Université de Strasbourg

Faculté de médecine Université de Strasbourg

Les Hôpitaux Universitaires de STRASBOURG

Les Journées Médicales de Strasbourg

Les co-infections virus-bactéries

Symposium Pfizer « Comment atténuer la triple épidémie hivernale? »

Docteur Victor Gerber
CCU-AH,
Service de maladies infectieuses et tropicales,
Nouvel Hôpital Civil

Déclarations d'intérêt

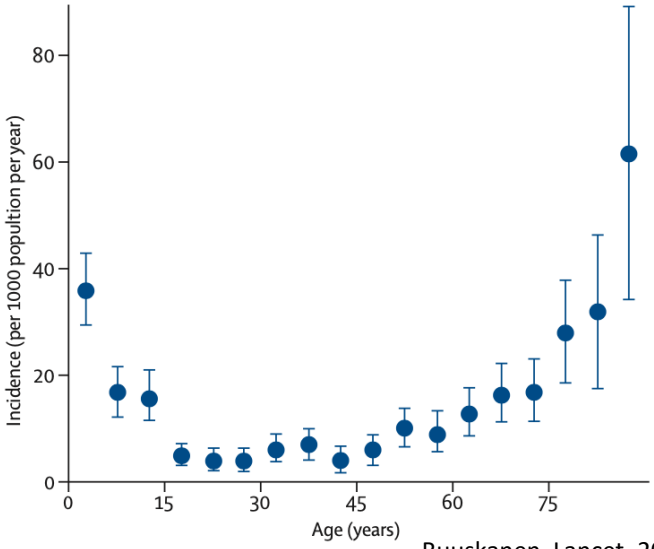
- **Intérêts financiers : Aucun**
- **Liens durables ou permanents : Aucun**
- **Interventions ponctuelles : Pfizer**
- **Intérêts indirects : Aucun**

PLAN

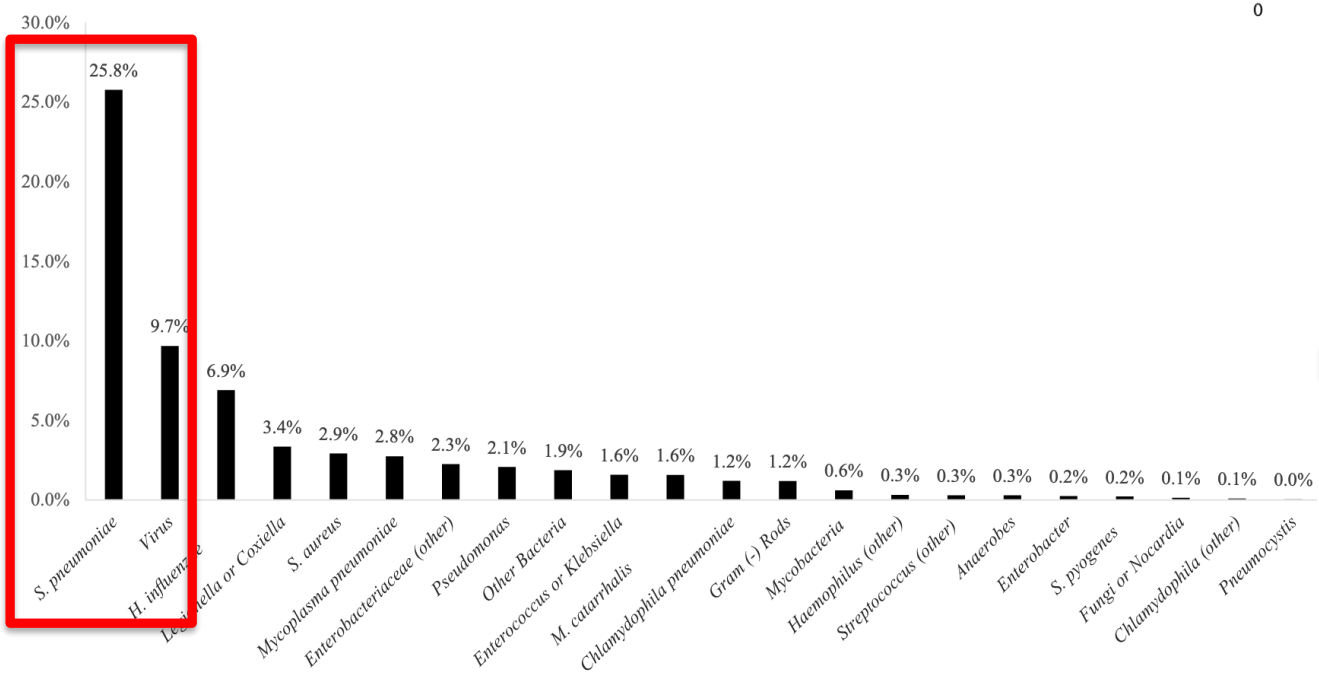
- INTRODUCTION
- EPIDEMIOLOGIE
- PHYSIOPATHOLOGIE
- DIAGNOSTIC
- IMPACT
- GRIPPE
- SARS-CoV-2
- VRS
- CONCLUSION

Introduction pneumonie

- Incidence majorées aux âges extrêmes
- Incidence : 14 cas / 1000 habitants
- ***S. pneumoniae* et virus = pathogènes les plus fréquents**
- Virus: grippe, VRS et actuellement SARS-CoV-2



Ruuskanen, Lancet, 2011



Tsoumani, Expert Review of Vaccines, 2023

***Panel*: Viruses linked to community-acquired pneumonia in children and adults**

- Respiratory syncytial virus
- Rhinovirus
- Influenza A, B, and C viruses
- Human metapneumovirus
- Parainfluenza viruses types 1, 2, 3, and 4
- Human bocavirus*
- Coronavirus types 229E, OC43, NL63, HKU1, SARS
- Adenovirus
- Enteroviruses
- Varicella-zoster virus
- Hantavirus
- Parechoviruses
- Epstein-Barr virus
- Human herpesvirus 6 and 7
- Herpes simplex virus
- Mimivirus
- Cytomegalovirus†
- Measles†

Ruuskanen, Lancet, 2011

Epidémiologie des co-infections

- 25% de virus dans les pneumonies
- 200 millions de pneumonie virale / an dans le monde
- Co-infections virus-bactéries ≈ 5%

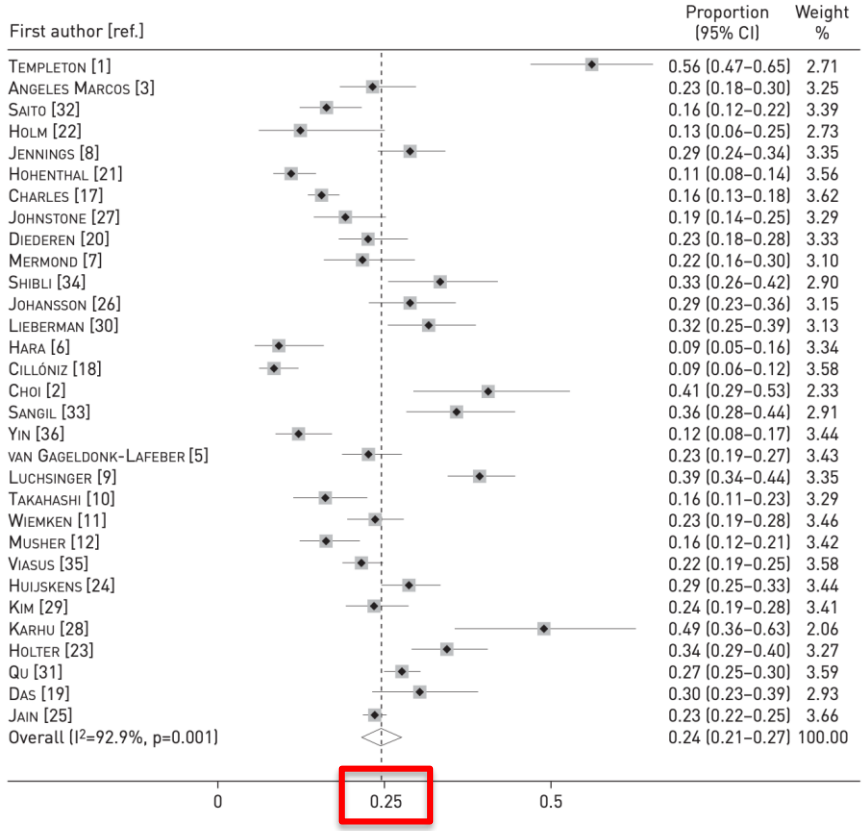
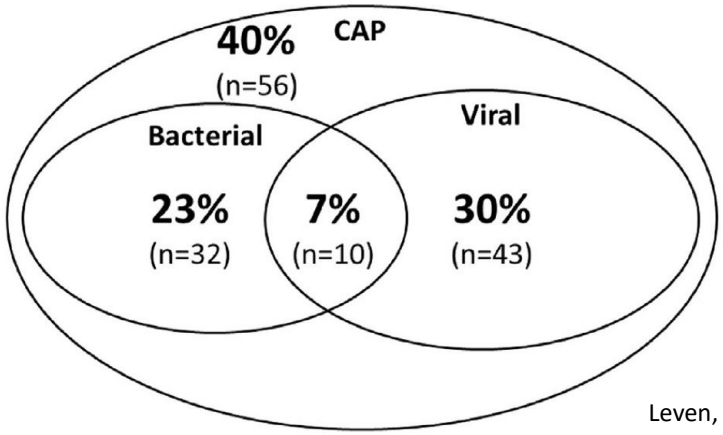
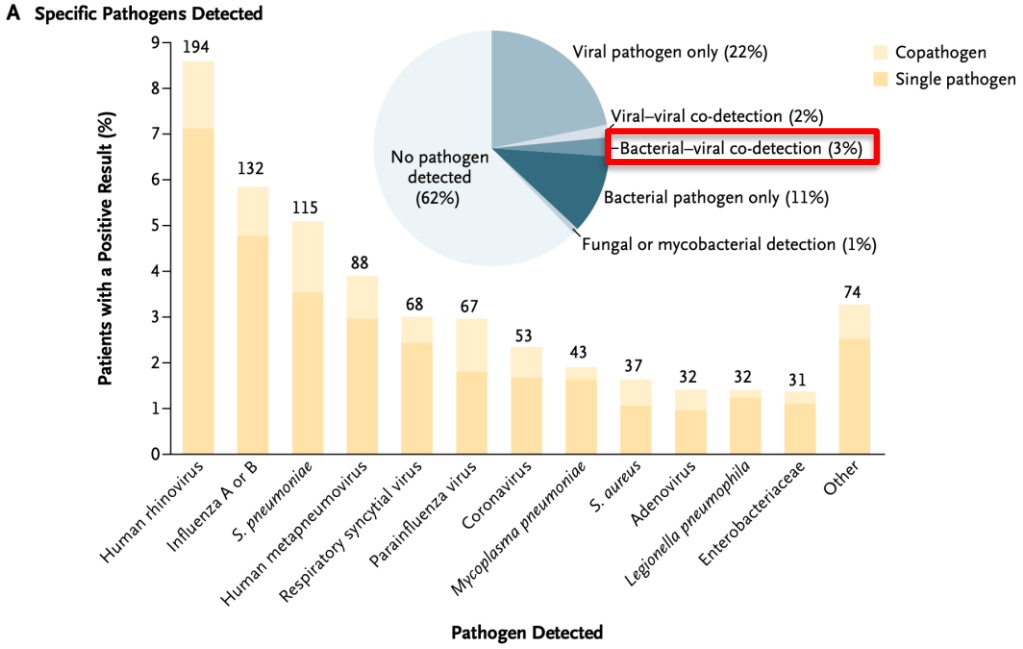


