org/10.1056/NEJMoa051642
https://doi.org/10.1016/S2666-5247(21)00064-1
DOI: 10.1080/14760584.2019.1676155
DOI: 10.7189/jogh.13.05001

Vaccins antipneumococciques

Childhood vaccines and antibiotic use in low- and middle-income countries

https://doi.org/10.1038/s41586-020-2238-4
Received: 3 December 2019

Joseph A. Lewnard[1,2,3] ✉, Nathan C. Lo[4], Nimalan Arinaminpathy[5], Isabel Frost[5,6] & Ramanan Laxminarayan[6,7]

Among children aged 24–59 months, estimation that vaccine-serotype pneumococci cause 24.8% (4.3–54.6%) of antibiotic-treated ARI cases

pathogens[22]. As of 2018, an estimated 66.8% of age-eligible children in countries with PCV programmes in place received a full series of at least three PCV10/13 doses[23] (Supplementary Table 23). Under these coverage levels, we estimate that direct effects of PCV10/13 prevent 23.8 (4.2–52.0) million episodes of antibiotic-treated ARI annually among children aged 24–59 months in LMICs (Fig. 4 and Supplemen-

tary Tables 24, 25). This effect represents 42.4% (32.7–47.5%) of all antibiotic-treated ARI episodes that vaccine-serotype pneumococci would be expected to cause among children aged 24–59 months in LMICs, in the absence of PCV10/13 use. We estimated that an additional 21.7 (3.8–47.5) million episodes of antibiotic-treated ARI could be prevented by the direct effects of vaccination if PCV10/13 coverage were expanded to reach all children aged 24–59 months in LMICs. This resid-

(a) antibiotic-treated ARI episodes attributable to PCV10/13-serotype pneumococci in children aged 24–59 months

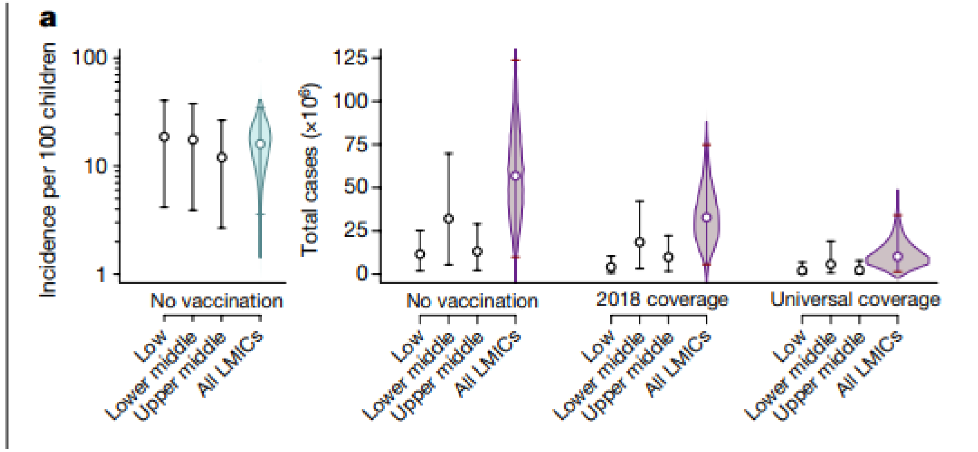
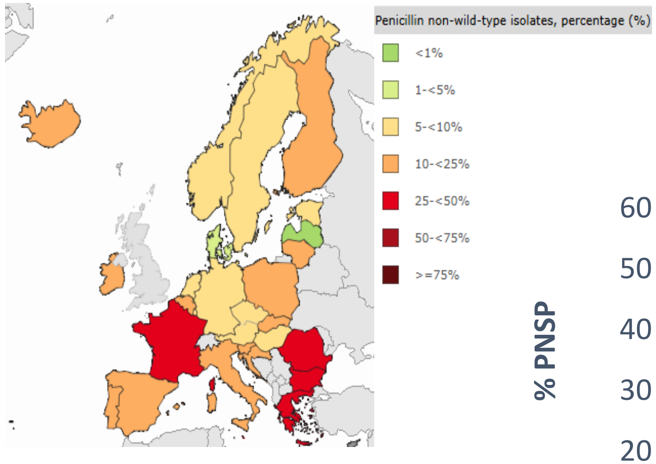


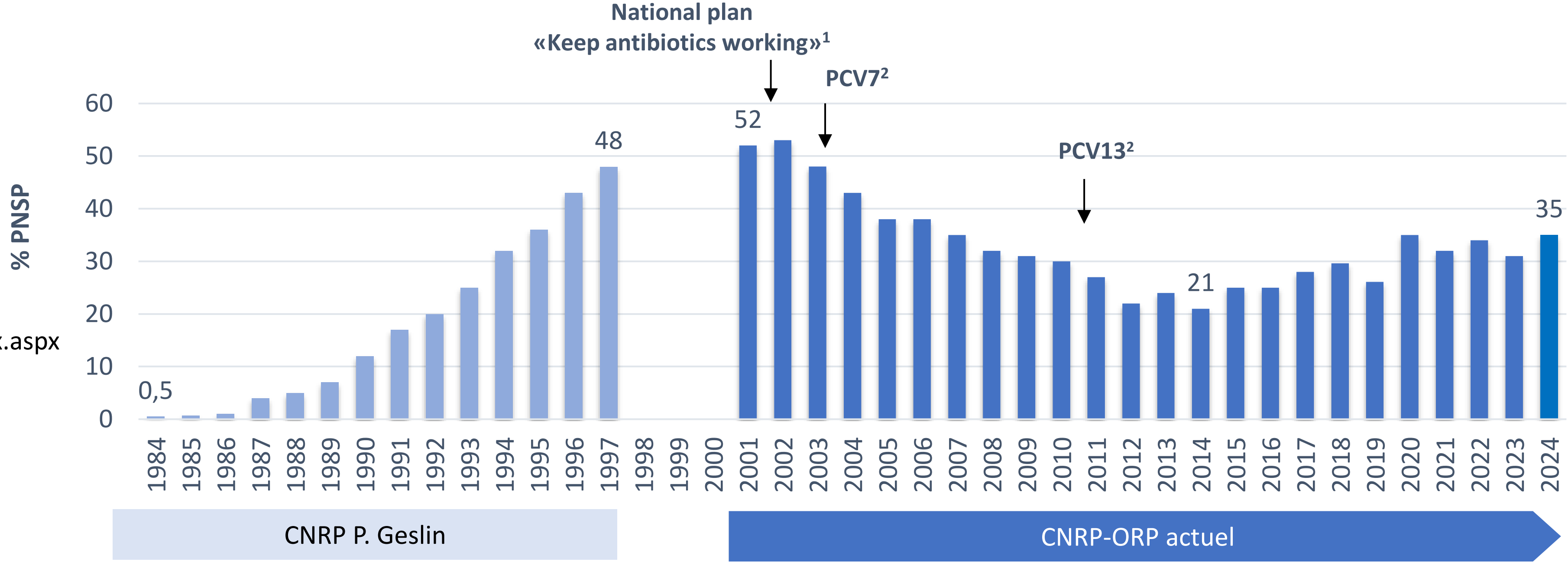
Fig. 4 | Total vaccine-preventable antibiotic consumption and incidence per 100 children. a, b, We estimated the incidence and total number of

Penicillin non susceptible *S. pneumoniae* (PNSP) in France

EARS-net Annual Report **2024**



http://atlas.ecdc.europa.eu/public/index.aspx



1984-2024: 71 491 isolates

[1]http://www.sante.gouv.fr/htm/actu/34_01.htm

[2]Pneumococcal conjugate vaccine (PCV)

Varon, CNRP-ORP 2024, unpublished data

Typhoide

- Maladie due à *Salmonella enterica*, sous-espèce enterica, sérotype Typhi ou *Salmonella typhi*
- Forme généralisée, diarrhées
- Large consommation ATB, résistance+++, portage LMICs
- Vaccins conjugués récents

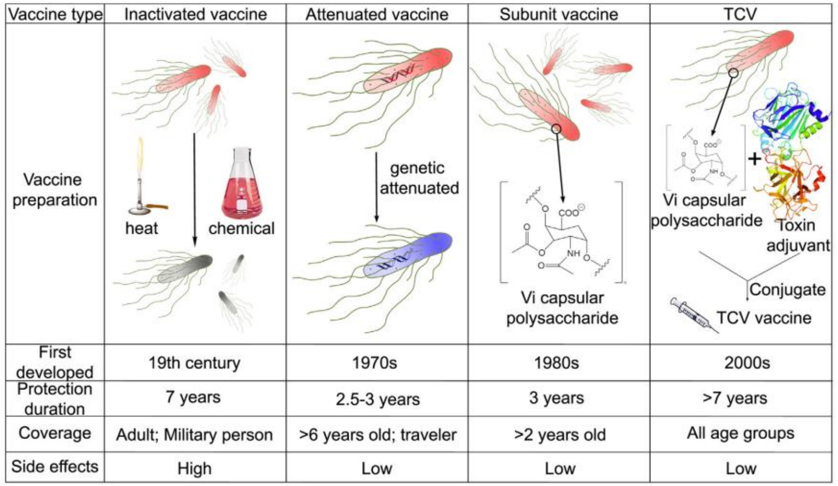


Figure 2. Comparison of typhoid vaccines. Method of preparation, protective efficacy, coverage, and side effects of different typhoid fever vaccines over time. TCV, typhoid conjugate vaccine.

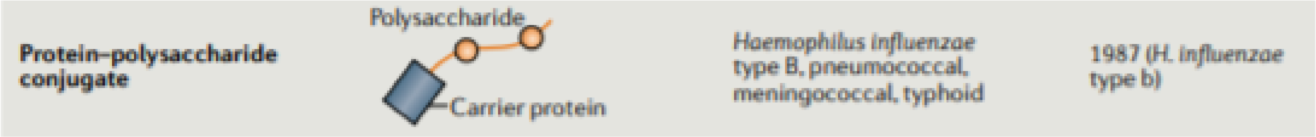


Table 3. Current Typhoid Conjugate Vaccine Development Pipeline

Manufacturer	Location	Technology Transfer Agreement	Product Details	Clinical Development Status	WHO Prequalification
Bharat Biotech Int. Ltd	India	Own R&D	Vi-TT	Licensure in India, Nepal, Nigeria	WHO prequalified January 2018
Bio-Med Pvt. Ltd	India	Own R&D	Vi-TT	Licensure in India	No plans for WHO PQ as of now
M/s Cadila Healthcare Limited	India	Unknown	Vi-TT	Licensed in India March 2018	WHO PQ will be sought
PT Bio Farma	Indonesia	IVI	Vi-DT	Phase II	WHO PQ will be sought after Indonesian NRA
Finlay Institute	Cuba	Unknown	Vi-DT	Phase I	Unknown plans for WHO PQ
Lanzhou Institute (CNBG)	China	US NIH	Vi-rEPA	Licensure application submitted	Interest in WHO PQ; need support
SK Bioscience	S. Korea	IVI	Vi-DT	Phase II	WHO PQ will be sought after licensure
Incepta	Bangladesh	IVI	Vi-DT	Preclinical	Interest in WHO PQ; need support
Biological E	India	NVGH (GSK)	Vi-CRM	Phase III	WHO PQ will be sought after licensure
DAVAC	Vietnam	Own R&D	Vi-DT	Preclinical	NA
Eubiologics	Korea	Own R&D	Vi-TT	Phase I	Interest in WHO PQ: Unknown

Abbreviations: CNBG, China National Biotec Group; DT, diphtheria toxoid; IVI, International Vaccine Institute; NA, not available; NIH, National Institutes of Health; NVGH, Novartis Vaccines Institute for Global Health; NRA, National Regulatory agency; R&D, research and development; rEPA, recombinant A subunit of *Pseudomonas aeruginosa* exoprotein; TT, tetanus toxoid; WHO, World Health Organization.

