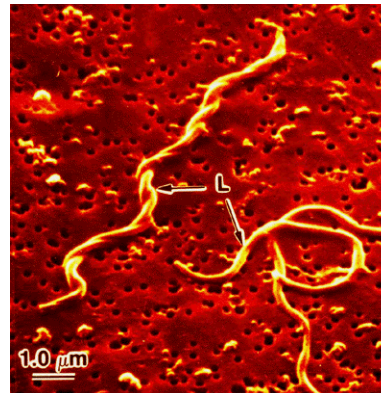
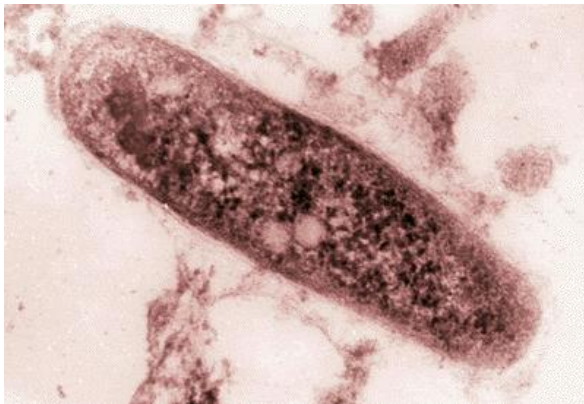


Infectious Disease Epidemiology: Influenza and Strep. Pneumonia epidemiology and prevention



Dr Munir Abu-Helalah
Associate Professor of Epidemiology
and Preventive Medicine



Influenza Virus

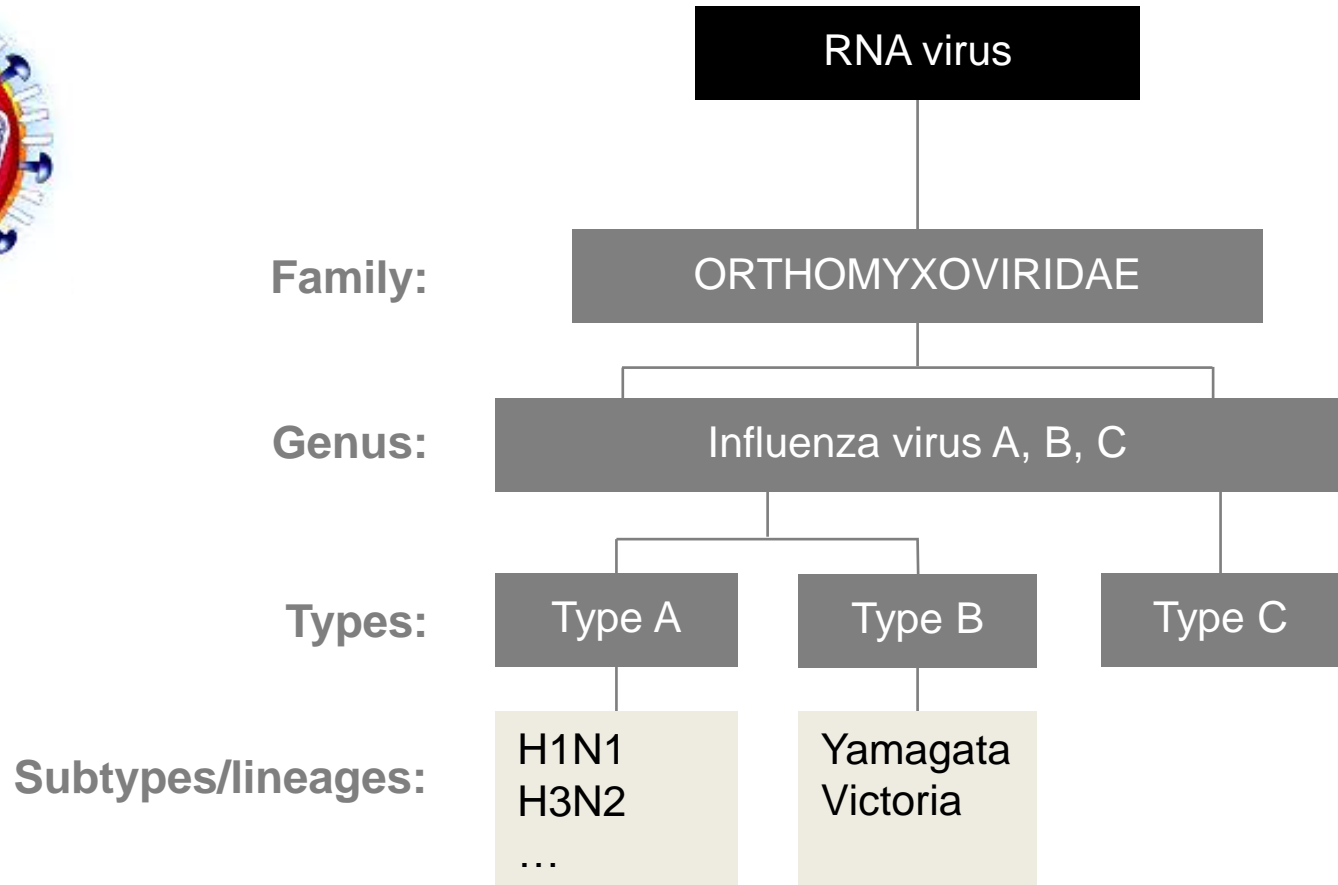
- Influenza uptake in Jordan based on all amount of seasonal vaccine delivery to Jordan: **1.5%-2.5%**

In the USA: 40-50% of the total population receives vaccine annually. Public Health experts consider this figure:

“Unmet Need!”

What do we miss in Jordan in term of flu vaccines selection and utilization??