FIGURE 2 Forest plot displaying meta-analysis of the proportion of viral infection in patients with community-acquired pneumonia. Weights are from random-effects analysis.

Burk, Eur Respir Revi, 2016



Leven, CMI, 2018



Jain, NEJM, 2015

Epidémiologie des co-infections (2)

- Principale bactérie impliquée: *Streptococcus pneumoniae*
- Saisonnalité des infections invasives à pneumocoque
- Lien entre infections invasives à pneumocoque et épidémies virales

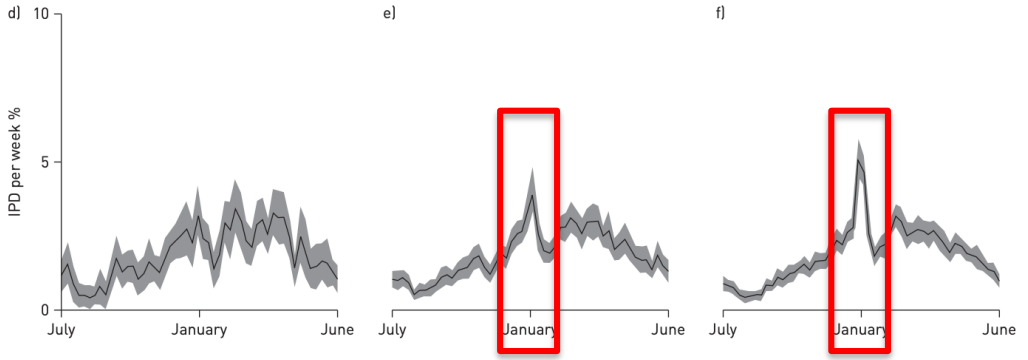
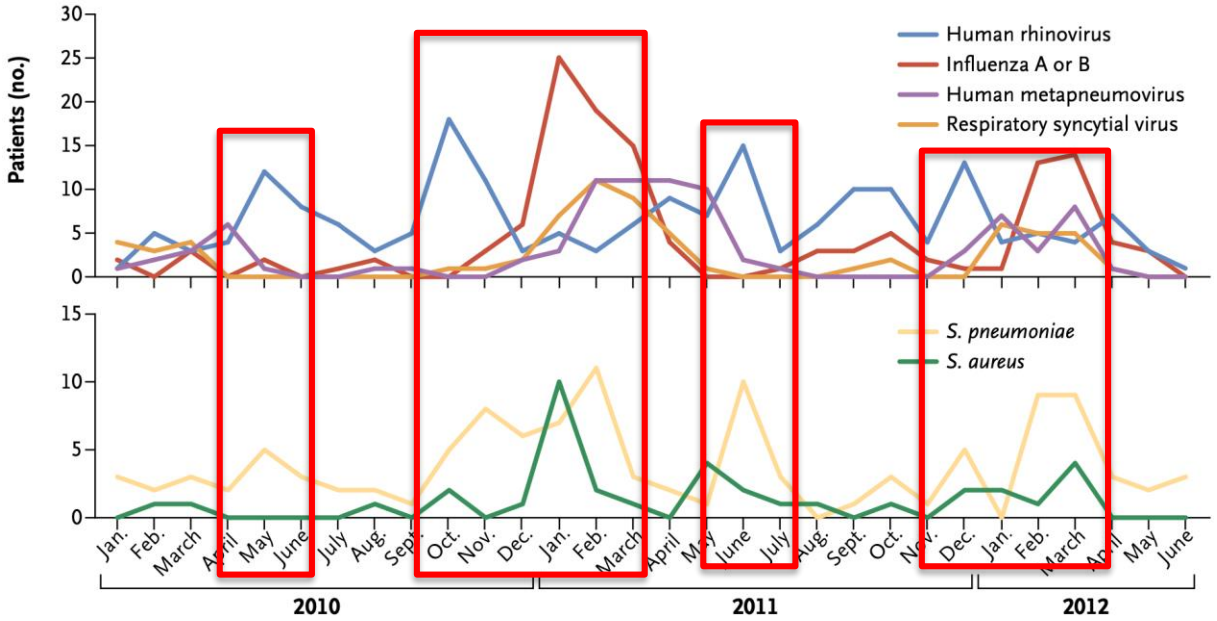


FIGURE 1 Seasonal fluctuations in the incidence of invasive pneumococcal disease (IPD), expressed as percentage of disease occurring in each week out of the total cases in each July–June season for those aged a) <5, b) 5–14, c) 15–24, d) 25–39, e) 40–64 and f) ⩾65 years. Shading shows the 95% confidence intervals by age group.