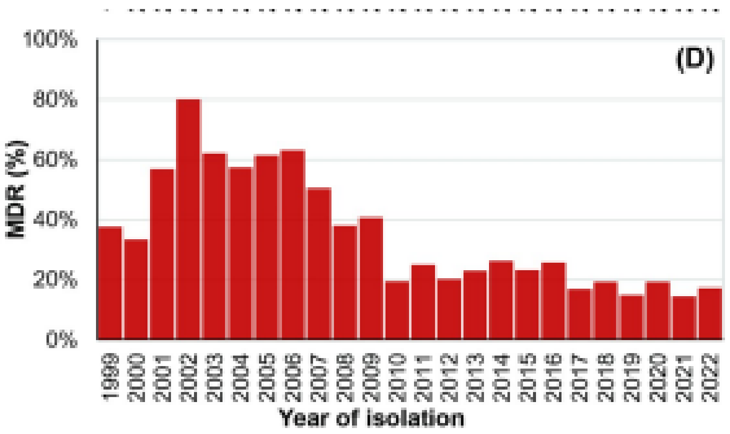
Syed KA, et al., Clin Infect Dis. 2020 Jul 29;71(Suppl 2):S141-S150. doi: 10.1093/cid/ciaa504.

Vaccin Typhoide

RESEARCH ARTICLE

Trends in antimicrobial resistance amongst *Salmonella* Typhi in Bangladesh: A 24-year retrospective observational study (1999–2022)

Arif Mohammad Tanmoy[1,2], Yogesh Hooda[1], Mohammad Saiful Islam Sajib[1], Hafizur Rahman[1], Anik Sarkar[1], Dipu Das[1], Nazrul Islam[1], Naito Kanon[1], Md. Asadur Rahman[3], Denise O. Garrett[4], Hubert P. Endtz[2], Stephen P. Luby[5], Mohammad Shahidullah[6], Md. Ruhul Amin[7], Jahangir Alam[7], Mohammed Hanif[7], Samir K. Saha[1,8], Senjuti Saha[1]*



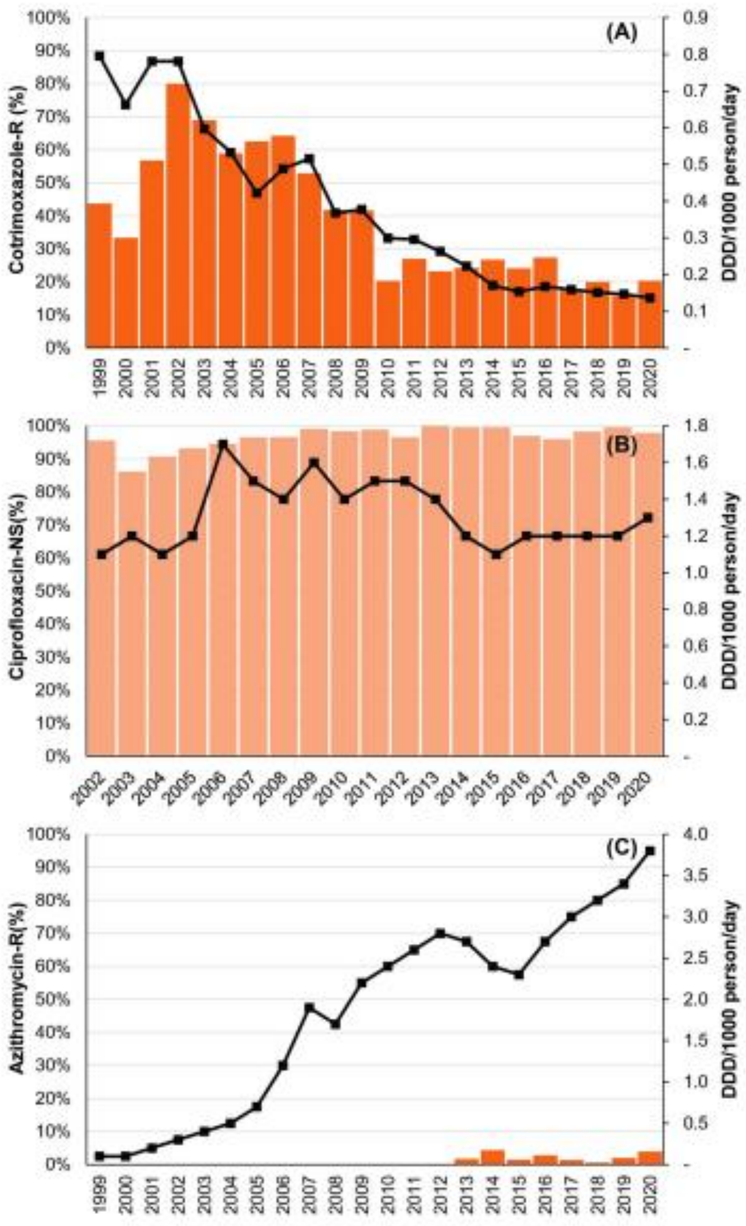


Fig 4. Patterns of antimicrobial consumption and resistance patterns in *Salmonella* Typhi in Bangladesh from

https://doi.org/10.1371/journal.pntd.0012558

Vaccin Typhoide

- Vaccin conjugué
- Efficacité importante
- Pas d'efficacité de groupe démontrée mais démontré avec les autres vaccins (pb methodo)

Protection by vaccination of children against typhoid fever with a Vi-tetanus toxoid conjugate vaccine in urban Bangladesh: a cluster-randomised trial

Firdausi Qadri, Farhana Khanam*, Xinxue Liu*, Katherine Theiss-Nyland, Prasanta Kumar Biswas, Amirul Islam Bhuiyan, Faisal Ahmmed, Rachel Colin-Jones, Nicola Smith, Susan Tonks, Merryn Voysey, Yama F Mujadidi, Olga Mazur, Nazmul Hasan Rajib, Md Ismail Hossen, Shams Uddin Ahmed, Arifuzzaman Khan, Nazia Rahman, Golap Babu, Melanie Greenland, Sarah Kelly, Mahzabeen Ireen, Kamrul Islam, Peter O'Reilly, Karin Sofia Scherrer, Virginia E Pitzer, Kathleen M Neuzil, K Zaman, Andrew J Pollard†, John D Clemens†*

	SA 14-14-2 group	Vi-TT group	Protective effectiveness (%)	Intracluster correlation coefficients	p value
Total vaccine protection	n=30 685	n=30 882	..	..	..
Typhoid fever	192	29	..	..	..
Person-years of follow-up	30 253	30 349	..	..	..
Incidence rate, per 100 000 person-years	635 (548 to 731)	96 (64 to 137)	85% (97·5% CI 76 to 91)	0·0013	<0·0001
Overall vaccine protection	n=155 448	n=155 841	..	..	..
Typhoid fever	331	144	..	..	..
Person-years of follow-up	155 458	154 449	..	..	..
Incidence rate, per 100 000 person-years	213 (191 to 237)	93 (79 to 110)	57% (97·5% CI 43 to 68)	0·0007	<0·0001
Indirect vaccine protection	n=134 835	n=135 110	..	..	..
Typhoid fever	139	115	..	..	..
Person-years of follow up	125 205	124 100	..	..	..
Incidence rate, per 100 000 person-years	111 (93 to 131)	93 (77 to 111)	19% (95% CI −12 to 41)	0·0008	0·20

Data are incidence rate (95% CI) or % (95% CI) unless stated otherwise. SA 14-14-2=Japanese encephalitis vaccine. Vi-TT=Vi-tetanus toxoid conjugate vaccine. *Protective effectiveness, p values, and CIs were adjusted for the stratifying variables for randomisation, including geographical ward, distance to study clinics, number of eligible children at baseline, and other baseline covariates prespecified in the statistical analysis plan, including age, sex, toilet type in the house, drinking water source, treatment of drinking water, handwashing before meals, and handwashing after defecation.

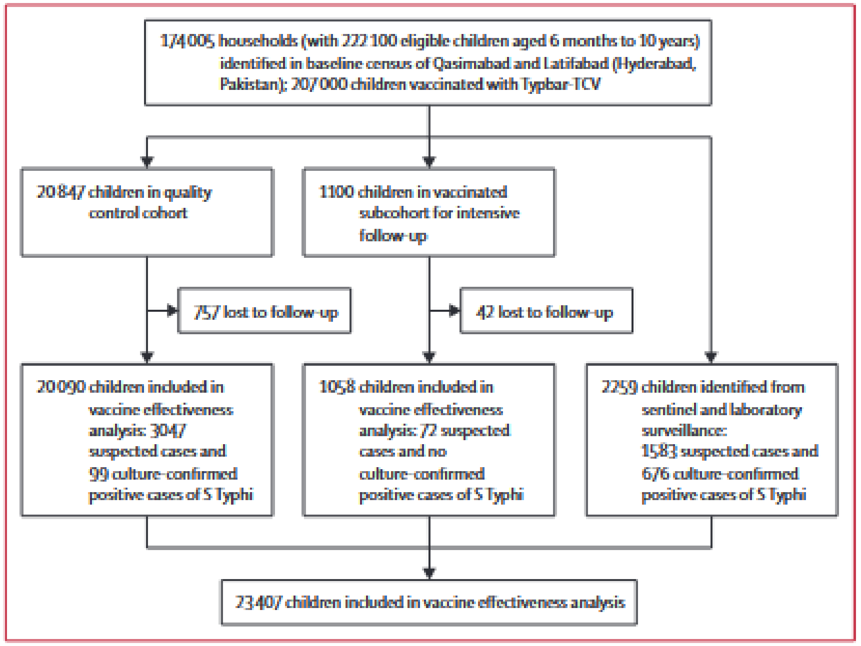
Table 2: **Incidence of blood culture-confirmed typhoid fever and protective effectiveness of Vi-TT***

https://doi.org/10.1016/ S0140-6736(21)01124-7

Vaccin Typhoide

Effectiveness of typhoid conjugate vaccine against culture-confirmed *Salmonella enterica* serotype Typhi in an extensively drug-resistant outbreak setting of Hyderabad, Pakistan: a cohort study

Mohammad Tahir Yousafzai, Sultan Karim, Sonia Qureshi, Momin Kazi, Hina Memon, Amber Junejo, Zohra Khawaja, Najeeb Ur Rehman, Muhammad Sajid Ansari, Rafey Ali, Ikram Uddin Ujjan, Heera Mani Lohana, Naveed M Memon, Mudassar Hussain, Roohi Nigar, Naor Bar-Zeev, Farah Naz Qamar



