Streptococcus suis infections in pigs, viewed from a one-health perspective

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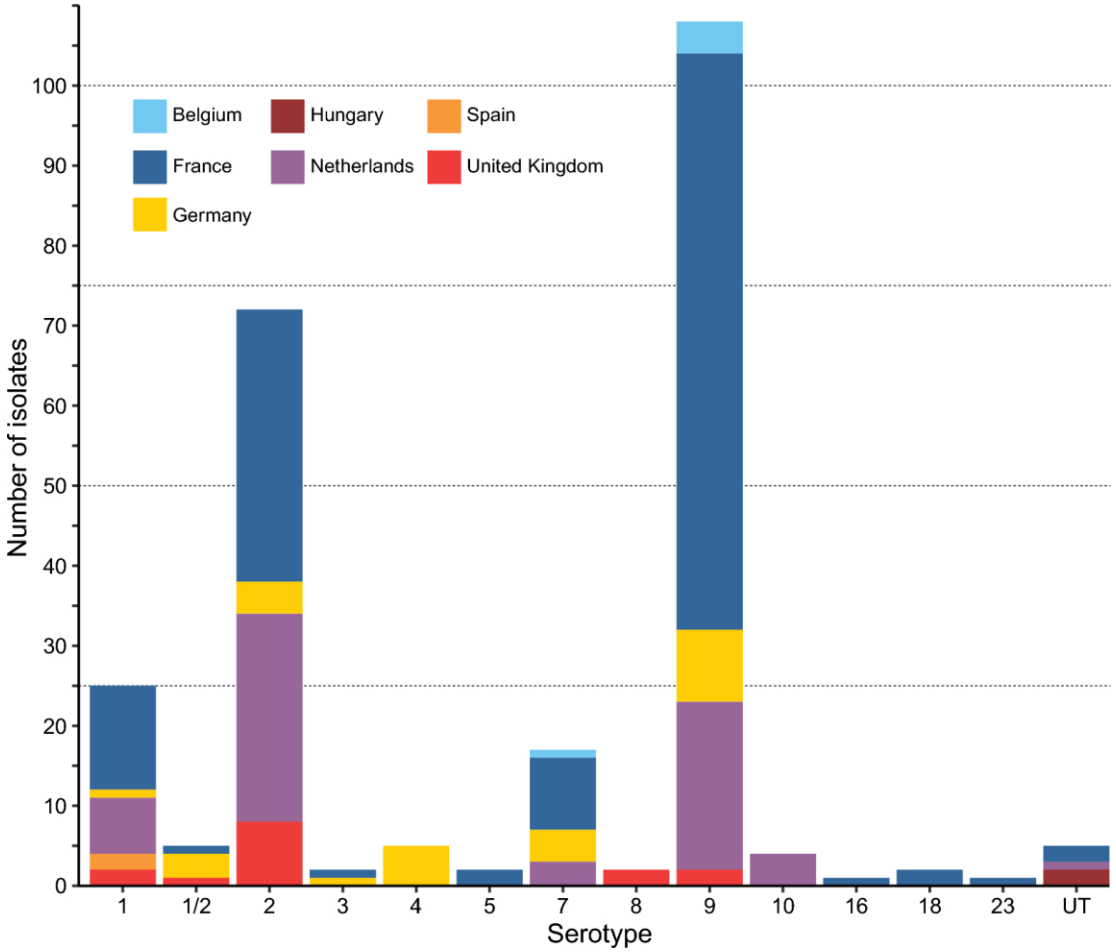
Streptococcus suis - characteristics

- **Gram-positive, encapsulated, hemolytic, fac. anaerobic**
- **High genetic diversity (Murray et al. 2021)**
- **35 different serotypes (6 reclassified → 29) based on capsular polysaccharides**
  - **non-typeable strains**
  - **virulence differences between and within serotypes**

S. suis – serotype distribution in European countries

Li et al. 2024



Serotypes:

- EU / Asia: mostly 9, 2, and 3 ; different sequence types (Li et al. 2024; Albert et al. 2025)
- North America: mostly 2, 3, 1/2, 8, 4, and 7
- Brazil: mostly 2, 3, 7, 1, 6, 8, 18, 28, and 27