Weinberger, ERJ, 2013



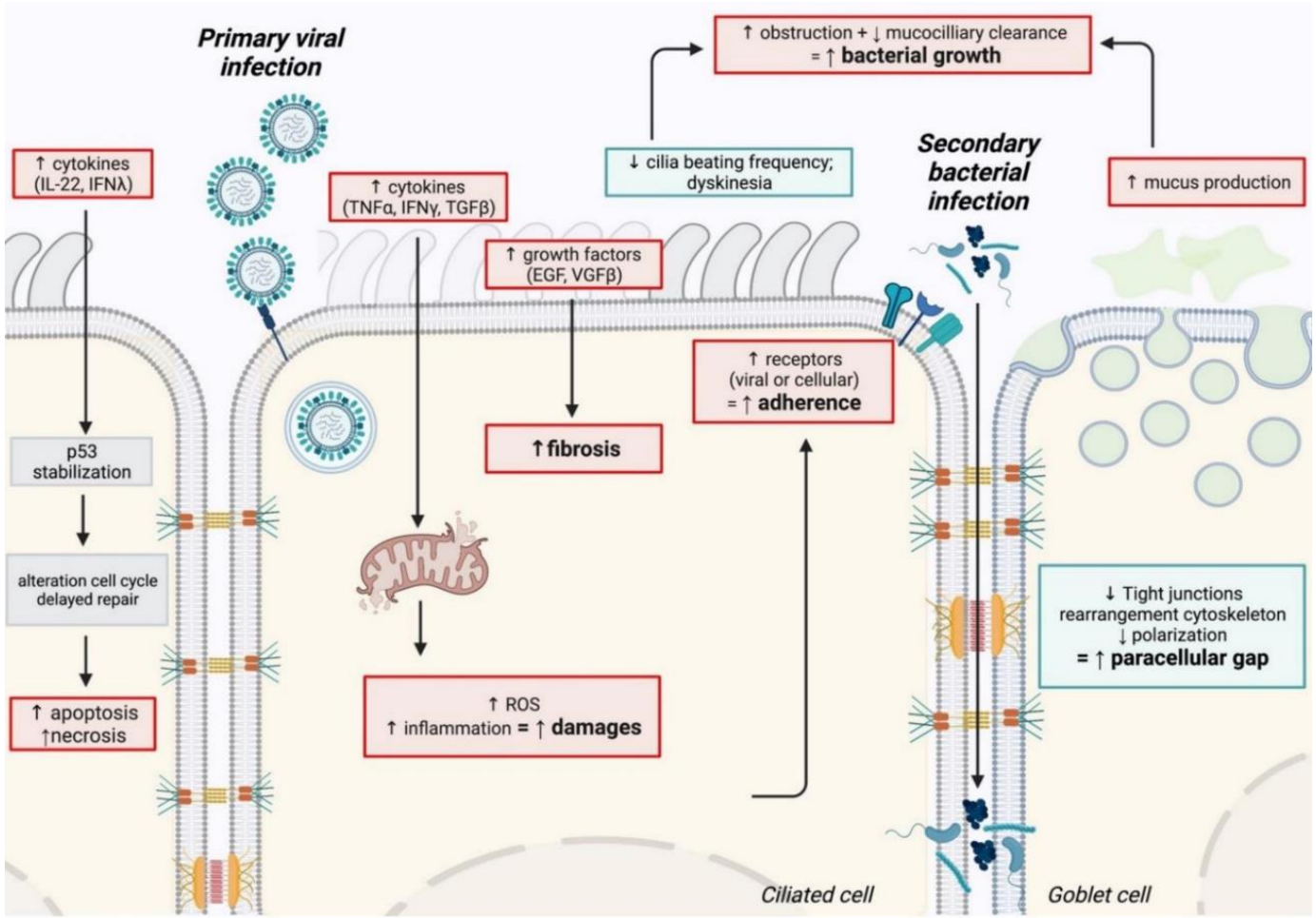
Jain, NEJM, 2015

Physiopathologie des co-infections

- Infection virale induit : apoptose, dommages cellulaire, fibrose, dyskinésie ciliaire

→ Perturbation fonction et intégrité épithélium

→ Milieu propice pour développement bactéries



Oliva, Viruses, 2021

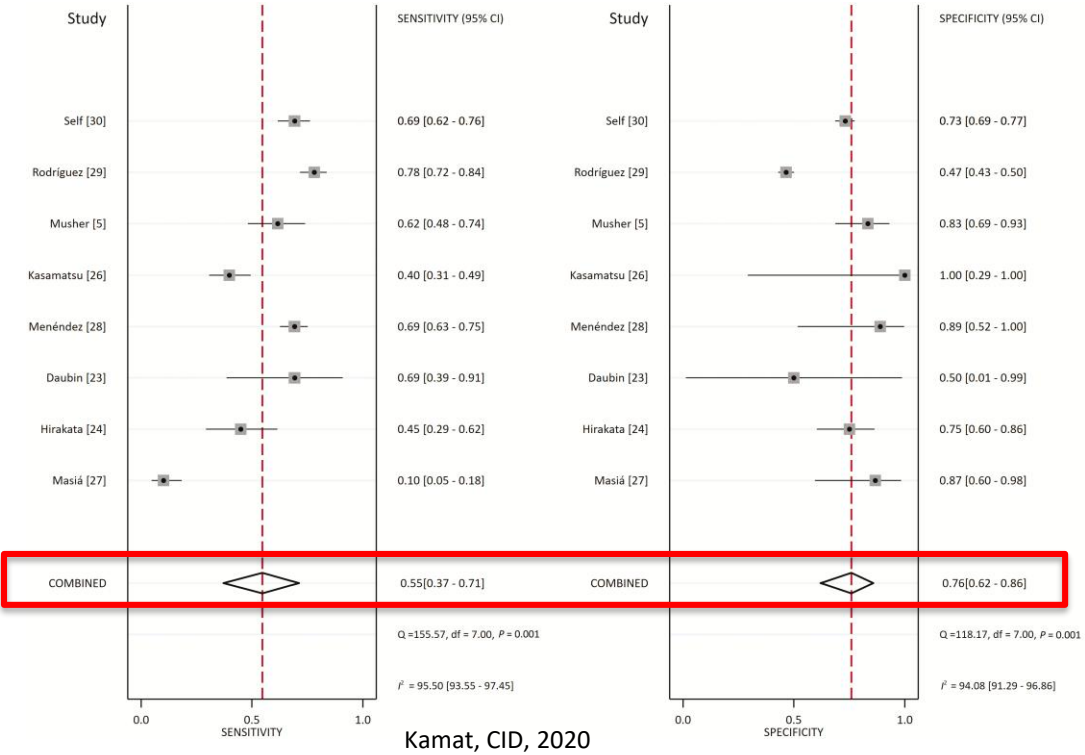
Diagnostic des co-infections

- A évoquer si tableau viral avec mauvaise évolution
- PCT mauvaise spécificité et sensibilité
- Pas de biomarqueur efficace pour différencier virale et infection et encore moins co-infection

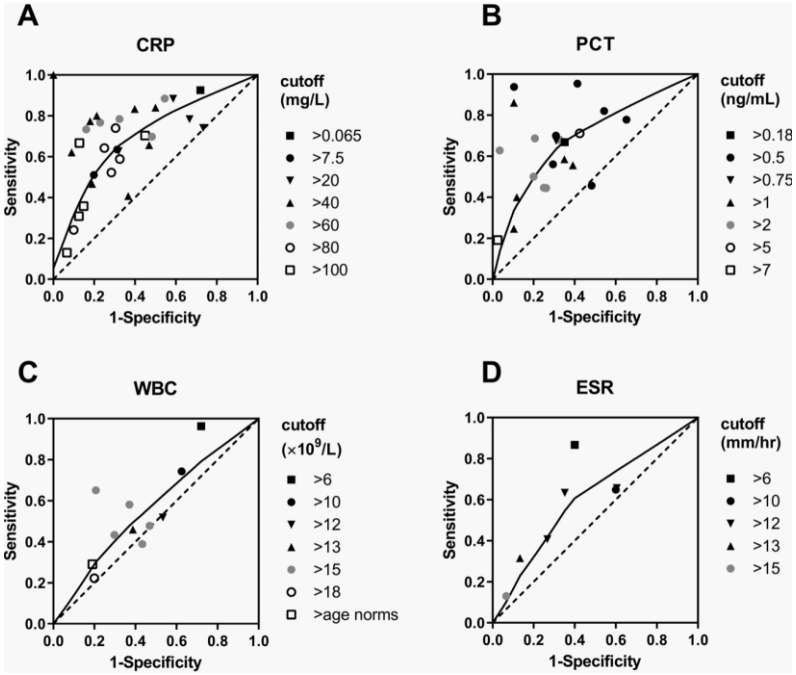
	Suggests viral cause	Suggests bacterial cause
Age	Younger than 5 years	Adults
Epidemic situation	Ongoing viral epidemic	..
History of illness	Slow onset	Rapid onset
Clinical profile	Rhinitis, wheezing	High fever, tachypnoea
Biomarkers		
Total white-blood cell count	<10×10⁹ cells per L	>15×10⁹ cells per L
C-reactive protein concentration in serum	<20 mg/L	>60 mg/L
Procalcitonin concentration in serum	<0·1 µg/L	>0·5 µg/L
Chest radiograph findings	Sole interstitial infiltrates, bilaterally	Lobar alveolar infiltrates
Response to antibiotic treatment	Slow or non-responsive	Rapid