	Number of participants (n)	At-risk population (n)	Total person-time at risk, years*	S Typhi incidence; number of cases per 100 000 population (95% CI)	S Typhi incidence; number of cases per 100 000 person-years (95% CI)	S Typhi incidence rate ratio (95% CI)	Vaccine effectiveness* (95% CI)
Both culture-confirmed and suspected S Typhi cases							
Age 6–59 months							
Vaccinated	940	5521	8646	17 025·9 (16 034·4–18 017·4)	10 872·2 (10 643·0–11 101·3)	0·50 (0·46–0·54)	50·0 (45·8–53·9)
Unvaccinated	1653	4647	7599	35 571·3 (34 194·9–36 947·8)	21 752·1 (21 263·0–22 241·1)	..	..
Age ≥5 years							
Vaccinated	1029	7915	12 103	13 000·6 (12 259·7–13 741·5)	8502·2 (8350·7–8653·6)	0·42 (0·39–0·46)	57·8 (54·4–60·9)
Unvaccinated	1756	5324	8722	32 982·7 (31 719·8–34 245·6)	20 132·0 (19 709·5–20 554·5)	..	..
Overall							
Vaccinated	1969	13 436	20 749	14 654·7 (14 056·7–15 252·7)	9489·7 (9360·6–9618·9)	0·45 (0·43–0·48)	54·6 (52·0–57·0)
Unvaccinated	3409	9971	16 322	34 189·1 (33 258·1–35 120·2)	20 886·3 (20 565·9–21 206·7)	..	..
Suspected typhoid fever cases							
Age 6–59 months							
Vaccinated	918	5521	8646	16 627·4 (15 645·3–17 609·6)	10 617·7 (10 393·9–10 841·5)	0·62 (0·57–0·67)	38·1 (32·6–43·2)
Unvaccinated	1304	4647	7599	28 061·1 (26 769·3–29 352·9)	17 159·5 (16 773·7–17 545·3)	..	..
Age ≥5 years							
Vaccinated	1004	7915	12 103	12 684·8 (11 951·6–13 418·0)	8295·6 (8147·8–8443·4)	0·53 (0·48–0·57)	47·5 (43·0–51·6)
Unvaccinated	1377	5324	8722	25 864·0 (24 687·8–27 040·3)	15 786·9 (15 455·6–16 118·2)	..	..
Overall							
Vaccinated	1922	13 436	20 749	14 304·9 (13 712·8–14 896·9)	9263·2 (9137·2–9389·2)	0·56 (0·53–0·60)	43·6 (40·2–46·8)
Unvaccinated	2681	9971	16 322	26 888·0 (26 017·7–27 758·3)	16 426·0 (16 174·0–16 678·0)	..	..
Culture-confirmed S Typhi cases							
Age 6–59 months							
Vaccinated	22	5521	8646	398·5 (232·3–564·7)	254·5 (249·1–259·8)	0·06 (0·03–0·09)	94·5 (91·5–96·6)
Unvaccinated	349	4647	7599	7510·2 (6752·4–8268·0)	4592·5 (4489·3–4695·8)	..	..
Age ≥5 years							
Vaccinated	25	7915	12 103	315·9 (192·2–439·5)	206·6 (202·9–210·2)	0·05 (0·03–0·07)	95·2 (92·9–97·0)
Unvaccinated	379	5324	8722	7118·7 (6428·0–7809·4)	4345·1 (4253·9–4436·3)	..	..
Overall							
Vaccinated	47	13 436	20 749	349·8 (250·0–449·6)	226·5 (223·4–229·6)	0·05 (0·04–0·07)	94·9 (93·2–96·3)
Unvaccinated	728	9971	16 322	7301·2 (6790·5–7811·8)	4460·3 (4391·9–4528·8)	..	..
XDR S Typhi cases							
Age 6–59 months							
Vaccinated	14	5521	8646	253·6 (120·9–386·2)	161·9 (158·5–165·3)	0·06 (0·03–0·10)	94·4 (90·4–97·0)
Unvaccinated	220	4647	7599	4734·2 (4123·6–5344·8)	2895·0 (2829·9–2960·1)	..	..
Age ≥5 years							
Vaccinated	4	7915	12 103	50·5 (1·0–100·1)	33·1 (32·5–33·6)	0·01 (0·00–0·04)	98·6 (96·4–99·6)
Unvaccinated	206	5324	8722	3869·3 (3351·2–4387·3)	2361·7 (2312·2–2411·3)	..	..
Overall							
Vaccinated	18	13 436	20 749	134·0 (72·1–195·8)	86·8 (85·6–87·9)	0·03 (0·02–0·05)	96·7 (94·7–98·0)
Unvaccinated	426	9971	16 322	4272·4 (3875·4–4669·3)	2610·0 (2570·0–2650·1)	..	..

(Table 2 continues on next page)

10.1016/S2214-109X(21)00255-2

Vaccin Typhoide

The effect of a comprehensive typhoid conjugate vaccine campaign on antimicrobial prescribing in children in Harare, Zimbabwe: a mixed methods study

Ioana D Olaru, Rudo M S Chingono*, Christian Bottomley, Faith R Kandiye, Fadzaishe Mhino, Chipo A Nyamayaro, Salome Manyau, Michael Vere, Phillomina Chitando, Prosper Chonzi, Thomas C Darton, Justin Dixon†, Katharina Kranzer†*

A 1-week mass vaccination campaign was done with Typbar-TCV (Bharat Biotech, Hyderabad, India) between Feb 25 and March 4, 2019.
Target: all children aged 6 months to 15 years.
Vaccine coverage reached 88%

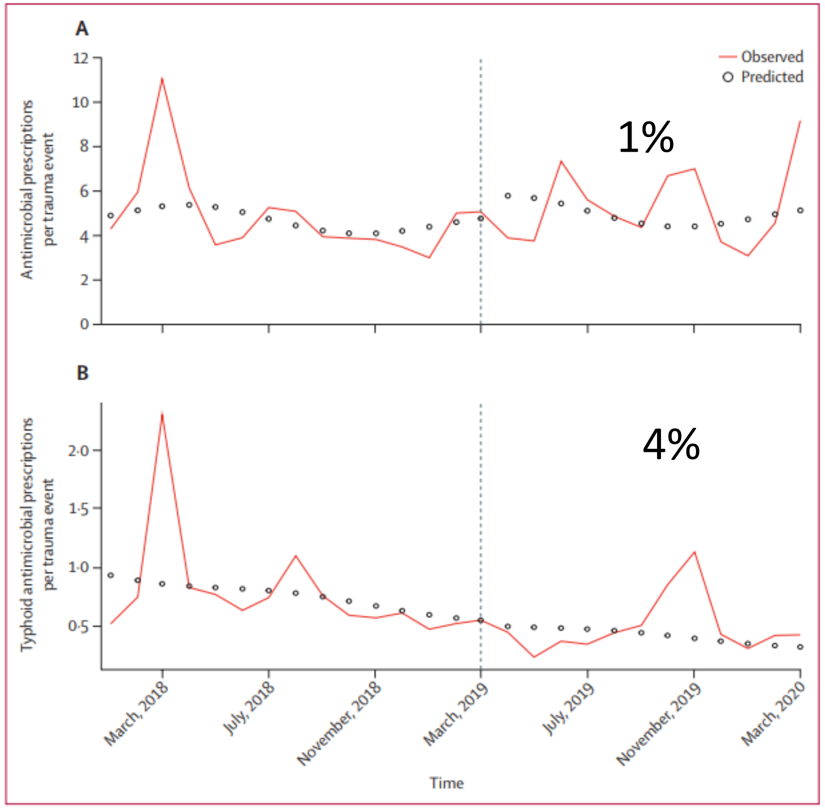
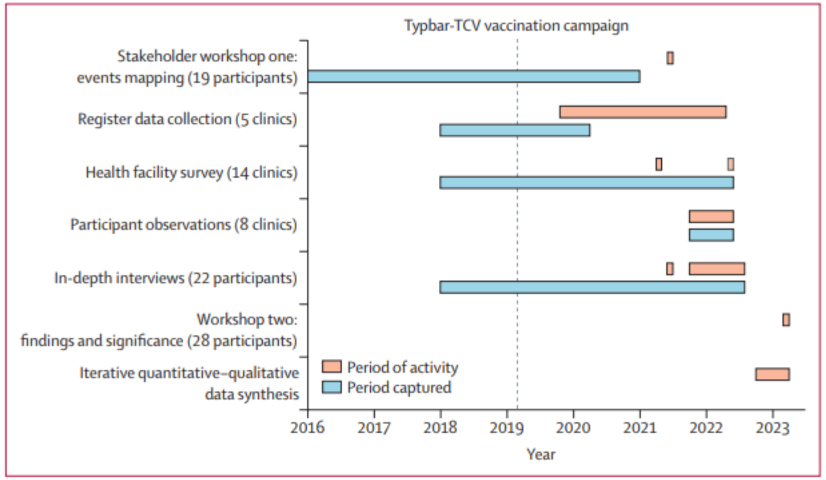
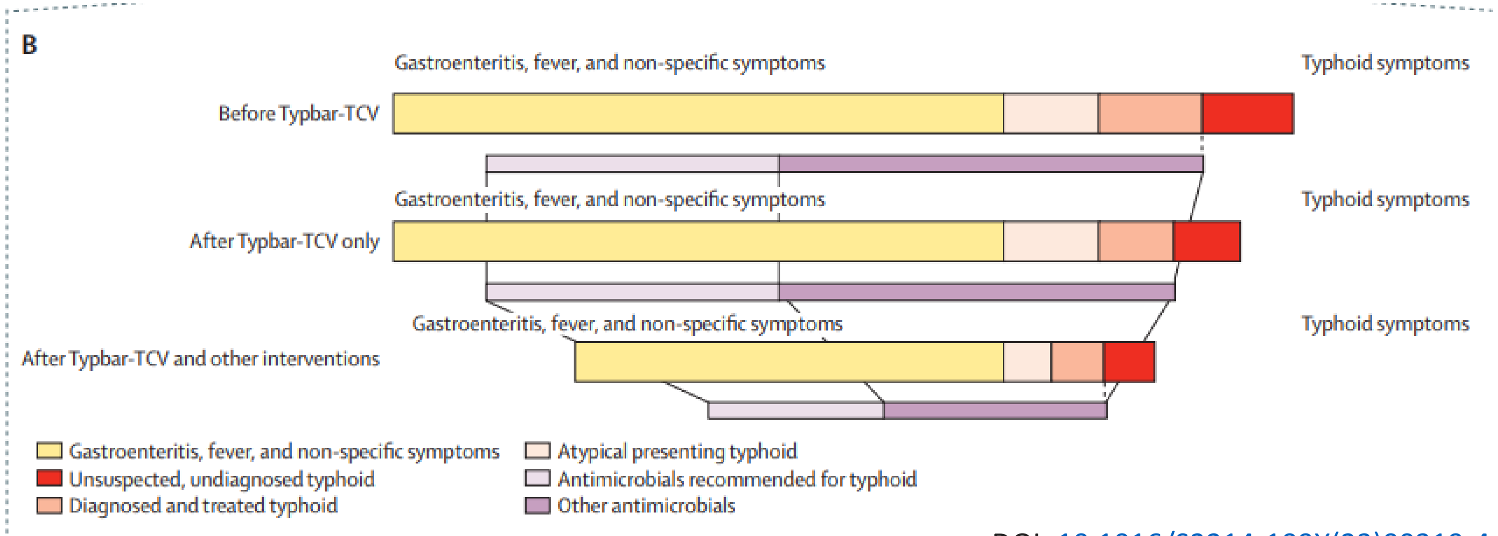


Figure 2: Observed monthly rates of prescriptions in children aged 6 months to 15 years





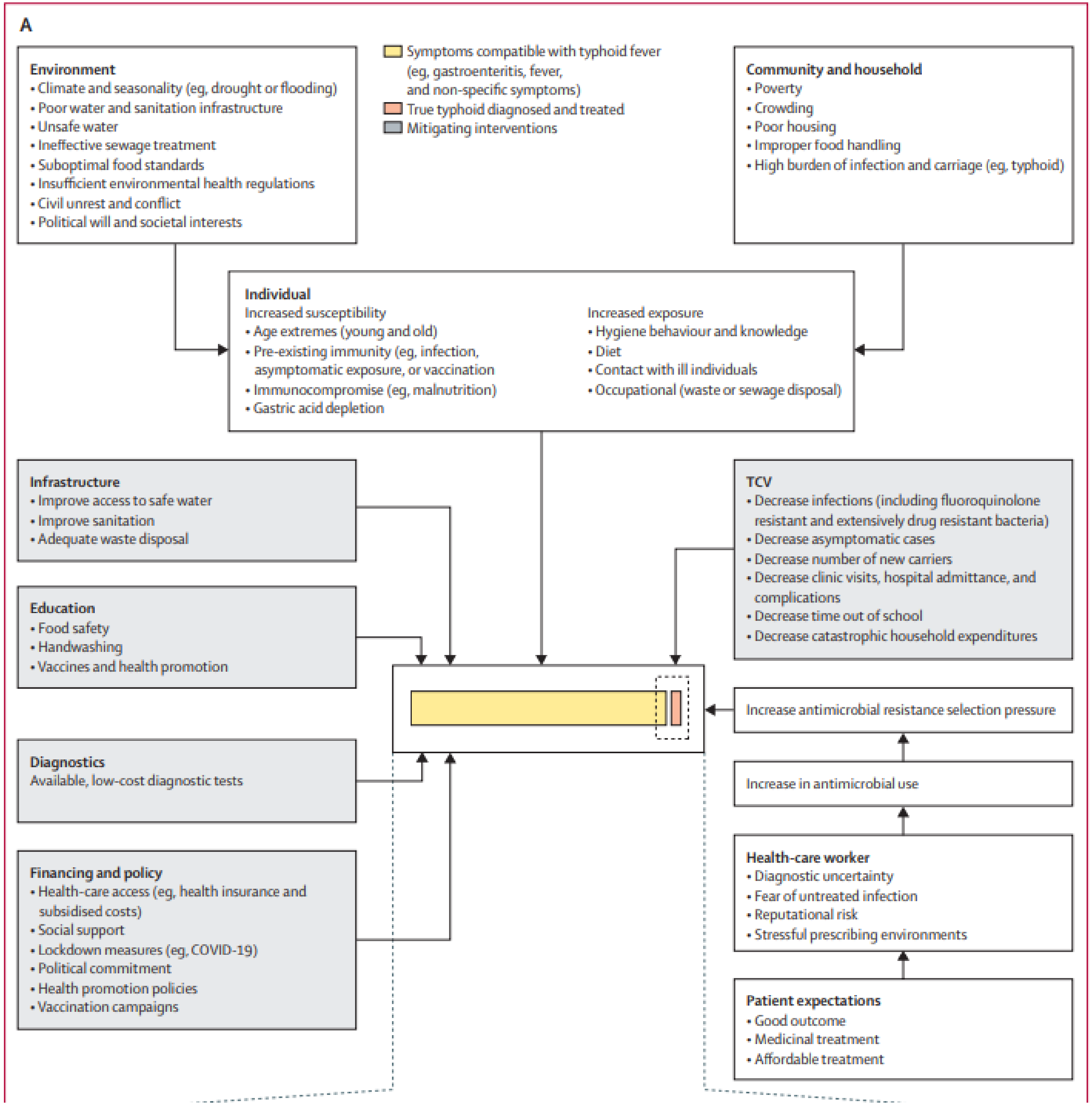
DOI: 10.1016/S2214-109X(23)00319-4

- Analyse ethnographique pour mieux comprendre:

Vacciner seulement ne suffit pas!