S. suis - epidemiology

- **Early colonizer:** (Cloutier et al 2003)
  - during or shortly after birth
  - via the vagina or respiratory tract
- **Becomes part of the normal microbiota**
- **Commonly found in the upper respiratory tract**

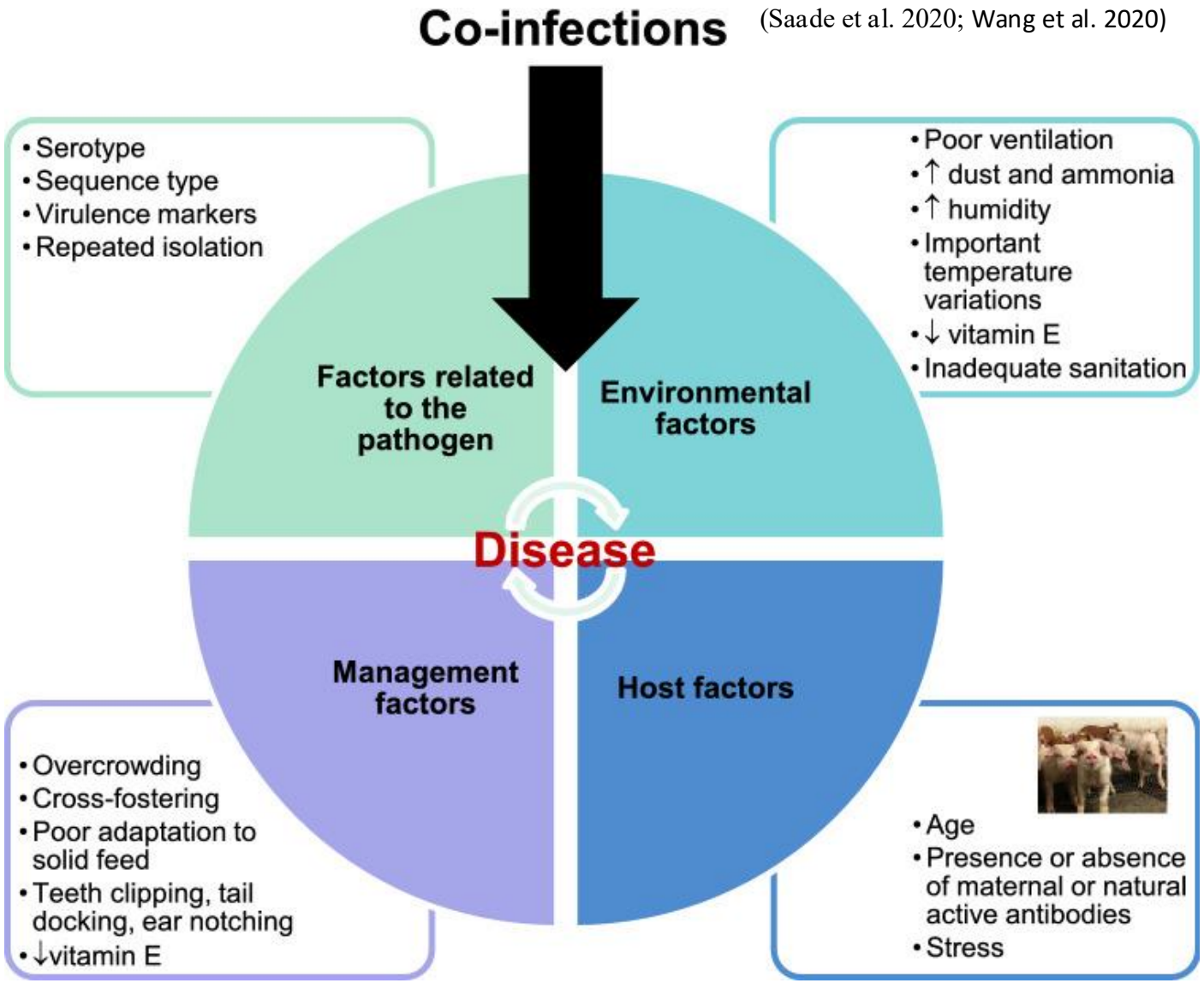
- **Important disease in pig farms**
- **Common reason for antimicrobial use**
- **Can also infect humans and other animals** (Dutkiewicz et al. 2017)