Table 1: **Variables used to distinguish viral from bacterial pneumonia**

Ruuskanen, Lancet, 2011



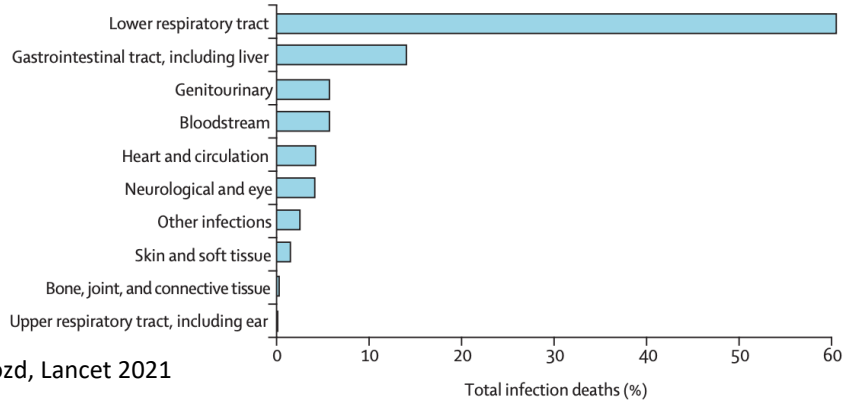
Kamat, CID, 2020



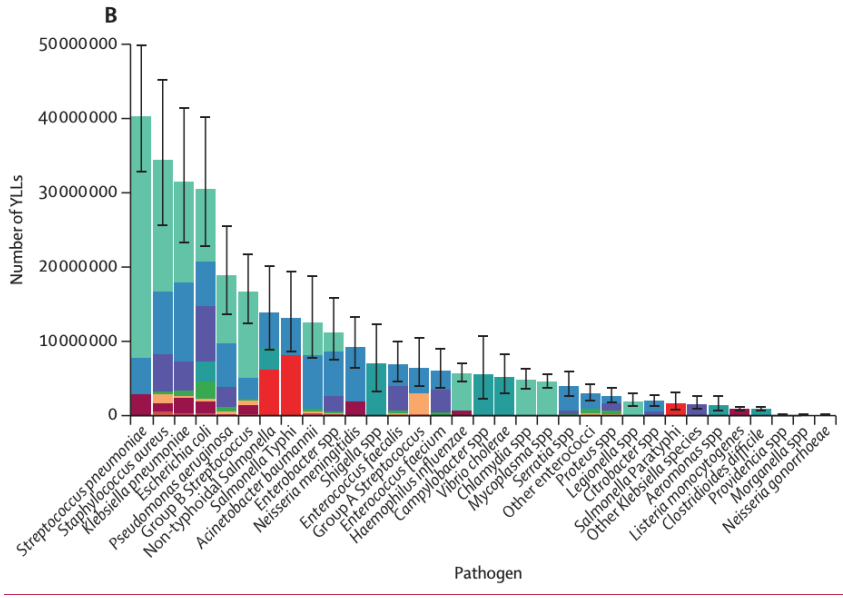
Gunaratnam, JPIDS, 2021

Impact des pneumonies

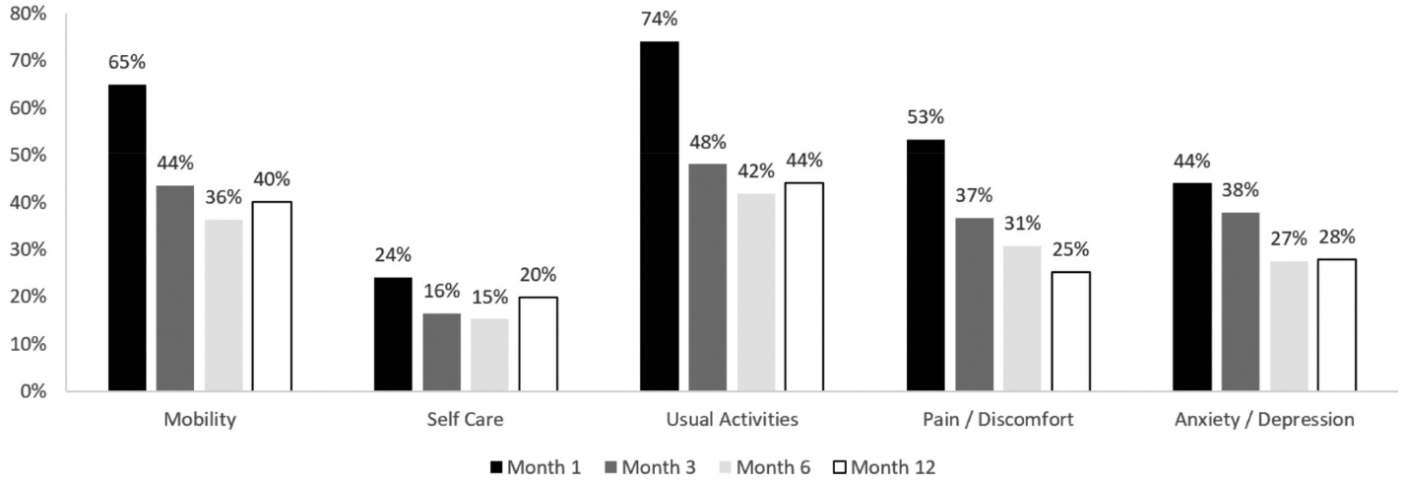
- Pneumonies = 1ère cause infectieuse de décès
- Impact du pneumocoque ++++
- Pneumonies impactent vie quotidienne +++



Drozd, Lancet 2021



Lancet, 2022



Tsoumani, Expert Review of Vaccines, 2023

Impact des co-infections

- Risque accru d'admission en réanimation

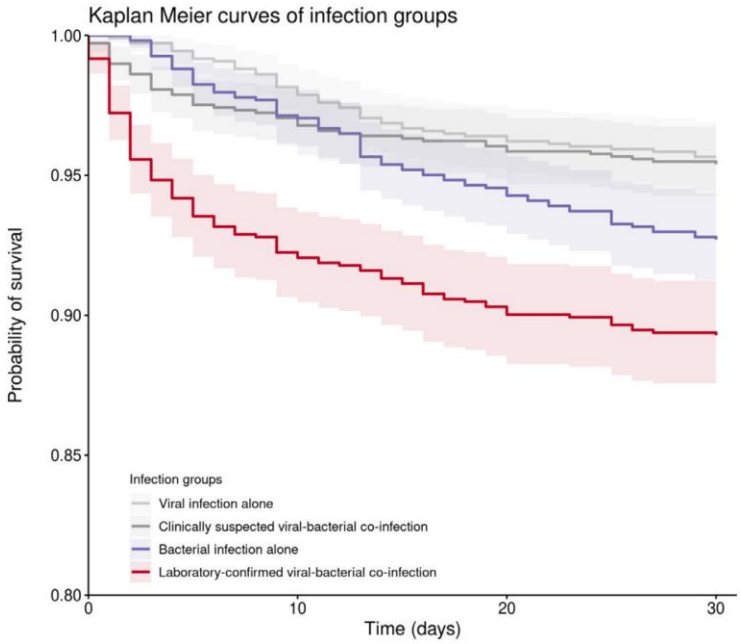
→ Mise en tension du système de soins

- Mortalité accrue

Table 3 Multivariate analysis of the risk factors for complicated course in 174 patients with severe CAP

Variables	OR	95 % CI	*p* value
Microbiological diagnosis			
Bacterial pneumonia	Ref	…	
Viral pneumonia	0.69	0.24–1.95	0.48
Mixed pneumonia	3.15	1.12–8.83	0.03
No etiology pneumonia	1.29	0.40–4.21	0.67
Coronary artery disease	3.52	1.22–10.15	0.02
Shock on ICU admission	4.63	1.56–13.74	0.006
Lactate dehydrogenase > 245 U/L	4.27	1.55–11.78	0.005
PSI class IV-V at hospital referral	4.67	1.96–11.12	0.0005