Besoin WASH et améliorer le diagnostic + éducation

« To realise effects beyond disease burden reduction, holistic approaches addressing these concerns are needed so that the value of vaccines mitigating the effects of antimicrobial use as a driver of antimicrobial resistance is fully achieved. »

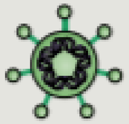


DOI: 10.1016/S2214-109X(23)00319-4

Vaccins antiviraux

Rotavirus

- Rotavirus virus ARN non enveloppés
- Rotavirus est la 1ère cause de diarrhées sévères chez les nourrissons et jeunes enfants dans le monde
- Infections nosocomiales
- Vaccins vivants atténués oraux

Live attenuated (weakened or inactivated)		Measles, mumps, rubella, yellow fever, influenza, oral polio, typhoid, Japanese encephalitis, rotavirus, BCG, varicella zoster	1798 (smallpox)

Vaccin rotavirus

Childhood vaccines and antibiotic use in low- and middle-income countries

https://doi.org/10.1038/s41586-020-2238-4

Received: 3 December 2019

Joseph A. Lewnard[1,2,3]✉, Nathan C. Lo[4], Nimalan Arinaminpathy[5], Isabel Frost[5,6] & Ramanan Laxminarayan[6,7]

Estimation that rotavirus would cause 21.6% (2.1–40.3%) of antibiotic-treated diarrhoea among children aged 0–23 months in unvaccinated LMIC populations.

Roughly 77.3% of age-eligible children in LMICs in which rotavirus vaccination has been implemented received a full rotavirus vaccine series as of 2018[23]. We estimated that direct effects of rotavirus vaccination currently prevent 13.6 (3.6–23.7) million episodes of antibiotic-treated diarrhoea annually among children aged 0–23 months in LMICs (Supplementary Table 26). This effect reflects only 31.0% (17.7–35.2%) of all antibiotic-treated diarrhoea episodes that we would expect rotavirus to cause annually among children aged 0–23 months who live in LMICs, in the absence of vaccination. We estimated that an additional

18.3 (4.2–32.6) million episodes of antibiotic-treated diarrhoea could be prevented annually by the direct effects of rotavirus vaccination among children aged 0–23 months under a scenario of universal vaccine coverage, representing 42.1% (14.6% to 50.7%) of all antibiotic use that we estimated to be attributable to rotavirus in this population.

(b) antibiotic-treated diarrhoea attributable to rotavirus in children aged 0–23 months

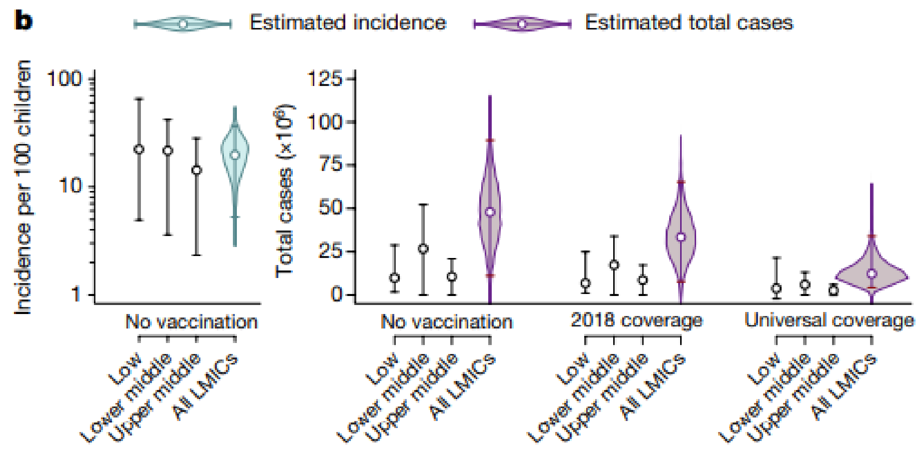


Fig. 4 | Total vaccine-preventable antibiotic consumption and incidence per 100 children. a, b, We estimated the incidence and total number of

Rougeole

- virus du genre *Morbillivirus,* famille des virus *Paramyxoviridae,*
- Réservoir **strictement humain**: éradication possible
- Transmission par voie aérienne et contact, R_0 12-18
- Surinfections bactériennes+++otites , PNP…
- Immunodépression post maladie: mortalité infantile+++
- Vaccin MMR: vaccin vivant atténué

Live attenuated (weakened or inactivated)	Measles, mumps, rubella, yellow fever, influenza, oral polio, typhoid, Japanese encephalitis, rotavirus, BCG, varicella zoster	1798 (smallpox)

Vaccin rougeole?

Table 3 Incidence rate ratios (IRRs) of events of interest in predefined time periods following measles infection

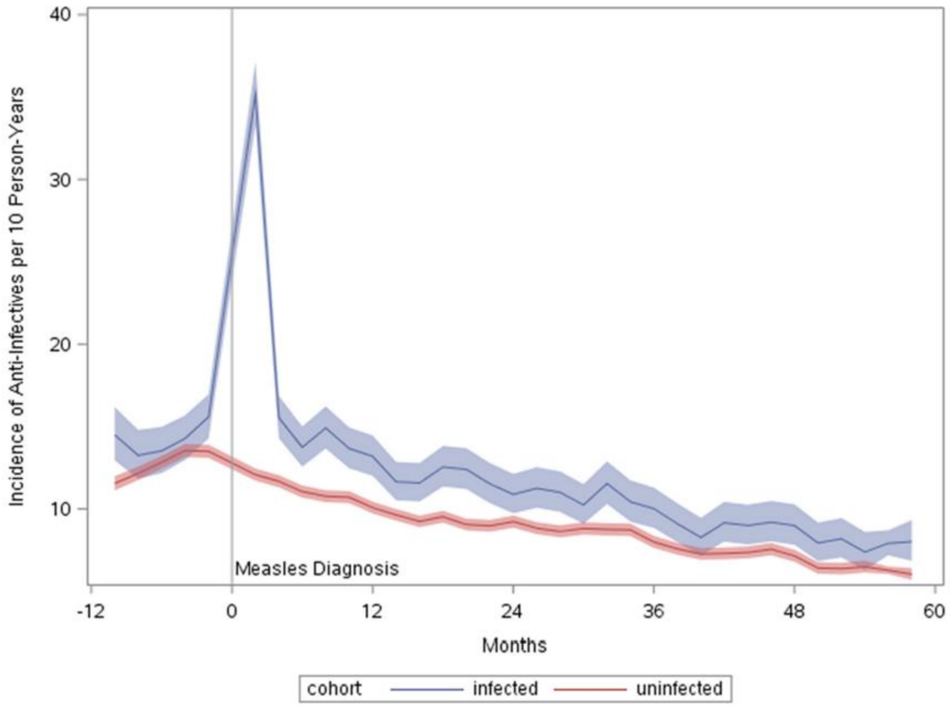
Time period	Analysis*	IRR (95% CI) Infections	Anti-infective prescriptions	Hospitalisation
Days 0–31	Primary	1.43 (1.22 to 1.68)	3.60 (3.31 to 3.91)	2.83 (1.72 to 4.67)
	Unadjusted	1.57 (1.34 to 1.84)	3.77 (3.48 to 4.08)	3.24 (2.03 to 5.19)
	Sensitivity (vaccinated measles subjects only)	1.47 (1.17 to 1.86)	4.65 (4.20 to 5.14)	1.92 (0.89 to 4.14)
	Sensitivity (unvaccinated measles subjects only)	1.33 (1.07 to 1.65)	2.45 (2.12 to 2.82)	3.30 (1.60 to 6.82)
Days 32–365	Primary	1.22 (1.14 to 1.31)	1.25 (1.18 to 1.32)	1.14 (0.88 to 1.48)
	Unadjusted	1.31 (1.21 to 1.41)	1.31 (1.24 to 1.39)	1.29 (0.94 to 1.77)
	Sensitivity (vaccinated measles subjects only)	1.15 (1.04 to 1.27)	1.25 (1.16 to 1.35)	0.95 (0.61 to 1.46)
	Sensitivity (unvaccinated measles subjects only)	1.26 (1.15 to 1.39)	1.24 (1.15 to 1.35)	1.29 (0.92 to 1.81)
Days 366–913	Primary	1.10 (1.02 to 1.19)	1.21 (1.13 to 1.29)	1.08 (0.80 to 1.47)
	Unadjusted	1.15 (1.06 to 1.24)	1.25 (1.17 to 1.34)	1.19 (0.85 to 1.66)
	Sensitivity (vaccinated measles subjects only)	1.10 (0.99 to 1.22)	1.21 (1.11 to 1.32)	1.26 (0.79 to 2.04)
	Sensitivity (unvaccinated measles subjects only)	1.09 (0.99 to 1.21)	1.22 (1.12 to 1.34)	0.93 (0.64 to 1.35)
Days 914–1826	Primary	1.15 (1.06 to 1.25)	1.15 (1.07 to 1.24)	1.24 (0.92 to 1.67)
	Unadjusted	1.23 (1.13 to 1.35)	1.22 (1.13 to 1.31)	1.38 (1.07 to 1.78)
	Sensitivity (vaccinated measles subjects only)	1.06 (0.94 to 1.20)	1.25 (1.13 to 1.37)	1.08 (0.76 to 1.54)
	Sensitivity (unvaccinated measles subjects only)	1.21 (1.07 to 1.35)	1.07 (0.96 to 1.19)	1.37 (0.87 to 2.17)

BMJ Open

Impact and longevity of measles-associated immune suppression: a matched cohort study using data from the THIN general practice database in the UK

Kartini Gadroen,[1] Caitlin N Dodd,[1] Gwen M C Masclee,[1] Maria A J de Ridder,[1] Daniel Weibel,[1] Michael J Mina,[2] Bryan T Grenfell,[3] Miriam C J M Sturkenboom,[1] David A M C van de Vijver,[4] Rik L de Swart[4]

This study examined **children aged 1–15 years** in The Health Improvement Network UK general practice medical records database. Participants included **2228 patients diagnosed with measles** between **1990 and 2014**, which were **matched on age, sex, general practitioner practice and calendar year with 19 930 children without measles**