S. suis - transmission

- **Purchase of pigs carrying virulent types**
- **Transmission within the farm:**
  - direct contact (mainly respiratory)
  - fomites *e.g.* flies can carry *S. suis* for 5 days
  - bioaerosols
  - environment *e.g.* feed troughs
- **Survival:**
  - water 4°C: 1-2 weeks
  - feces 22°C: 8 days
  - dust: <24 h
  - chilled carcasses: 6 weeks

S. suis disease - risk factors Obradovic et al. 2021

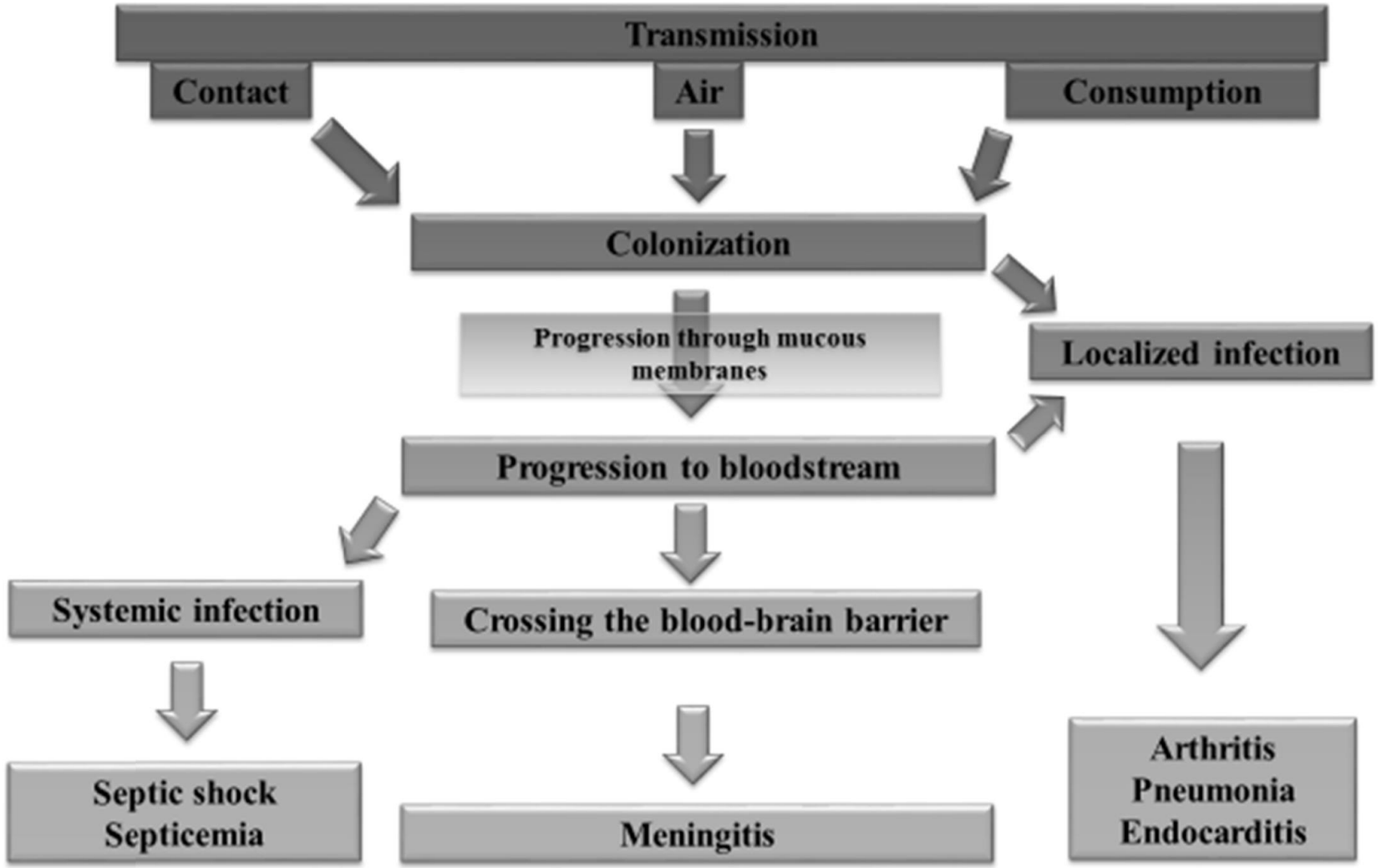
PRRSV, sIAV, PCV2
(Saade et al. 2020; Wang et al. 2020)