Voirot, Critical Care, 2016



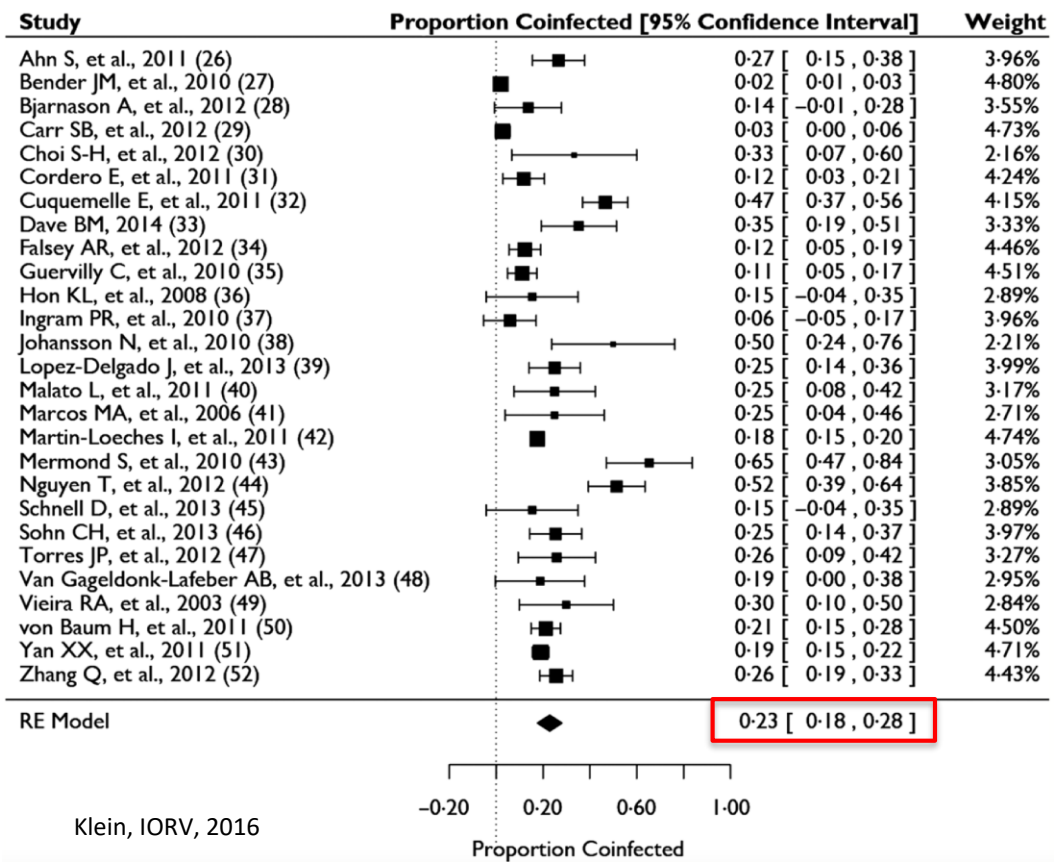
Liu, EClinicalMedicine, 2021

	Before propensity score matching*				After propensity score matching			
	Reference group	Laboratory-confirmed viral-bacterial coinfection group	Risk of the coinfection group [95% CI]	*p*-value	Reference group	Laboratory-confirmed viral-bacterial coinfection group	Risk of the coinfection group [95% CI]	Adjusted *p*-value
Laboratory-confirmed viral-bacterial co-infection versus viral infection alone	*N* = 6368	*N* = 1087			*N* = 1083	*N* = 1083		
30-day mortality *N* (%)	332 (5.2%)	118 (10.9%)	HR =2.2 [1.8, 2.7]	<0.001	47 (4.3%)	117 (10.8%)	HR =2.6 [1.9, 3.7]	<0.001
ICU admission *N* (%)	207 (3.3%)	103 (9.5%)	RR = 2.9 [2.3, 3.7]	<0.001	35 (3.2%)	102 (9.42%)	RR =2.9 [2.3, 3.6]	<0.001
Laboratory-confirmed viral-bacterial co-infection versus bacterial infection alone	*N* = 3455	*N* = 1087			*N* = 1083	*N* = 1083		
30-day mortality *N* (%)	310 (9.0%)	118 (10.9%)	HR =1.3					
[1.01, 1.5]	0.114	79 (7.3%)	116 (10.7%)	HR =1.4 [1.1, 1.9]	0.028			
ICU admission *N* (%)	196 (5.7%)	103 (9.5%)	RR= 1.8					
[1.3, 2.1]	<0.001	44 (4.1%)	103 (9.5%)	RR =1.6 [1.2, 2.1]	<0.001			
Laboratory-confirmed viral-bacterial co-infection versus clinically suspected viral-bacterial co-infection	*N* = 8451	*N* = 1087			*N* = 1086	*N* = 1086		
30-day mortality *N* (%)	400 (4.7%)	118 (10.9%)	HR =2.4					
[1.9, 2.9]	<0.001	53 (4.9%)	118 (10.9%)	HR =2.3 [1.7, 3.2]	<0.001			
ICU admission *N* (%)	254 (3.0%)	103 (9.5%)	RR =3.15					
[2.5, 3.9]	<0.001	35 (3.2%)	103 (9.5%)	RR =3.2 [2.5, 3.9]	<0.001			

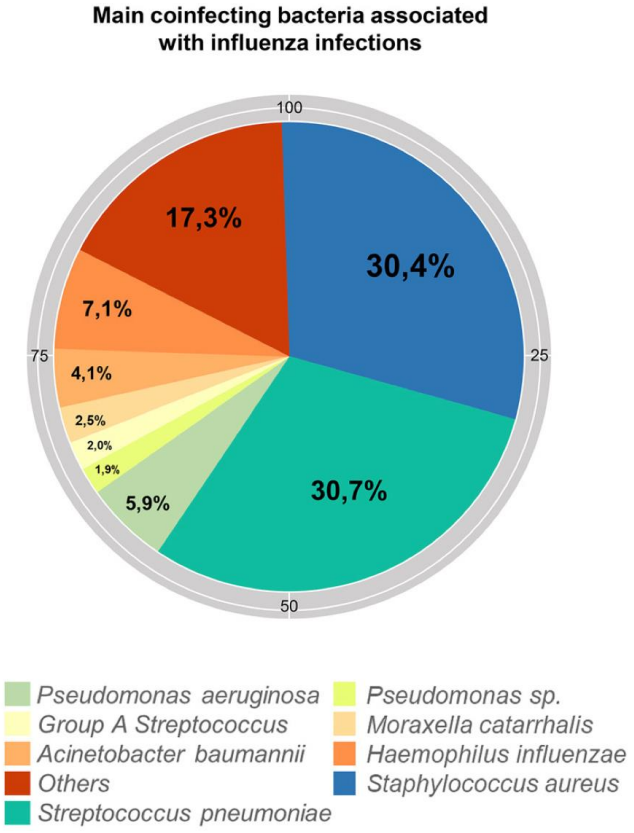
Liu, EClinicalMedicine, 2021

Co-infections grippe – bactéries (1/3)

- Co-infections entre 20 et 25%
- Principalement *Streptococcus pneumoniae*
- Attention à *Staphylococcus aureus*



Klein, IORV, 2016



Javier Arranz-Herrero, IJID, 2023

Co-infections grippe – bactéries (2/3)

- Conséquences co-infections:

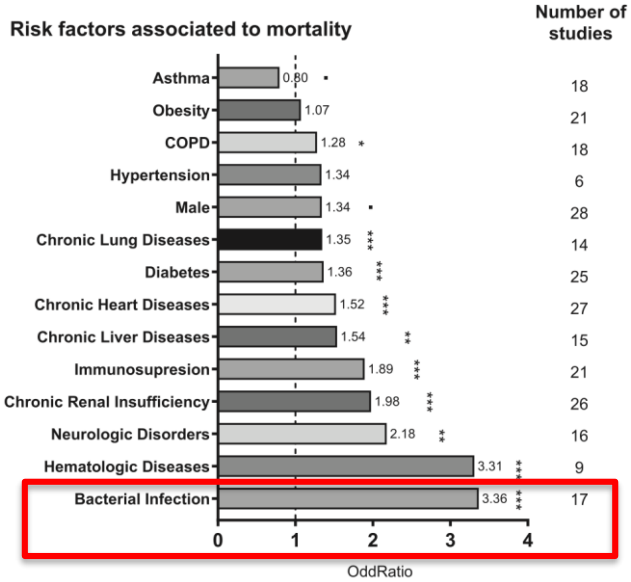
→ Augmentation des hospitalisations

→ Augmentation du risque de séjour en réanimation

→ Augmentation des coûts

→ Augmentation des durées de séjour

→ Augmentation de la mortalité



Javier Arranz-Herrero, IJID, 2023

Outcomes of Influenza Patients With and Without Community-Onset Bacterial Coinfection[a]

Variable	Total (N = 4,313)	Influenza Only (N = 3,868; 2.3%)	Bacterial Coinfection (N = 445; 0.3%)
In hospital mortality, No. (%)	251 (5.8)	193 (5.0)	58 (13.0)
Length of stay, median (IQR)	5.0 (3.0–7.0)	4.0 (3.0–7.0)	6.0 (4.0–11.0)
Cost, median (IQR)	7,722 (4,906–13,792)	7,430 (4,725–12,953)	11,486 (6,667–22,825)
Late ICU (day2+)*, no. (%)	261 (8.0)	209/3,003 (7.0)	52/280 (18.6)
Late IMV (day2+)*, no. (%)	243 (6.1)	189/3,616 (5.2)	54/366 (14.8)
Late Vasopressor (day2+)*, no. (%)	200 (4.9)	149/3,720 (4.0)	51/283 (13.3)

p< 0.001

Bartley, Infect Control, Hosp, Epidemiol, 2022

Co-infections grippe – bactéries (3/3)

- Traitements:

→ Intérêt Oseltamivir si patients à risque

→ Intérêt de couvrir *S. aureus*

- Prévention:

→ Vaccination antigrippale

→ Vaccination anti-pneumocoque

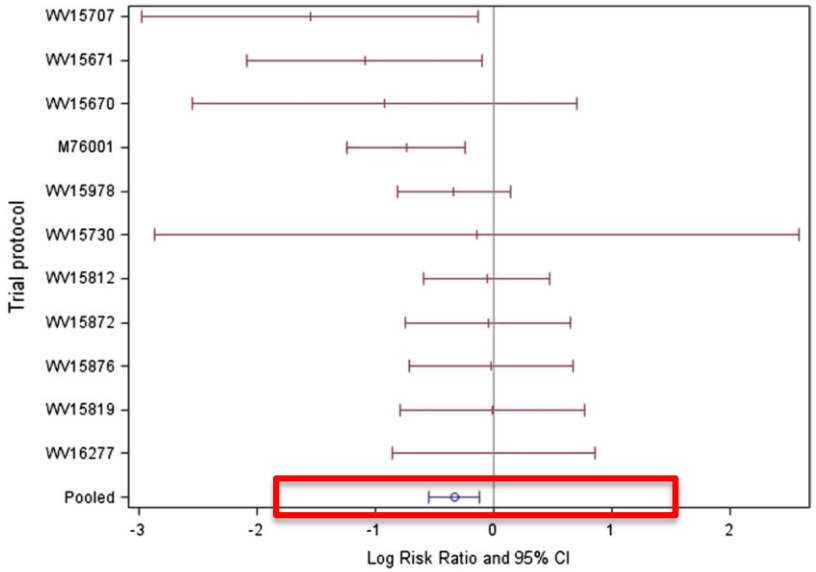


Figure 1. Oseltamivir and the risk of lower respiratory tract complications requiring antibiotics.

Hernàn, CID, 2011

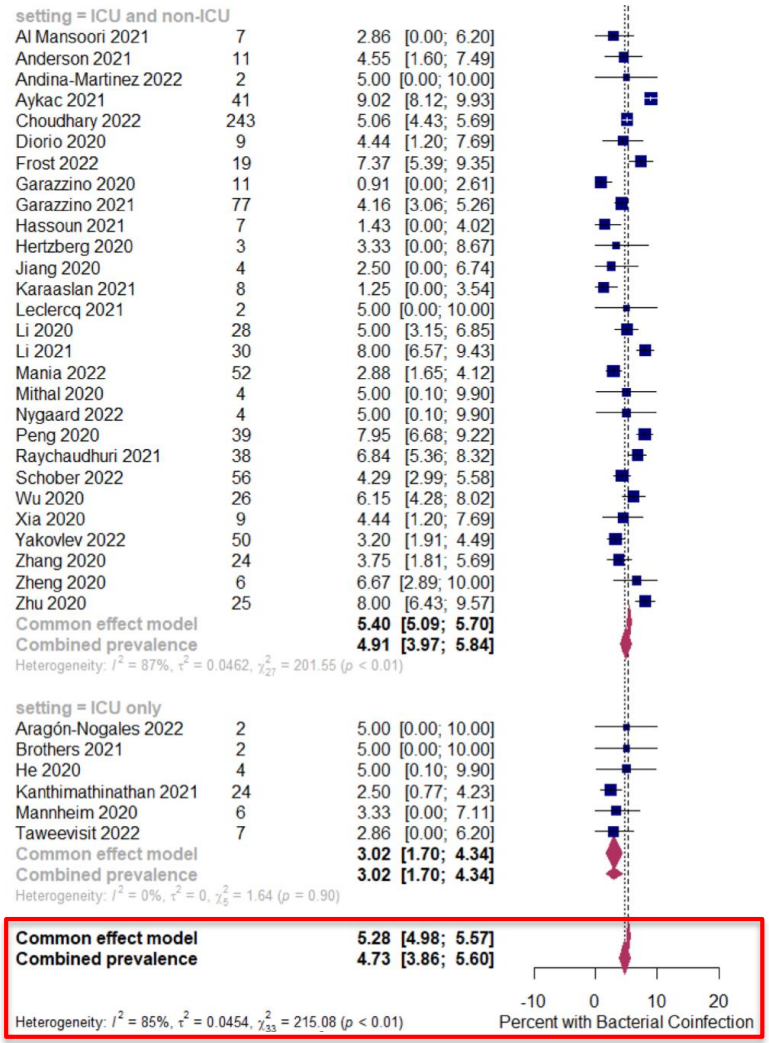
Pooled relative vaccine efficacy/effectiveness of HD-IIV3 vs. SD-IIV against influenza-related outcomes.