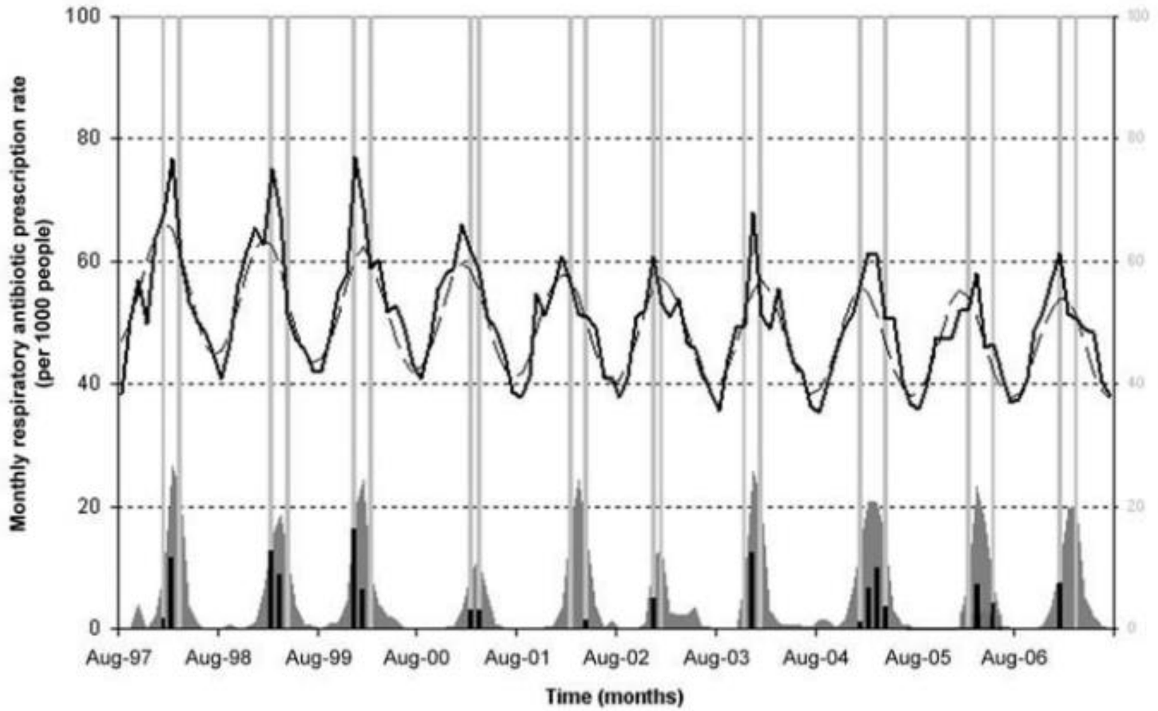


doi:10.1136/ bmjopen-2017-021465

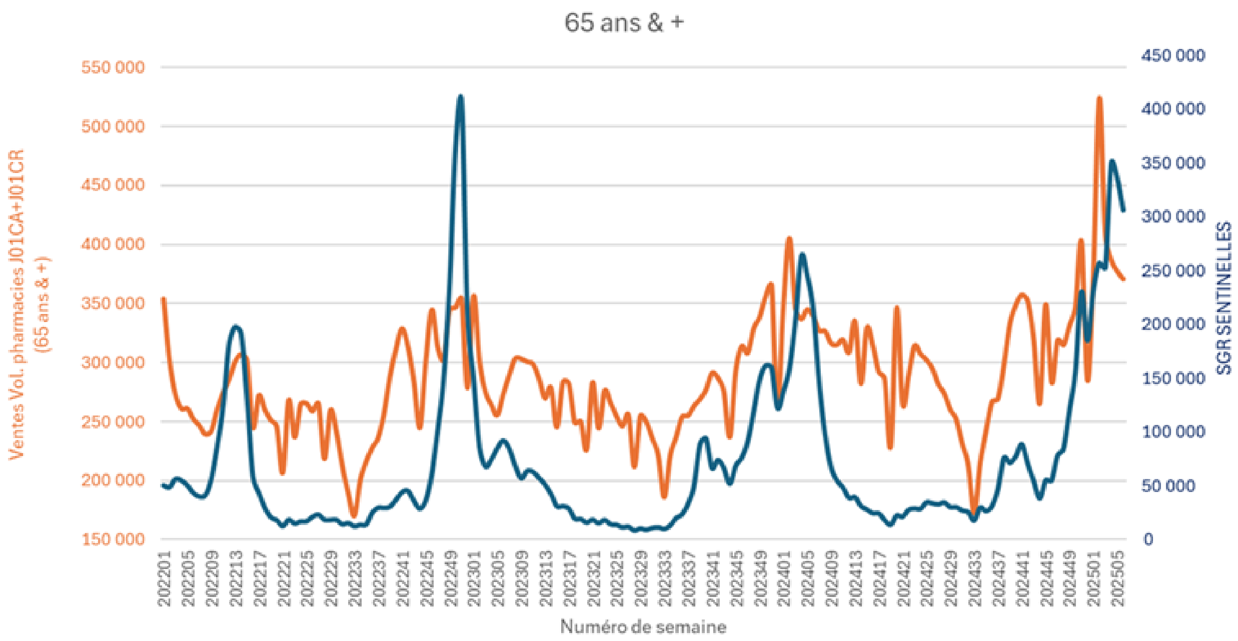
Les vaccins contre les virus respiratoires

Infections virales, quel impact sur la consommation d'ATB?

- Grippe



- Sd grippaux réseau Sentinelles



Kwong JC, et al., Clin Infect Dis. 2009 Sep 1;49(5):750-6.
Magali Lemaitre 2025 OpenHealth Company

Infections respiratoires virales, quel impact sur la consommation d’ATB?

- Toutes les infections virales respiratoires sont associées à une consommation importante d’ATB:
  - 68% dans une étude norvégienne 4000 infections respiratoires documentées
- VRS= ~70%
  - *Sur 190 adultes VRS+, 65% gardait des ATB au-delà du résultat, Parmi eux 22% recevaient une ATB pour une surinfection bactérienne, 31% pour une autre cause, mais au total 47% recevaient une ATB thérapie non justifiée*
- Grippe= 30%-74% en fonction du contexte (ambulatoire/ hôpital)
- COVID= prescription d’ATB dans 39%-95%! notamment au début

Hovind MJ, et al., Infect Dis (Lond). 2024 Dec;56(12):1031-1039.
van Brummelen S, Int J Chron Obstruct Pulmon Dis. 2022 Jun 1;17:1261-1267
Zanchetta T. manuscript submitted
Van Laethem J,et al., . Intern Emerg Med. 2022 Jan;17(1):141-151
Calderon M, et al., BMC Infect Dis. 2023 Jan 9;23(1):14.

Effet de la vaccination sur la consommation ATB

- Vaccination Grippe associée à 13-50% de réduction de consommation ATB

Efficacy studies of influenza vaccine impact on antibiotic use		
Turkey	Influenza	Episodes of acute otitis media and otitis media with effusions occurred in 2.3% and 22.8% of influenza vaccine recipients, respectively, vs. 5.2% and 31.1% of controls during influenza season; $P < 0.001$ (26)
Italy	Influenza	In a control study of influenza vaccination, vaccinated children had 13.2% fewer antibiotic prescriptions during the 6-mo observation period in their study; study children had 54.8% fewer otitis media episodes, which likely contributed to the reduction in antibiotic use (27)
Europe	Influenza	In this randomized, controlled study in 6- to 36-mo-old children, influenza vaccinees had 50% fewer antibiotic prescriptions and 47% fewer confirmed influenza infections during five consecutive seasons (28)
Observational studies of influenza vaccine impact on antibiotic use		
Canada	Influenza	Influenza vaccine recipients had 64% fewer antibiotic prescriptions than controls (29)
United Kingdom	Influenza (live attenuated virus vaccine)	In vaccinated children, 14.5% fewer amoxicillin prescriptions were given during the period of influenza virus circulation compared with other time periods (30)

K.P. Klugman, et al., *Proc. Natl. Acad. Sci. U.S.A.* 115 (51) 12896-12901

Clinical Microbiology and Infection 25 (2019) 1213–1225

Contents lists available at ScienceDirect

Clinical Microbiology and Infection

journal homepage: www.clinicalmicrobiologyandinfection.com

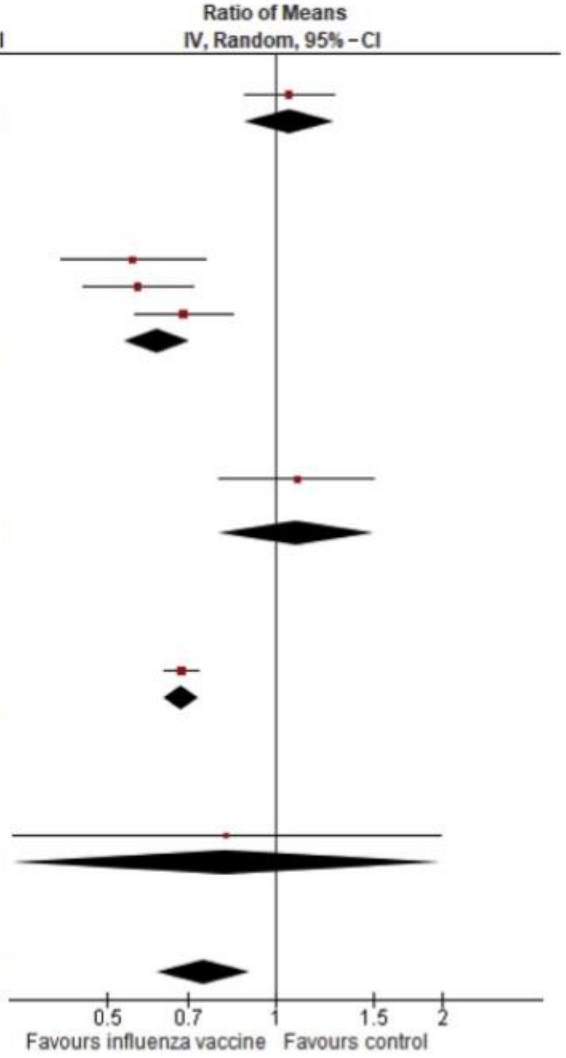
Systematic review

Impact of vaccination on antibiotic usage: a systematic review and meta-analysis

B.S. Buckley [1,2], N. Henschke [2,*], H. Bergman [2], B. Skidmore [3], E.J. Klemm [4], G. Villanueva [2], C. Garritty [5], M. Paul [6]

(a)

Study or Subgroup	log[Ratio of Means]	SE	Influenza vaccine Total	Control Total	Weight	Ratio of Means IV, Random, 95% CI
4.1.1 Infants and children up to 24 months						
Hoberman 2003 (40)	0.05931658	0.09320084	513	252	17.2%	1.06 [0.88, 1.27]
Subtotal (95% CI)			**513**	**252**	**17.2%**	**1.06 [0.88, 1.27]**
Heterogeneity: Not applicable						
Test for overall effect: Z = 0.64 (P = 0.52)						
4.1.2 Infants and children 6 months to 14 years						
Esposito 2003 (38)	-0.58438819	0.15287943	64	63	13.6%	0.56 [0.41, 0.75]
Marchisio 2009 (41)	-0.56639547	0.11600359	90	90	15.8%	0.57 [0.45, 0.71]
Principi 2003 (43)	-0.37561214	0.10377834	202	101	16.6%	0.69 [0.56, 0.84]
Subtotal (95% CI)			**356**	**254**	**46.0%**	**0.62 [0.54, 0.70]**
Heterogeneity: Tau² = 0.00; Chi² = 2.03, df = 2 (P = 0.36); I² = 1%						
Test for overall effect: Z = 6.99 (P < 0.00001)						
4.1.3 Adults with COPD 40 to 88 years						
Clancy 2016 (37)	0.09097178	0.16245614	160	160	13.0%	1.10 [0.80, 1.51]
Tandon 2010 (44)	-0.81719983	0	18	20		Not estimable
Subtotal (95% CI)			**178**	**180**	**13.0%**	**1.10 [0.80, 1.51]**
Heterogeneity: Not applicable						
Test for overall effect: Z = 0.56 (P = 0.58)						
4.1.4 Older adults >60 years with chronic bronchitis						
Gao 2011 (39)	-0.38519247	0.03507004	73	65	19.9%	0.68 [0.64, 0.73]
Subtotal (95% CI)			**73**	**65**	**19.9%**	**0.68 [0.64, 0.73]**
Heterogeneity: Not applicable						
Test for overall effect: Z = 10.98 (P < 0.00001)						
4.1.5 All age groups						
Pisu 2005 (42)	-0.2006707	0.45080957	75	48	3.8%	0.82 [0.34, 1.98]
Subtotal (95% CI)			**75**	**48**	**3.8%**	**0.82 [0.34, 1.98]**
Heterogeneity: Not applicable						
Test for overall effect: Z = 0.45 (P = 0.66)						
Total (95% CI)			**1195**	**799**	**100.0%**	**0.75 [0.62, 0.90]**
Heterogeneity: Tau² = 0.05; Chi² = 33.62, df = 6 (P < 0.00001); I² = 82%						
Test for overall effect: Z = 3.02 (P = 0.003)						
Test for subgroup differences: Chi² = 31.55, df = 4 (P < 0.00001), I² = 87.3%						



ig. 4. Forest plots for influenza vaccines. (a) Number of antibiotic courses or prescriptions (follow up: 4 months to 2 years);

van Heuvel *et al.*
Antimicrobial Resistance & Infection Control (2023) 12:70
https://doi.org/10.1186/s13756-023-01272-6