Tonsillar microbiome
(Frederiksen et al. 2024)

S. suis - pathogenesis

Haas & Grenier 2018



S. suis – clinical signs

- Mainly in pigs of 3-12 weeks
- Many infections are subclinical
- Sudden death (all ages)
- Arthritis
- Meningitis

S. suis disease - treatment

Diseased pigs:

- **parenteral antibiotics + anti-inflammatory drugs**
- **isolate the pig; keep warm; rehydrate → full recovery possible**

Metaphylactic treatment of pen mates might be recommended

AMCRA
VERBETER GEZONDHEID, VERMINDER RESISTENTIE

Formulary AMCRA:

1st choice: penicillin (majority of strains are sensitive)

2nd choice: trim-sulfa, ampi, amoxy, peni-neomycin

3rd choice: linco; oxytetra; cefquinome; ceftiofur

S. suis – molecular characterization of isolates

Li et al. 2024

- **251 *S. suis* isolates from diseased pigs: Be, Fr, Ge, Hu, Ne, Sp, UK**
- **13 serotypes (9 and 2); 34 sequence types (ST16 and ST1)**
- **AMR genes in 85% of the isolates**
- **High frequencies of genes conferring resistance to tetracyclines (49% *tetO* gene) and macrolides (65% *ermB* gene)**
- **Diverse array of virulence-associated genes, including the classical:**
  - **mrp muramidase-released protein: 92%**
  - **epf extracellular protein factor: 51%**
  - **sly suilysin: 85%**

S. suis – antimicrobial resistance

Reservoir of antimicrobial resistance genes (Libante et al. 2019)

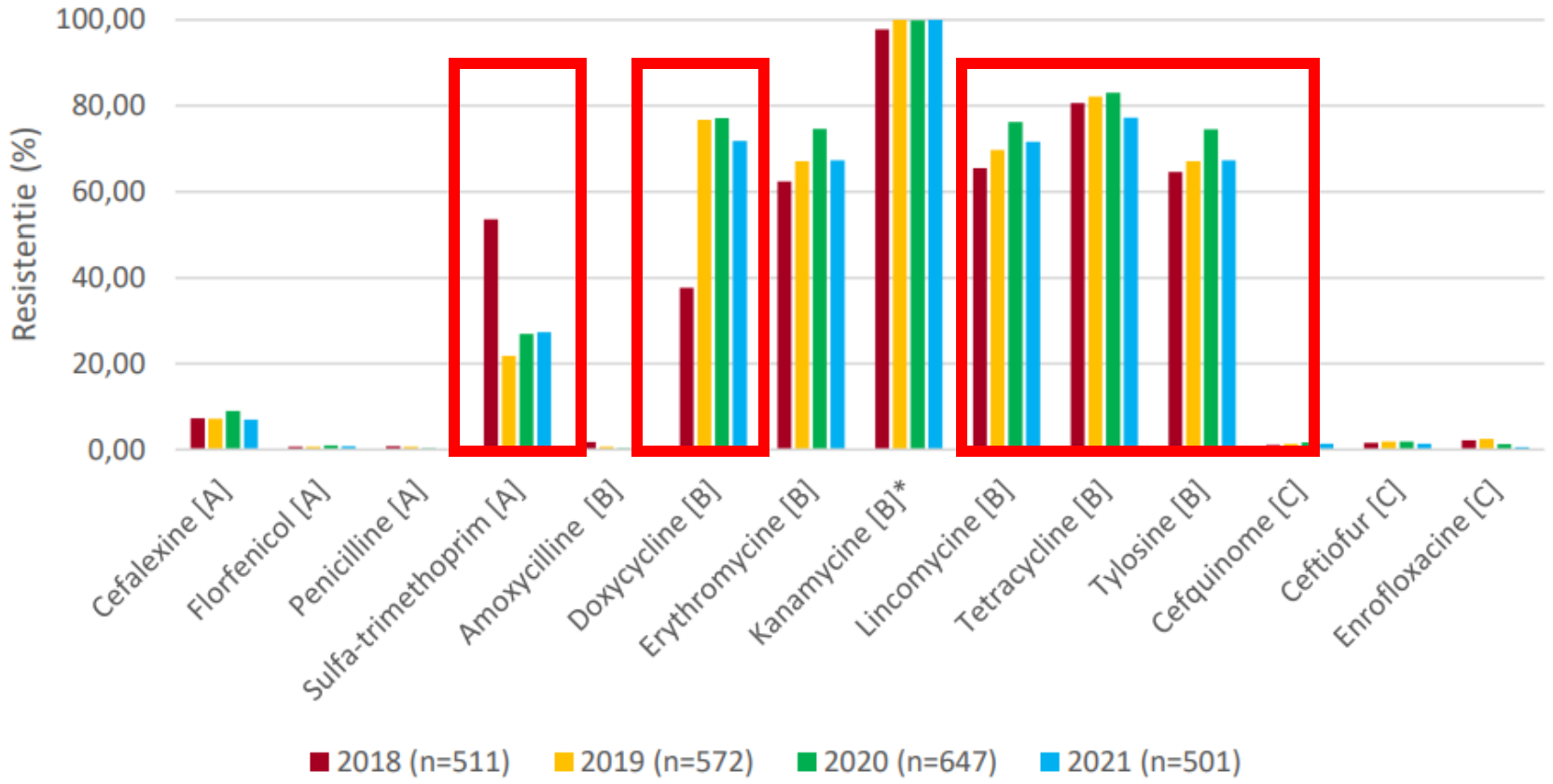
- **214 *S. suis* strains of 27 serotypes**
- **High diversity of chromosomal mobile genetic elements (MGEs) transferring by conjugation:**