Outcome	All Seasons			Predominant Circulating Strain[a]						Antigenic Similarity with Predominant Circulating Strain[b]					
				A/H3N2-predominant Seasons			A/H1N1-predominant Seasons			Matched Seasons			Mismatched Seasons		
	n	*rVE*[c] *(95%CI)*	*p-value*	*n*	*rVE (95%CI)*	*p-value*	*n*	*rVE (95%CI)*	*p-value*	*n*	*rVE (95%CI)*	*p-value*	*n*	*rVE (95%CI)*	*p-value*
Influenza-like Illness[d]	7	**15.9%** (4.1–26.3%)	0.01	4	**18.3%** (0.8–32.7%)	0.041	3	10.7% (-6.1–24.8%)	0.199	3	27.0% (-6.8–50.1%)	0.105	4	14.3% (-3.4–29.0%)	0.107
Influenza Hospitalization[e]	10	**11.7%** (7.0 – 16.1%)	<0.001	7	**12.1%** (6.3 – 17.6%)	<0.001	3	**9.6%** (2.1–18.9%)	<0.001	3	**10.9%** (2.1–18.9%)	0.016	7	**12.1%** (6.3 – 17.6%)	<0.001
Pneumonia Hospitalization[f]	4	**27.3%** (15.3–37.6%)	<0.001	2	**39.9%** (19.3–55.3%)	<0.001	2	**22.0%** (6.7–34.8%)	<0.001	3	**28.9%** (10.1–43.8%)	0.004	1	–	–
Pneumonia/Influenza Hospitalization[g]	7	**13.4%** (7.3–19.2%)	<0.001	5	**12.4%** (5.7–18.7%)	<0.001	2	**19.6%** (3.0–33.4%)	0.023	5	**13.5%** (5.0–21.3%)	0.002	2	**13.3%** (4.1–21.6%)	0.005
Cardiorespiratory Hospitalization	7	**17.9%** (15.0–20.8%)	<0.001	6	**17.7%** (14.5–20.8%)	<0.001	1	–	–	4	**17.4%** (13.5–21.1%)	<0.001	3	**18.6%** (14.1–22.9%)	<0.001
All-cause Hospitalization	11	**8.4%** (5.7–11.0%)	<0.001	8	**8.3%** (4.5–12.0%)	<0.001	3	**8.9%** (5.4–12.2%)	<0.001	7	**6.4%** (4.1–8.6%)	<0.001	4	**12.6%** (7.8–17.2%)	<0.001
Post-influenza Mortality	2	22.2% (-18.2–48.8%)	0.240	1	–	–	1	–	–	1	–	–	1	–	–
Pneumonia/Influenza Mortality	3	**39.9%** (18.6–55.6%)	<0.001	2	**43.2%** (18.1 – 60.6%)	0.002	1	–	–	1	–	–	2	**43.2%** (18.1 – 60.6%)	0.002
Cardiorespiratory Mortality	3	**27.7%** (13.2–32.0%)	<0.001	2	**27.3%** (20.3 – 33.6%)	<0.001	1	–	–	1	–	–	2	**27.3%** (20.3 – 33.6%)	<0.001
All-cause Mortality	5	2.5% (-5.1–9.5%)	0.514	4	4.6% (-12.6–19.3%)	0.575	1	–	–	3	0.7% (-4.3–5.6%)	0.768	2	**17.3%** (0.2–31.5%)	0.048

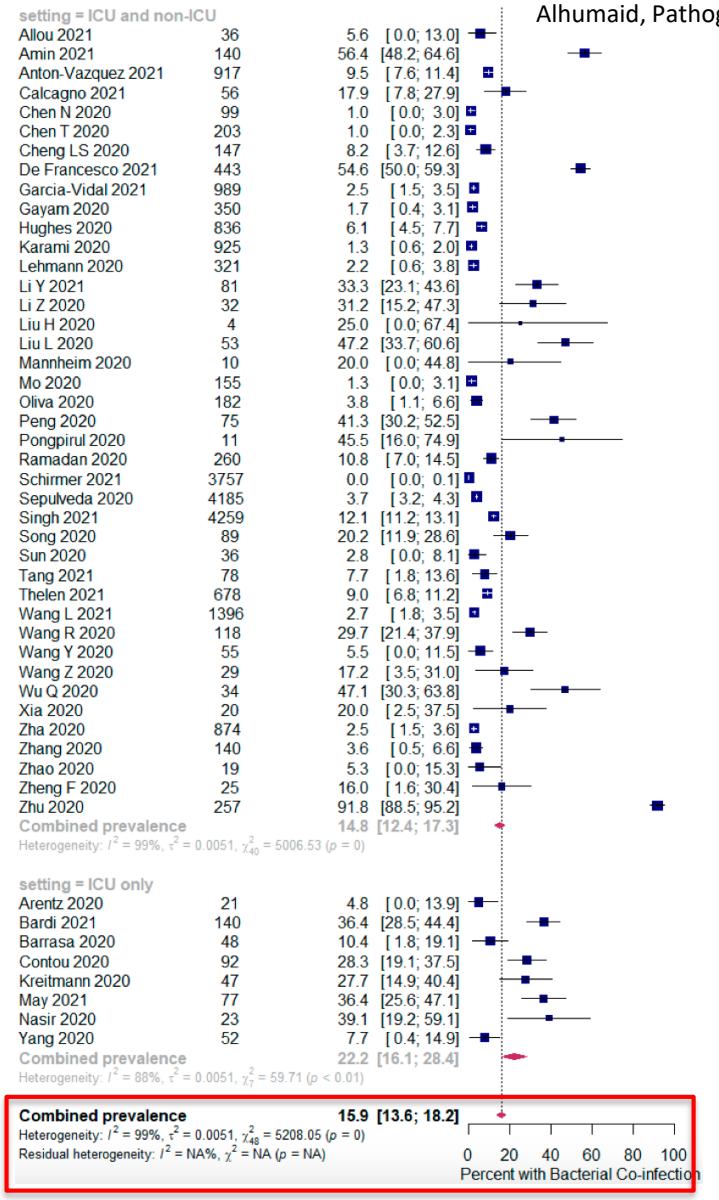
Lee, Vaccine, 2020

Co-infections SARS-CoV-2 – bactéries (1/4)

- Prévalence de ≈ 5% chez les enfants
- Prévalence de ≈ 15% chez les adultes



Alhumaid, Pathogens, 2021



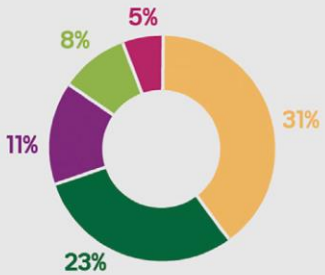
Alhumaid, TMID, 2022

Co-infections SARS-CoV-2 – bactéries (2/4)

- En communautaire: *S. aureus* et *S. pneumoniae,* bactéries sphère ORL
- En hospitalier: BGN et *S. aureus*

Community-onset infection

Bloodstream and respiratory infections
Total - 132
S. aureus - 41
S. pneumoniae - 31
H. influenzae - 15
P. aeruginosa - 10
Klebsiella spp. - 6



Hospital-acquired infection

Bloodstream infections
Total - 335
CoNS - 113
Enterococcus spp. - 73
P. aeruginosa - 26
S. aureus - 25
Klebsiella spp. - 24

Respiratory tract infections
Total - 165
P. aeruginosa - 34
Klebsiella spp. - 31
S. aureus - 31
E. coli - 12
Enterobacter spp. - 11

Westblade, Tends in Microbiology, 2021

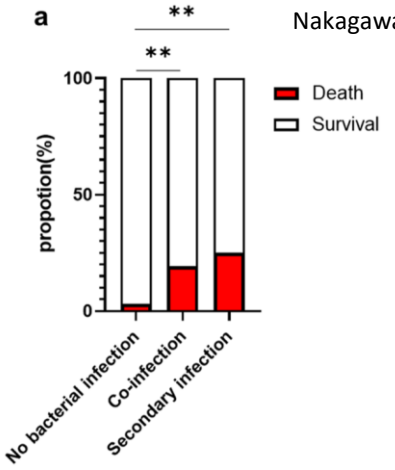
Table 2. Proportion of all identified SARS-CoV-2 bacterial co-infections (N = 3468).