Antimicrobial Resistance
and Infection Control

REVIEW Open Access

The impact of influenza and pneumococcal vaccination on antibiotic use: an updated systematic review and meta-analysis

Lotte van Heuvel[1], John Paget[1*], Michel Dückers[1,2,3] and Saverio Caini[1]

« [comparative studies] show that the effect of influenza vaccination on the number of antibiotic prescriptions or days of antibiotic use (Ratio of Means (RoM) 0.71, 95% CI 0.62–0.83) **is stronger compared to the effect of pneumococcal vaccination** (RoM 0.92, 95% CI 0.85–1.00)”

Study	Ratio of means (95% CI)
Adults	
Yilmaz, 2013	0.24 (0.12-0.49)
van Werkhoven, 2021	1.04 (0.99-1.09)
Subtotal (I-squared = 93.8%)	**0.52 (0.12-2.20)**
Children	
Dagan, 2001	0.85 (0.76-0.96)
Fireman, 2003	0.94 (0.93-0.96)
Jansen, 2008	0.73 (0.40-1.33)
Palmu, 2018	0.93 (0.86-1.00)
O'Grady, 2018	0.87 (0.66-1.15)
Subtotal (I-squared = 1.7%)	**0.94 (0.92-0.96)**
Summary	**0.92 (0.85-1.00)**

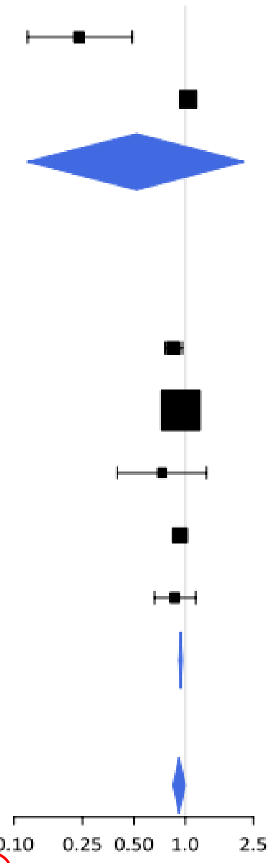


Fig. 4 Number of antimicrobial prescriptions or days of antibiotic use after pneumococcal vaccination

Study	Risk Ratio (95% CI)
WHO European Region	
Marchisio, 2002	0.61 (0.43-0.87)
Allsup, 2003	1.43 (0.71-2.89)
Vesikari, 2006	1.01 (0.89-1.14)
Dbaibo, 2020	0.29 (0.18-0.48)
Subtotal (I-squared = 89.8%)	**0.70 (0.40-1.23)**
WHO Region of the Americas	
Belshe, 1998	0.71 (0.62-0.81)
Bridges, 2000	0.81 (0.52-1.27)
Loeb, 2010	0.69 (0.58-0.83)
Dbaibo, 2020	0.41 (0.27-0.62)
Subtotal (I-squared = 55.1%)	**0.66 (0.55-0.79)**
WHO Western Pacific Region	
Dbaibo, 2020	0.64 (0.50-0.81)
Subtotal (I-squared = .)	**0.64 (0.50-0.81)**
Mixed Regions	
Pepin, 2019	0.39 (0.27-0.56)
Subtotal (I-squared = .)	**0.39 (0.27-0.56)**
Summary	**0.63 (0.51-0.79)**

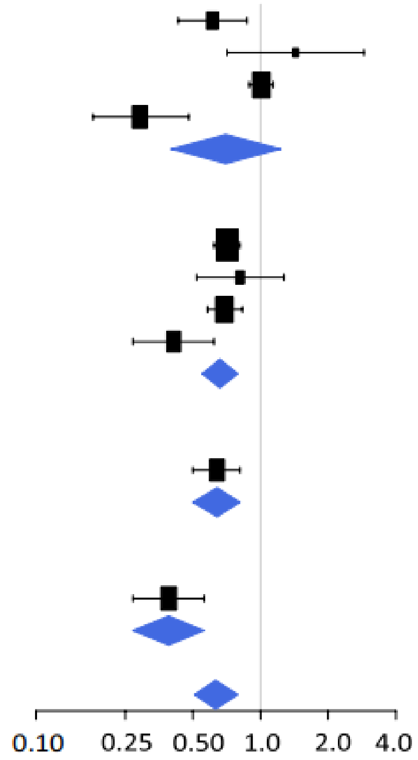


Fig. 3 Number of antimicrobial prescriptions or days of antibiotic use after influenza vaccination

van Heuvel L, et al.Antimicrob Resist Infect Control. 2023 Jul 14;12(1):70.

Effet de la vaccination sur la consommation ATB

- Impact de la vaccination COVID-19

Clinical Infectious Diseases
MAJOR ARTICLE
IDSA hivma OXFORD

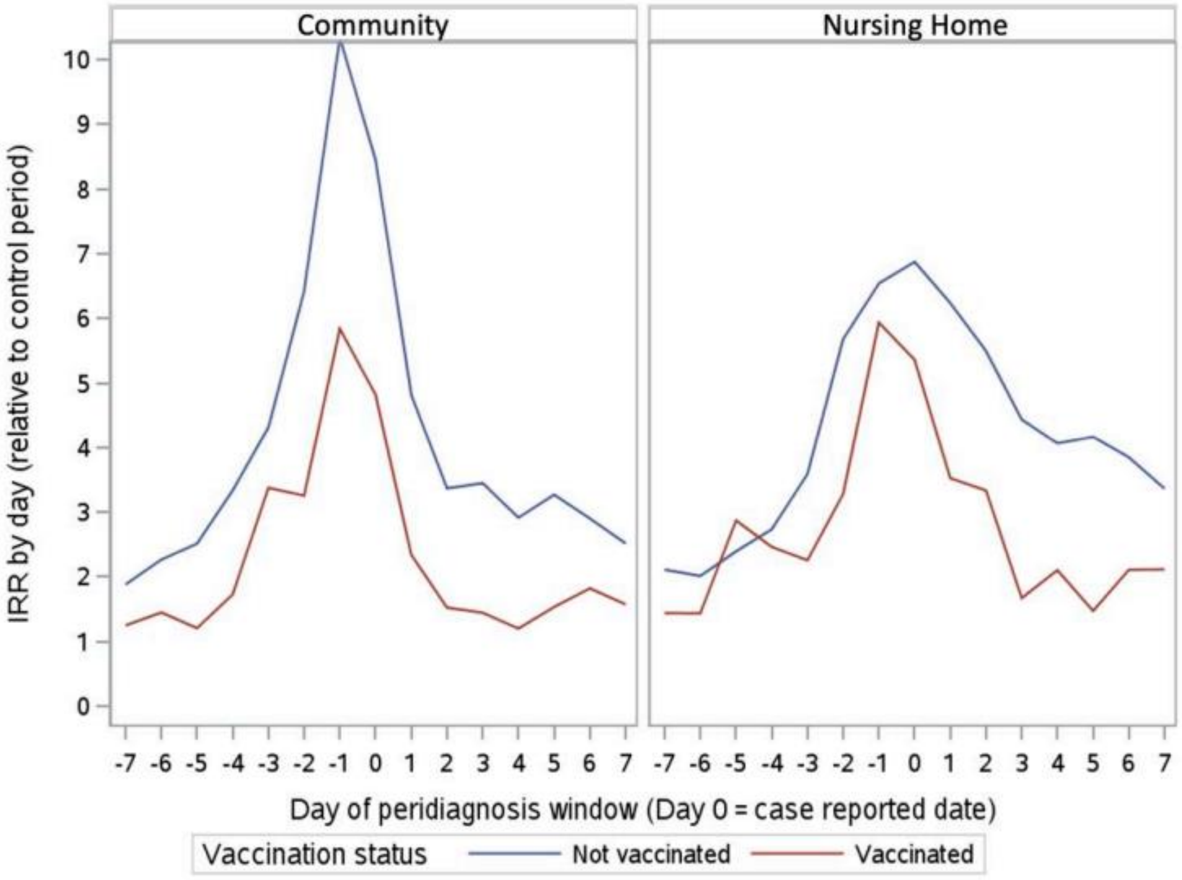
Coronavirus Disease 2019 Vaccination Is Associated With Reduced Outpatient Antibiotic Prescribing in Older Adults With Confirmed Severe Acute Respiratory Syndrome Coronavirus 2: A Population-Wide Cohort Study

Derek R. MacFadden,[1,2,3] Colleen Maxwell,[2,4] Dawn Bowdish,[5] Susan Bronskill,[2] James Brooks,[3] Kevin Brown,[6,7] Lori L. Burrows,[5] Anna Clarke,[2] Bradley Langford,[6,7] Elizabeth Leung,[8,9] Valerie Leung,[7,10] Doug Manuel,[2] Allison McGeer,[11] Sharmistha Mishra,[2,6,12,13,14] Andrew M. Morris,[11] Caroline Nott,[3] Sumit Raybardhan,[6,15] Mia Sapin,[16] Kevin L. Schwartz,[2,6,7,8] Miranda So,[9,17] Jean-Paul R. Soucy,[6] and Nick Daneman[2,18]

Ontario, 13 529 eligible nursing home residents and 50 885 eligible community-dwelling adults with SARS-CoV-2 infection 2020-2021

	Prediagnosis		Postdiagnosis		Control Period	
Variable	Rate	IRR (95% CI)	Rate	IRR (95% CI)	Rate	IRR
All	14.97	3.52 (3.28–3.77)	20.92	4.92 (4.59–5.27)	4.25	Ref
Age, y						
65–74	15.92	3.41 (2.83–4.10)	22.02	4.71 (3.89–5.70)	4.67	Ref
75–84	15.76	3.57 (3.15–4.06)	20.33	4.61 (4.05–5.24)	4.41	Ref
≥85	14.37	3.52 (3.21–3.86)	20.99	5.14 (4.70–5.63)	4.08	Ref
Sex						
Female	13.98	3.29 (3.03–3.58)	19.06	4.49 (4.13–4.88)	4.24	Ref
Male	17.13	4.01 (3.53–4.55)	25.14	5.88 (5.20–6.65)	4.27	Ref
COVID-19 vaccine						
<2 doses	15.00	3.59 (3.34–3.85)	21.43	5.12 (4.77–5.50)	4.19	Ref
≥2 doses	14.56	2.81 (2.18–3.63)	14.40	2.78 (2.13–3.64)	5.18	Ref
Index period						
January–June 2020	18.33	4.31 (3.86–4.83)	18.71	4.40 (3.91–4.96)	4.25	Ref
July–December 2020	12.75	3.11 (2.75–3.51)	20.58	5.02 (4.45–5.66)	4.10	Ref
January–June 2021	13.34	3.14 (2.71–3.63)	26.54	6.24 (5.46–7.14)	4.25	Ref
July–December 2021	13.95	2.66 (2.03–3.50)	13.17	2.52 (1.87–3.38)	5.23	Ref

Abbreviations: CI, confidence interval; COVID-19, coronavirus disease 2019; IRR, incidence rate ratio; Ref, reference.



MacFadden DR, et al., Clin Infect Dis. 2023 Aug 14;77(3):362-370.