  - ICEs: integrative conjugative elements

  - IMEs: integrative mobilizable elements

- **Almost 400 antimicrobial resistance genes → half of them carried by putative IMEs**

S. suis isolates from lesions – evolution of antibiotic resistance 2018-2021 (Animal Health Care Flanders)



% of resistant *S. suis* isolates (Dialab; 2021-2022; n=319): Trim-sulfa 15%, Tiamulin 14%, Doxy 8%, Lincospectin 8%

S. suis – antimicrobial resistance

Dechêne-Tempier et al. 2023

- 200 isolates (France) – 22 antibiotics
- Low resistance rate to penicillins and trim-sulfonamides
- Resistance against macrolides, lincosamides, and tetracycline → more common in isolates from pigs than from wild boar or humans
- Multi-resistance in 138 isolates

S. suis infections – control

- **Reduce or eliminate risk factors**
- **Bactericidal products → <u>in vitro</u> studies**

  e.g. **Clove oil (eugenol), cinnamon, thyme, essential oils (de Aguiar et al. 2021)**
- **No efficacious commercial vaccine**
- **Autogenous vaccines → variable results (strains, adjuvant, etc.)**

S. suis – humans

Mainly serotype 2; also other: 4, 5, 7, 9, 14, 16, 21, 24, and 31
Mainly sequence type ST1 (sporadic cases) and ST7 (toxic shock-like syndrome)

Southeast Asia: foodborne disease

- **General population at risk (more reported human cases)**
- **Risk factors:** Kerdsin et al. 2022
  - **consumption of raw pork products** ("high-risk dishes")
  - **close contact with pigs**

Western countries: occupational disease

S. suis – humans

Incubation period: hours to 3 days

Symptoms:

- **Flu-like: chills, fever, malaise, upper respiratory disease**
- **Gastrointestinal: nausea, vomiting, abdominal pain**
- **Systemic: septicemia, endocarditis, glomerulonephritis, meningitis, septic shock**

Complications: - hearing loss
- balance system dysfunction

Streptococcal toxic shock-like syndrome (STSLS): purpura and evidence of gangrenous changes in the leg (Yu et al. 2006)

S. suis – prevention in humans

- **Wash hands - clean & cover wounds**
- **Slaughterhouse:**
  - **better ante-mortem and carcass inspection**
  - **hygiene**
- **Protective equipment (gloves, coveralls) when handling animals and raw pork**
- **Health education**

→ government, cultural, and societal factors

Conclusions *S. suis*

- Very diverse species
- Present on almost all pig herds
- Important in young pigs → antimicrobial use
- Reservoir for antibiotic resistance genes
- Zoonotic pathogen (Asia!)
- Control: - reducing risk factors
  - autogenous vaccines → variable results