Bacterial Pathogen Type	Identified Number (%)	Bacterial Pathogen Type	Identified Number (%)
S. aureus	1,095 (31.6)	*Corynebacterium* spp.	6 (0.2)
M. catarrhalis	352 (10.1)	*Bordetella pertussis*	5 (0.1)
M. pneumoniae	338 (9.7)	*Micrococcus luteus*	5 (0.1)
S. pneumoniae	316 (9.1)	*Citrobacter koseri*	4 (0.1)
C. pneumoniae	261 (7.5)	*Hafnia alvei*	3 (0.1)
K. pneumoniae	259 (7.5)	*S. maltophilia*	3 (0.1)
H. influenzae	197 (5.7)	*Streptococcus anginosus*	3 (0.1)
CoNS	115 (3.3)	*Streptococcus* Group A	3 (0.1)
E. coli	65 (1.9)	*Burkholderia cepacia*	3 (0.1)
P. aeruginosa	48 (1.4)	*Bacteroides* spp.	3 (0.1)
Staphylococcus epidermidis	42 (1.2)	*Stephanoascus ciferrii*	3 (0.1)
MSSA	31 (0.9)	*Elizabethkingia meningosepticum*	2 (0.1)
Other *Enterococcus* spp.	31 (0.9)	*Granulicatella adiacens*	2 (0.1)
Staphylococcus hominis	28 (0.8)	*Lactobacillus*	2 (0.1)
A. baumannii	24 (0.7)	*Streptococci agalactiae*	2 (0.1)
Enterococcus faecium	23 (0.7)	*Fusobacterium* spp.	2 (0.1)
MRSA	18 (0.5)	*Aerococcus urinae*	1 (0.03)
Enterococcus faecalis	17 (0.5)	*Streptococcus intermedius*	1 (0.03)
Other *Klebsiella* spp.	15 (0.4)	*Streptococcus sanguinis*	1 (0.03)
Enterobacter cloacae	15 (0.4)	*Actinomyces turicensis*	1 (0.03)
Pseudomonas spp.	13 (0.4)	*Providencia* spp.	1 (0.03)
Streptococcus pneumoniae	12 (0.3)	*Ralstonia mannitolilytica*	1 (0.03)
Staphylococcus capitis	11 (0.3)	*Rothia aeria*	1 (0.03)
Methicillin Susceptible- CoNS	10 (0.3)	*Legionella pneumophila*	1 (0.03)
Other *Streptococcus* spp.	9 (0.3)	*Clostridium perfringens*	1 (0.03)
Proteus mirabilis	9 (0.3)	*Comamonas testosteroni*	1 (0.03)
Bacillus non-anthracis	9 (0.3)	*Dolosigranulum pigrum*	1 (0.03)
Other *Staphylococcus* spp.	8 (0.2)	*Globicatella sanguinis*	1 (0.03)
Serratia marcescens	8 (0.2)	*Kocuria marina*	1 (0.03)
Staphylococcus haemolyticus	8 (0.2)	*Morganella morganii*	1 (0.03)
Stenotrophomonas maltophilia	8 (0.2)	*Moraxella osloensis*	1 (0.03)
Methicillin Resistant- CoNS	7 (0.2)		

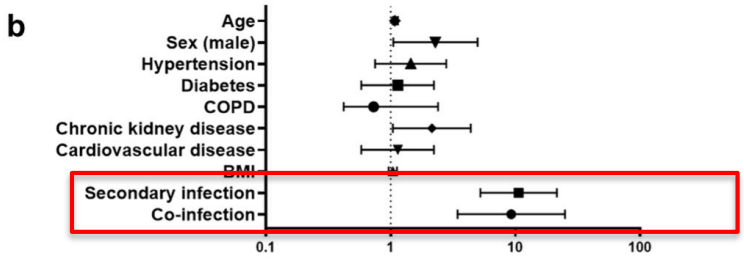
Alhumaid, Pathogens, 2021

Co-infections SARS-CoV-2 – bactéries (3/4)

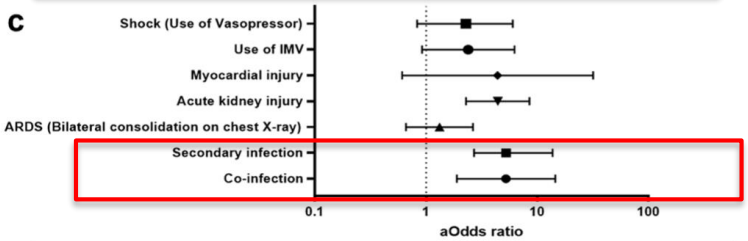
- Augmentent admission réanimation
- Augmentent ventilation mécanique
- Augmentent mortalité



Nakagawara, BMC Pulmonary Medicine, 2023



	aOdds ratio (95% confidence interval)	P-value
Age	1.08 (1.05-1.11)	<0.0001
Sex (male)	2.12 (0.95-4.73)	0.07
Hypertension	1.45 (0.75-2.79)	0.27
Diabetes	1.29 (0.68-2.44)	0.71
COPD	0.73 (0.42-4.47)	0.60
Chronic kidney disease	2.52 (1.27-5.00)	0.04
Cardiovascular disease	1.90 (0.94-3.82)	0.08
BMI	1.04 (0.96-1.12)	0.32
Secondary infection	9.57 (4.74-19.3)	<0.0001
Co-infection	9.21 (3.50-24.2)	0.0001



	aOdds ratio (95% confidence interval)	P-value
Shock (Use of Vasopressor)	2.28 (0.83-6.01)	0.11
Use of IMV	2.39 (0.92-6.23)	0.07
Cardiac injury	4.39 (061-31.7)	0.14
Acute kidney injury	4.41(2.29-8.48)	<0.0001
ARDS (Bilateral consolidation on chest X-ray)	1.32 (0.66-2.64)	0.44
Secondary infection	5.24 (2.70-13.7)	<0.0001
Co-infection	5.23 (1.89-14.5)	0.0001

Nakagawara, BMC Pulmonary Medicine, 2023

	Total sampled hospitalized adults with COVID-19 tested for a bacterial infection (n = 18 376)		Clinically relevant bacterial infection within ±7 days of admission (n = 1140)		No clinically relevant bacterial infection within first 7 days of admission among those with any bacterial culture performed (n = 17 236)		
	n	Weighted column % with 95% CI	n = 1140	Weighted column % with 95% CI	n = 17 236	Weighted column % with 95% CI	p value
Symptoms							
Cough	11 855	62.3 (61.0–63.6)	598	52.5 (47.5–57.5)	11 257	62.9 (61.6–64.3)	<0.0001
Shortness of breath	12 404	65.4 (64.1–66.7)	733	58.8 (53.6–63.8)	11 671	65.8 (64.5–67.2)	0.0054
Congestion	1855	10.6 (9.9–11.4)	89	9.4 (6.9–12.5)	1766	10.7 (9.9–11.5)	0.3855
Wheezing	802	4.6 (4.1–5.1)	51	4.2 (2.7–6.3)	751	4.6 (4.1–5.2)	0.6688
Hemoptysis	271	1.2 (0.9–1.4)	25	2.4 (1.0–4.8)	246	1.1 (0.9–1.3)	0.0283
Chest X-ray							
Abnormal chest X-ray	14 735	84.5 (83.5–85.5)	965	88.7 (85.5–91.4)	13 770	84.3 (83.2–85.3)	0.0101
Consolidation	1401	9.1 (8.3–10.0)	125	13.1 (9.9–17.0)	1276	8.8 (8.0–9.7)	0.006
Lobar infiltrate	14 735	84.5 (83.5–85.5)	965	88.7 (85.5–91.4)	13 770	84.3 (83.2–85.3)	0.0101
Outcomes							
Intensive care required	6459	30.4 (29.2–31.5)	747	60.0 (54.9–64.9)	5712	28.5 (27.3–29.7)	<0.0001
Mechanical ventilation	3627	17.5 (16.6–18.5)	594	47.6 (42.6–52.6)	3033	15.6 (14.7–16.6)	<0.0001
Death	2535	14.3 (13.4–15.3)	329	31.7 (27.2–36.5)	2206	13.2 (12.3–14.1)	<0.0001

Shah, IORV, 2023

Co-infections SARS-CoV-2 – bactéries (4/4)

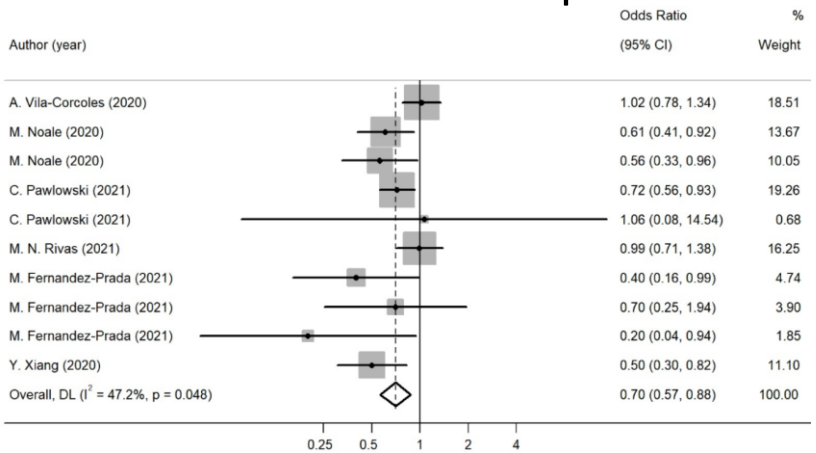
- Co-infection avec *S. pneumoniae* associée à une surmortalité