Clinical Infectious Diseases
MAJOR ARTICLE

The Effect of COVID-19 Vaccination on Outpatient Antibiotic Prescribing in Older Adults: A Self-Controlled Risk-Interval Study

Sarah C. J. Jorgensen,[1,2,3] Kevin Brown,[2,3,4] Anna E. Clarke,[3] Kevin L. Schwartz,[2,3,4,5] Colleen Maxwell,[3,6] Nick Daneman,[3,7] Jeffrey C. Kwong,[2,3,4,8,9,10] and Derek R. MacFadden[1,3,11]

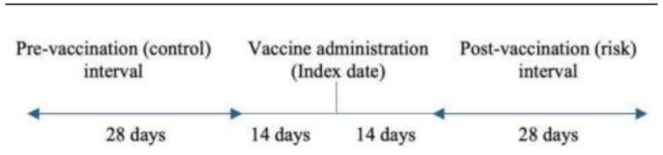
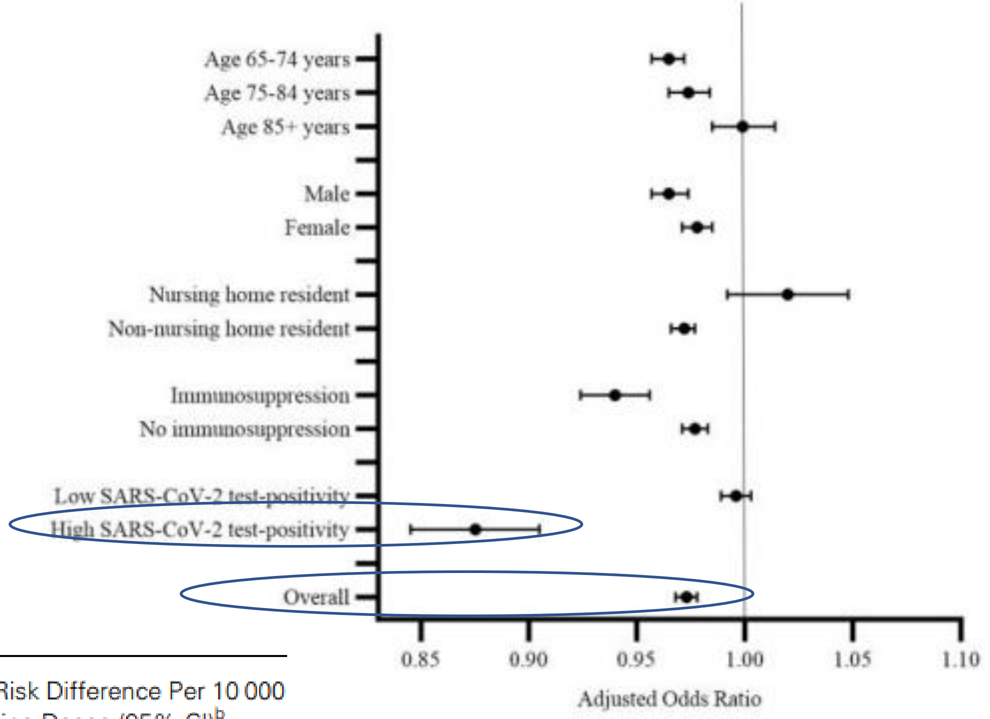


Figure 1. Self-controlled risk-interval study design.

Adults aged ≥65 years who received their first, second, and/or third COVID-19 vaccine dose from December 2020 to December 2022.

469 923 vaccine doses met inclusion criteria

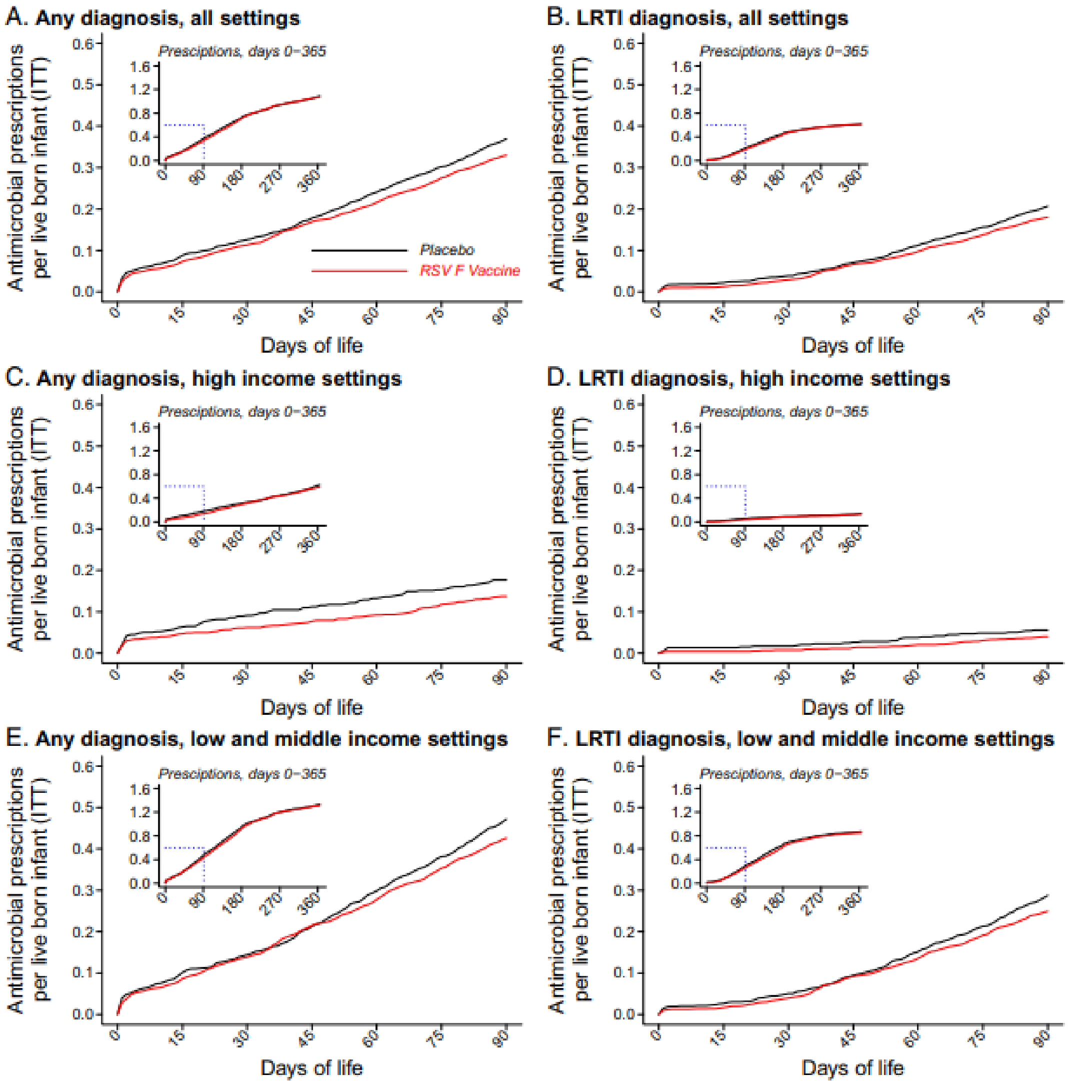


odds ratios for antibiotic prescribing comparing the post-
val with the pre-vaccination (control) interval, by age, sex,
e, immunosuppression status, and Ontario SARS-CoV-2 test-
n: SARS-CoV-2, severe acute respiratory syndrome coronavi-

Antibiotic Group	Post-Vaccination (Risk) Interval[a]	Pre-Vaccination (Control) Interval[a]	Unadjusted OR (95% CI)	Adjusted OR (95% CI)[b]	Adjusted Risk Difference Per 10 000 Vaccine Doses (95% CI)[b]
All antibiotics					
All doses	230 276/469 923 (49.0%)	239 647/469 923 (51.0%)	.961 (.956–.966)	.973 (.968–.978)	9 (7–11)
Dose 1	77 149/156 177 (49.4%)	79 028/156 177 (50.6%)	.976 (.967–.986)	.983 (.973–.993)	6 (2–9)
Dose 2	79 971/157 092 (50.9%)	77 121/157 092 (49.1%)	1.037 (1.027–1.047)	1.010 (.994–1.026)	−3 (−8–2)
Dose 3	73 156/156 654 (46.7%)	83 498/156 654 (53.3%)	.876 (.867–.885)	.909 (.897–.921)	34 (30–39)
Respiratory antibiotics[c]					
All doses	125 758/257 812 (48.8%)	132 054/257 812 (51.2%)	.952 (.945–.959)	.961 (.953–.968)	7 (6–9)
Dose 1	41 802/84 122 (49.7%)	42 320/84 122 (50.3%)	.988 (.974–1.001)	.993 (.980–1.007)	1 (−1–4)
Dose 2	41 617/83 081 (50.1%)	41 464/83 081 (49.9%)	1.004 (.990–1.017)	.997 (.983–1.013)	1 (−2–3)
Dose 3	42 339/90 609 (46.7%)	48 270/90 609 (53.3%)	.877 (.866–.889)	.898 (.885–.911)	22 (20–25)
Urinary antibiotics[d]					
All doses	79 707/160 431 (49.7%)	80 724/160 431 (50.3%)	.987 (.978–.997)	.996 (.987–1.006)	0 (−1–2)
Dose 1	26 491/53 337 (49.7%)	26 846/53 337 (50.3%)	.987 (.970–1.004)	.989 (.973–1.006)	1 (−1–3)
Dose 2	28 522/54 678 (52.2%)	26 156/54 678 (47.8%)	1.090 (1.072–1.109)	1.029 (.998–1.061)	−3 (−7–0)
Dose 3	24 694/52 416 (47.1%)	27 722/52 416 (52.9%)	.891 (.876–.906)	.958 (.934–.983)	5 (2–8)

Jorgensen SCJ, et al., Clin Infect Dis. 2024 Aug 16;79(2):375-381.

Vaccin VRS



PNAS RESEARCH ARTICLE | MEDICAL SCIENCES OPEN AC

Prevention of antimicrobial prescribing among infants following maternal vaccination against respiratory syncytial virus

Joseph A. Lewnard[a,b,c,1], Louis F. Fries[d], Iksung Cho[d], Janice Chen[d], and Ramanan Laxminarayan[e,f]

Plan

- Vaccins et antibiorésistance (AMR): rationnel
- Vaccins et antibiorésistance (AMR): données sur les vaccins existants
  - Vaccins antibactériens
  - Vaccins antiviraux
- Vaccins et antibiorésistance (AMR):perspectives

Pas que les enfants

Global burden of bacterial antimicrobial resistance 1990–2021: a systematic analysis with forecasts to 2050

*GBD 2021 Antimicrobial Resistance Collaborators**

- Problème majeur d'AMR chez les > 70 ans
- Population avec un élargissement des vaccins recommandés
- Couverture vaccinale très faible chez les sujets adultes

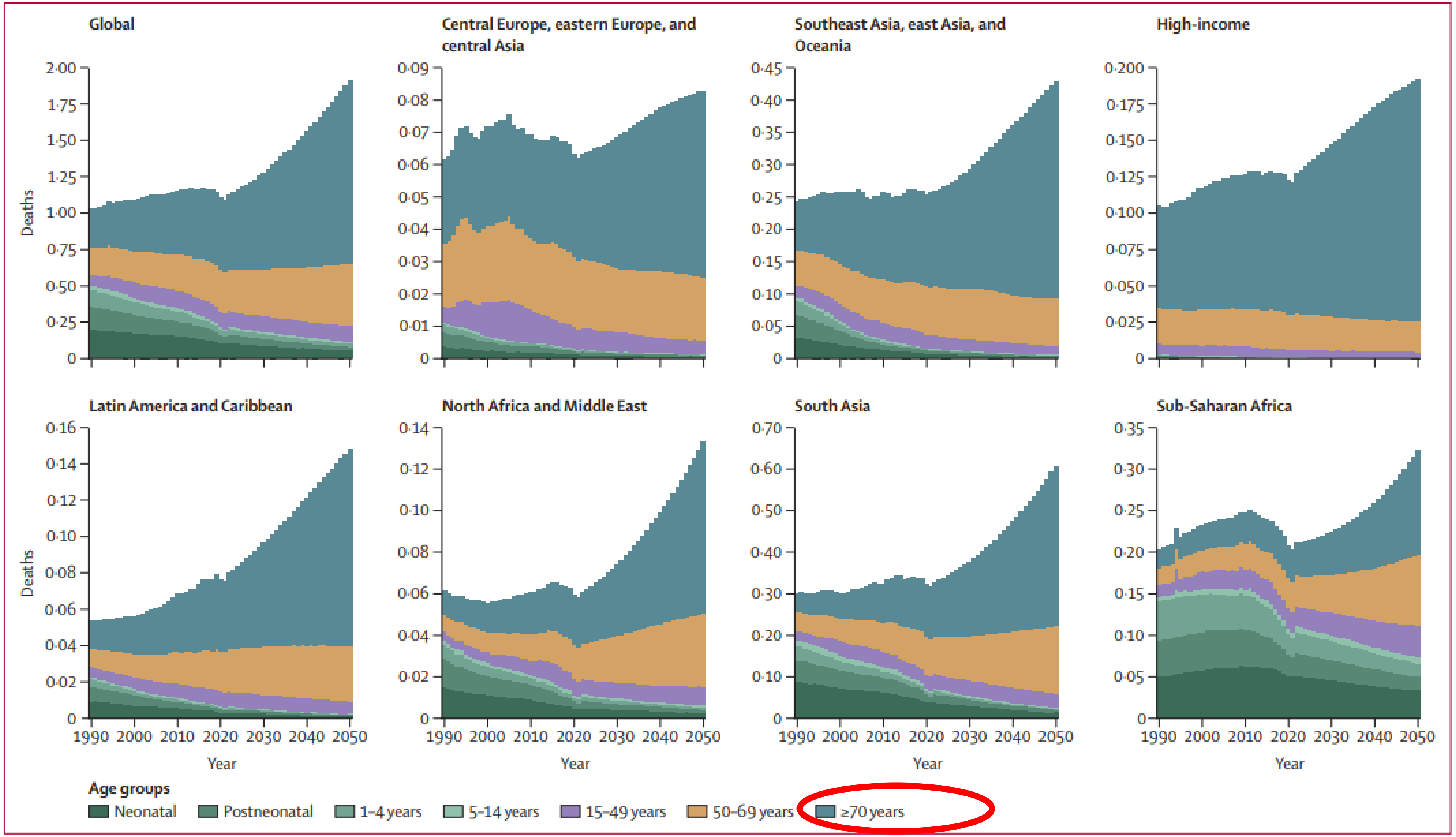
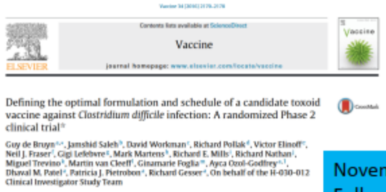


Figure 7: Deaths attributable to AMR by age group and location in the reference scenario, 2022–2050 Units are in millions.

https://doi.org/10.1016/ S0140-6736(24)01867-1

Les vaccins à venir

- SANOFI Pasteur: *Cdiffense*



Vaccine 34 (2016) 2170–2178

Contents lists available at ScienceDirect

Vaccine

journal homepage: www.elsevier.com/locate/vaccine

Defining the optimal formulation and schedule of a candidate toxoid vaccine against *Clostridium difficile* infection: A randomized Phase 2 clinical trial

Guy de Bruyn, Jamshid Saleh, David Workman, Richard Pollak, Victor Elinoff, Neil J. Fraser, Gigi Lefebvre, Mark Martens, Richard E. Mills, Richard Nathan, Miguel Trevino, Martin van Cleeff, Ginamarie Foglia, Ayca Ozol-Godfrey, Dhaval M. Patel, Patricia J. Pietrobon, Richard Gesser, On behalf of the H-030-012 Clinical Investigator Study Team

Vaccin toxoïde à base de toxine A et de toxine B inactivées, adjuvanté par l'alun. 3 injections (J0, J7, J30) pour obtenir le taux d'AC. Population cible 50-85 ans

Interim analysis

November 2017
Following an external analysis of study data the **Independent Data Monitoring Committee (IDMC)** has recommended that the *Cdiffense* study (Phase 3) be stopped for **futility** (non-efficacy). The planned interim analysis by the IDMC of the *Cdiffense* trial concluded that the probability the study would meet its primary objective is low.

INDEPENDENT DATA MONITORING COMMITTEE RECOMMENDS DISCONTINUATION OF THE PHASE 2B STRIVE CLINICAL TRIAL OF STAPHYLOCOCCUS AUREUS VACCINE FOLLOWING PLANNED INTERIM ANALYSIS

Thursday, December 20, 2018 - 4:30pm EST

NEW YORK--(BUSINESS WIRE)--Pfizer Inc. (NYSE:PFE) announced today that the Phase 2b trial STRIVE (*STaphylococcus aureus* SuRgical Inpatient Vaccine Efficacy) evaluating the company's investigational *Staphylococcus aureus* (*S. aureus*) multi-antigen vaccine (PF-06290510) is being discontinued due to futility. This decision is based on a recommendation from an independent Data Monitoring Committee (DMC), composed of external experts, after conducting a pre-planned interim analysis.

A safety review by the DMC indicated that the investigational vaccine has been safe and well tolerated. STRIVE participants who are enrolled in the study will complete the study's follow-up evaluations.

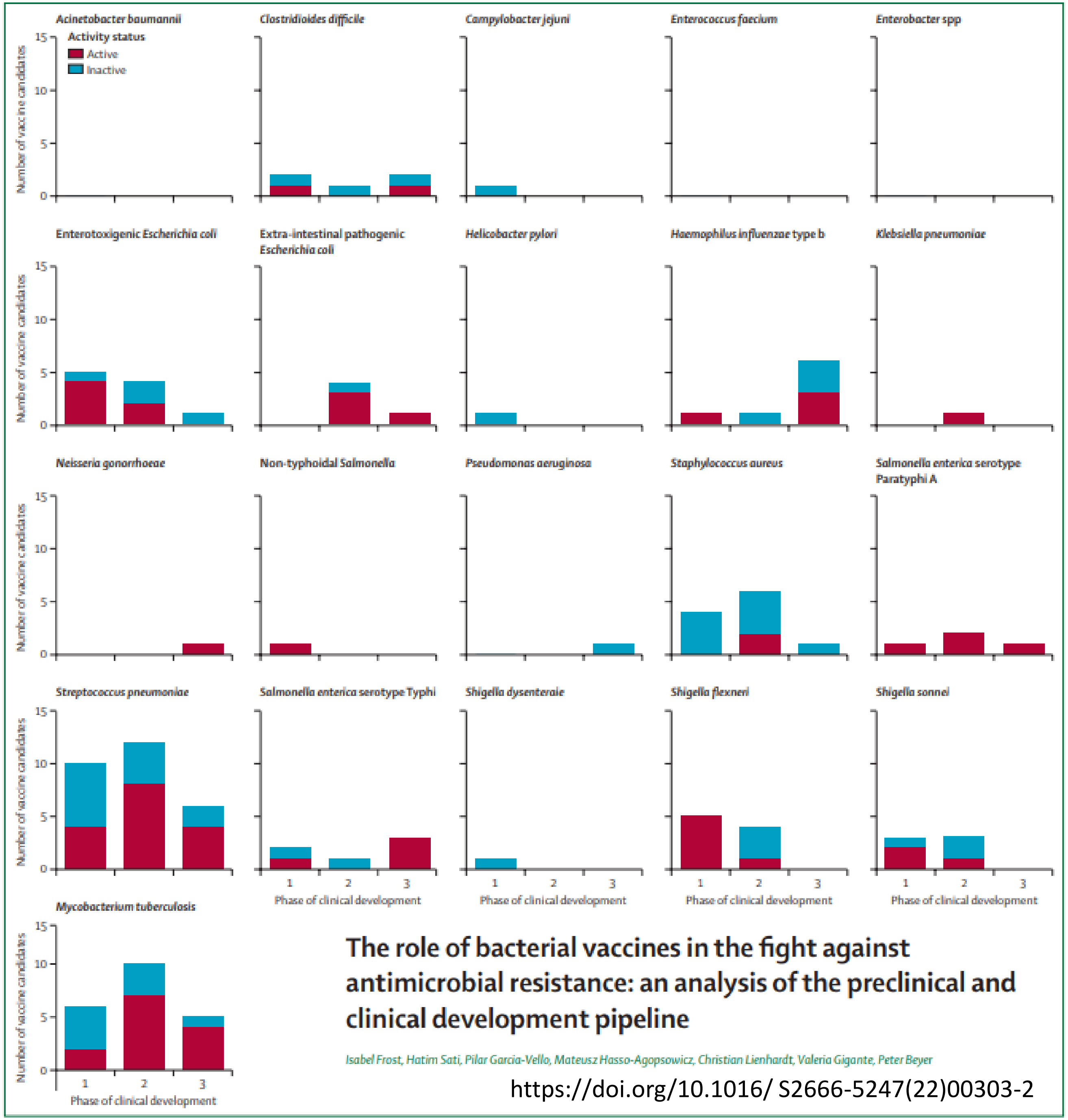
Pfizer is evaluating next steps for the potential development of a *S. aureus* vaccine.

BREAKING NEWS, COLLABORATIONS & ALLIANCES, TRIALS & FILINGS

Sanofi, J&J Discontinue E.mbrace Study

Sanofi and Johnson & Johnson's E. coli vaccine candidate failed to prevent invasive E. coli disease effectively.

February 14, 2025



The role of bacterial vaccines in the fight against antimicrobial resistance: an analysis of the preclinical and clinical development pipeline

Isabel Frost, Hatim Sati, Pilar Garcia-Vello, Mateusz Hasso-Agopsowicz, Christian Lienhardt, Valeria Gigante, Peter Beyer

https://doi.org/10.1016/ S2666-5247(22)00303-2

Figure 3: Number of vaccine candidates by phase of clinical development and continued activity

La vaccination animale

REVIEW Open Access

CrossMark

Vaccines as alternatives to antibiotics for food producing animals. Part 1: challenges and needs

Karin Hoelzer[1*], Lisa Bielke[2], Damer P. Blake[3], Eric Cox[4], Simon M. Cutting[5], Bert Devriendt[4], Elisabeth Erlacher-Vindel[6], Evy Goossens[7], Kemal Karaca[8], Stephane Lemiere[9], Martin Metzner[10], Margot Raicek[6], Miquel Collell Suriñach[11], Nora M. Wong[1], Cyril Gay[12] and Filip Van Immerseel[7]

"in US, 70% of antimicrobials that are medically important are used in agriculture"

Table 1: Infections for which new or improved vaccines would significantly reduce the need for antibiotic use in chickens

Key syndrome	Primary pathogen(s) (disease)	Antibiotic use	Commercial* Vaccine exists	Major contraints to use of vaccine / vaccine development	Vaccine research priority
Systemic (Broilers)	*Escherichia coli (Yolk sac infection, airsacculitis, cellulitis)*	High	Yes	• Omphalitis: a secondary bacterial infection - not a disease one can immunize against • Strain coverage limited • Airsacculitis, cellulitis: vaccines available, e.g. live aerosol vaccine. However, Serotype coverage limited and field efficacy variable	High
	Infectious Bursal Disease virus (secondary bacterial infection)	Medium	Yes	• Issues with vaccine application • Short window of opportunity to vaccinate • Maternal antibody interference	Medium
Systemic (Breeders, Layers)	*Escherichia coli (airsacculitis, cellulitis, salpingitis, and periotonitis)*	High	Yes	• Strain coverage limited	High
Enteric (Broilers, Breeders, and Layers)	*Clostridium perfringens*, type A *(necrotic enteritis)*	High	Yes	• Toxoid vaccine for layers providing only short-lasting passive immunity • Research needed to achieve active immunity • Improved and/or more convenient (mass vaccination) vaccine needed for broilers	High
	Coccidiosis (secondary bacterial infections	High	Yes	• Lack of cross-protection • Strains ust be matched to infectious agent • Current vaccines are not attenuated and can produce low dose infection • Sub-unit vaccines have not been successful	High
	Infectious Bronchitis virus (secondary bacterial infection)	Medium	Yes	• Issues with strain matching and strain coverage • High mutation rate of virus	Medium

https://doi.org/10.1186/s13567-018-0560-8

http://resistancecontrol.info/2018-frontpage/2018-3/establishing-the-importance-of-human-and-animal-vaccines-in-preventing-antimicrobial-resistance/

https://www.hhs.gov/sites/default/files/erlacher-vindel-paccarb.pdf

Au total,

- Vaccins sont rarement réellement intégrés dans les plans d’AMR
- Vaccins existants ont un potentiel important pour réduire l’AMR
  - Pas que les vaccins antibactériens
  - Souvent pas assez utilisés (CV basses)
  - Ou non disponibles
  - Parfois pas/peu de données d’efficacité sur ce point
- Même avec des vaccins efficaces ne pas oublier tout le reste++
- Vaccins en développement +++ mais le chemin est assez lointain
- One health
- Au-delà de la résistance aux ATB… à d’autres anti-infectieux