Table 3. Multivariable Logistic Regression to Assess Independent Risk Factors for Death Within 28 Days of the Last Infection in Patients With Invasive Pneumococcal Disease (IPD) and COVID-19 Within 28 Days of Each Other Compared With Those With IPD Only

	Baseline, n/N (%)	IPD and COVID-19 Within 28 Days,[a] n/N (%)	aOR [95% CI]	*P*
Age group				
<16 years	77/1075 (7.2)	0/61 (0.0)	.39 [.13–1.12]	.081
16–64 years	404/1075 (37.6)	15/61 (32.8)	Base	
65–84 years	420/1075 (39.1)	14/61 (39.3)	1.41 [.96–2.07]	.082
≥85 years	174/1075 (16.2)	11/61 (27.9)	3.61 [2.33–5.58]	<.001
Serotype group				
PCV13	172/976 (17.6)	7/55 (12.7)	2.55 [1.70–3.83]	<.001
Additional PPV23	558/976 (57.2)	31/55 (56.4)	Base	
Non-PPV23	246/976 (25.2)	17/55 (30.9)	1.76 [1.20–2.58]	.004
Sex				
Male	517/1075 (48.1)	25/61 (41.0)	.81 [.58–1.12]	.20
Female	558/1075 (51.9)	36/61 (59.0)	Base	
Infection type				
IPD only	N = 1075	…	Base	
IPD/COVID-19 coinfection (within 2 days)	…	40/61 (65.6)	7.75 [3.80–15.82]	<.001
IPD followed by COVID-19 (3–27 days later)	…	21/61 (34.4)	3.88 [1.41–10.65]	.008

Amin-Chowdhury, CID, 2021

- Baisse infection SARS-CoV-2 si vaccination antipneumococcique ?



Kapoula, Diagnostics, 2022

Co-infections VRS – bactéries (1/2)

- Co-infections ≈ 40-45% bronchiolites sévères (Thornburn, Thorax, 2006; Duttweiler, Arch Dis Child 2004)
- *S. pneumoniae* et *S. aureus* +++
- Risque accru : séjour en réanimation, ventilation mécanique, séjour prolongé

Table 1 Demographic characteristics of patients with RSV infection.

	Overall (N = 620)	Mono-infection (N = 419)	Co-infection (N = 201)	*p* value
Gender				
Male, N (%)	366 (59.0%)	254 (60.6%)	112 (55.7%)	0.246
Age, years, median (IQR)	1.33 (0.67–2)	1.42 (0.75–2.08)	1.17 (0.58–1.75)	0.011
Age group, N (%)				0.021
0–12 month	239 (38.6%)	148 (35.3%)	91 (45.3%)	
13–24 month	234 (37.7%)	160 (38.2)	74 (36.8%)	
>24 month	147 (23.7%)	111 (26.5%)	36 (17.9%)	
Pathogen, N (%)				
Mycoplasma pneumoniae	4 (0.6%)			
Streptococcus pneumoniae	82 (13.2%)			
Haemophilus influenzae	51 (8.2%)			
Moraxella catarrhalis	32 (5.2%)			
Staphylococcus aureus	82 (13.2%)			
Streptococcus pyogenes	1 (0.2%)			

Lin, Journal of the Formosan Medical Association, 2022

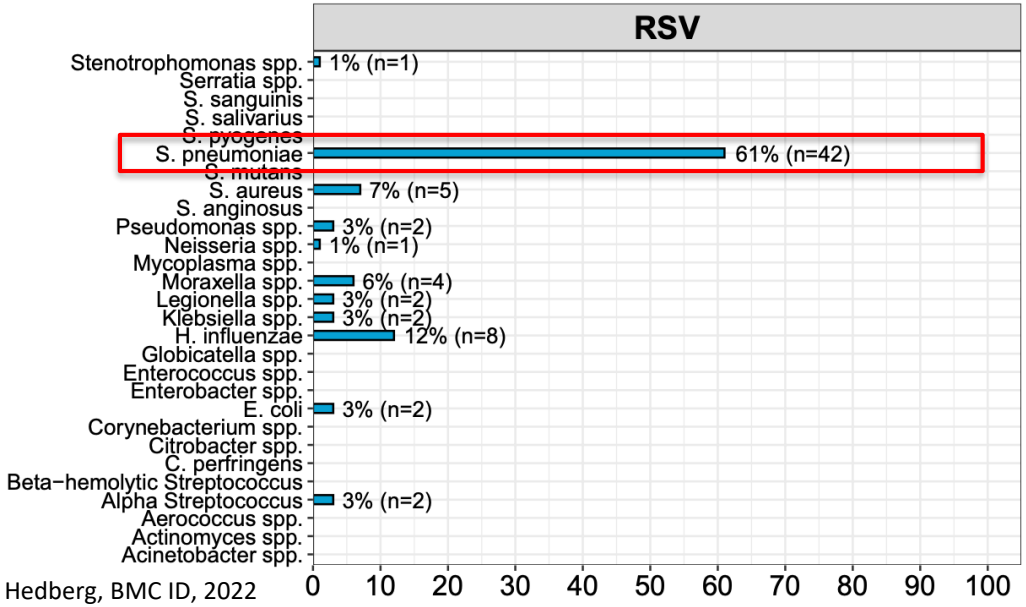
Table 3 Clinical outcomes of RSV mono-infection versus RSV with bacterial co-infection.

	Overall (N = 620)	Mono-infection (N = 419)	Co-infection (N = 201)	*p* value
Antibiotics use	473 (76.3%)	301 (71.8%)	172 (85.6%)	<0.001
Surgery	2 (0.3%)	0 (0.0%)	2 (1.0%)	0.105
Inotropic agents use	1 (0.2%)	0 (0.0%)	1 (0.5%)	0.324
Ventilator use	24 (3.9%)	11 (2.6%)	13 (6.5%)	0.020
Noninvasive ventilator	21 (3.4%)	11 (2.6%)	10 (5.0%)	0.130
Invasive ventilator	6 (1.0%)	0 (0.0%)	6 (3.0%)	0.001
Ventilation days	7 (5–11)	6 (5–11)	7 (6–11)	0.564
Hospitalization LOS	5 (4–6.5)	5 (4–6)	5 (4–7)	<0.001
ICU rate	51 (8.2%)	27 (6.4%)	24 (11.9%)	0.020
LOS of ICU	4.9 (1.9–8.6)	4.7 (1.8–8.0)	5.6 (2.5–10.1)	0.395

Lin, Journal of the Formosan Medical Association, 2022

Co-infections VRS – bactéries (2/2)

- 17% co-infections chez adultes hospitalisés
- *S. pneumoniae* +++
- Hausse durée séjour, hospitalisation en réanimation
- Hausse mortalité



Hedberg, BMC ID, 2022

Table 1 Demography, characteristics, and outcome of the 89 patients with an RSV-positive sample and a radiologically confirmed pneumonia

	RSV-bacteria-associated pneumonia		RSV-positive pneumonia		*p* value
	n = 27	%	*n* = 62	%	
Age, median (IQR)	70 (56; 82)		76 (59; 85)		ns
18–64	12	44.4	21	33.9	
≥65	15	55.6	41	66.1	
Sex					ns
male	14	51.9	34	54.8	
female	13	48.1	28	45.2	
Living situation					
Independent	24	88.9	53	85.5	ns
In nursing facility	3	11.1	9	14.5	ns
Chronic illnesses					
Cardiovascular disease	11	40.7	32	51.6	ns
Pulmonary disease	13	48.1	18	29.0	ns
Diabetes mellitus	6	22.2	10	16.1	ns
Immunodeficiency	10	37.0	28	45.2	ns
No chronic illness	6	22.2	5	8.1	ns
Clinical severity and outcomes					
Length of stay, median (IQR)*	16 (10; 23)		10 (6; 19)		$p < 0.05$
ARDS	10	37.0	12	19.4	ns
ICU admission	18	66.7	13	21.0	$p < 0.01$
In-hospital death	7	25.9	11	17.7	ns

Jeannoël, EJCM ID, 2019

	RSV Alone (n = 616)	Bacterial Coinfection (n = 85)	*P*
Age, mean ± SD, y	70.4 ± 19.4	66.6 ± 18.6	.083
Women, No. (%)	367 (59.6)	43 (50.6)	.098
Length of stay, mean ± SD, d	9.2 ± 7.1	9.6 ± 6.2	.58
Hospital-acquired RSV, No. (%)	101 (16.4)	15 (17.6)	.75
In-hospital mortality, No. (%)	30 (4.9)	11 (12.9)	.01

Godefroy, OFID, 2020

Conclusions

- Co-infections virus-bactéries $\approx 5\%$
- Pas de marqueur spécifique pour diagnostiquer une co-infection
- Co-infections principalement avec *S. aureus* et *S. pneumoniae*
- Impact important en terme d'hospitalisation, de risque de séjour en réanimation et de mortalité
- Prévention par vaccination contre les viroses et par vaccination anti-pneumococcique dans les groupes à risque