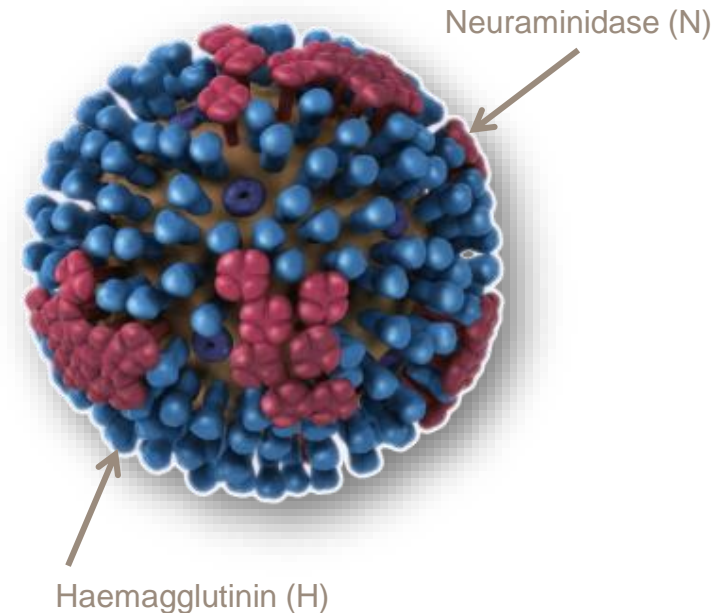
Influenza virus classification^{1,2}



Influenza as a cause of disease

- **Type A** influenza virus
 - Affects both humans and animals
 - Divided into subtypes, based on two surface proteins: haemagglutinin and neuraminidase
 - Main circulating strains are H1N1 and H3N2
- **Type B** influenza virus
 - Affects predominantly humans
 - Not divided into subtypes, but split into two lineages: Victoria and Yamagata
- **Type C** influenza virus
 - Rarely reported in humans, and most cases subclinical

Influenza A virion showing the two major surface glycoproteins



CDC, Centers for Disease Control and Prevention
US CDC. [The pink book: influenza](#). 2012 (accessed April 2014); Nelson MI, Holmes EC. *Nat Rev Genet* 2007;8:196–205.

Overview: influenza

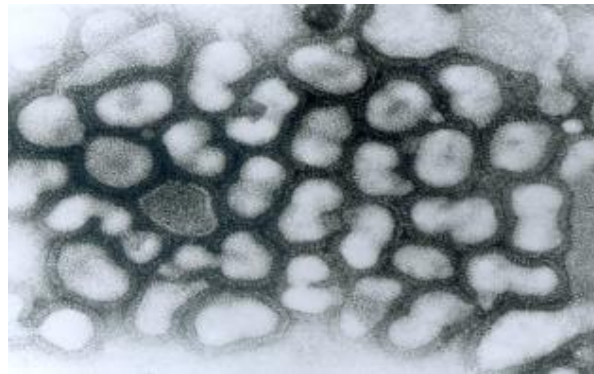
- Influenza is an acute viral infection of the respiratory tract
- There are three types of influenza virus: A, B and C
- Influenza A and influenza B are responsible for most clinical illness

Emergency hospital during the flu pandemic in 1918



Source: US National Museum of Health and Medicine, Armed Forces Institute of Pathology, Washington DC, USA (NCP1603)

Electron micrograph of cells infected with influenza A virions



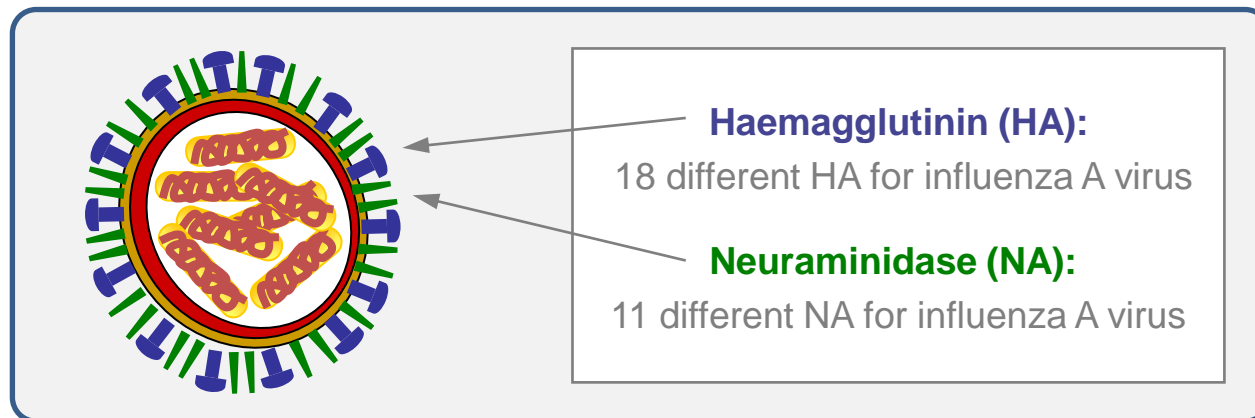
Source: US CDC

• WHO, World Health Organization
WHO. Influenza (seasonal) 2009. [Fact sheet No. 211](#) (accessed April 2014); US CDC. [The pink book: influenza](#). 2012 (accessed April 2014).

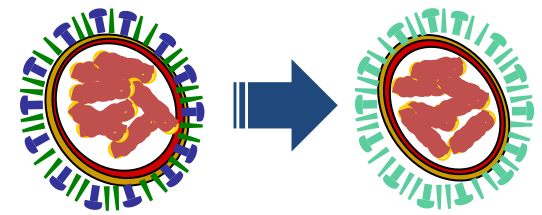
Constant and rapid genetic evolution of influenza¹

Surface antigens of influenza viruses change:

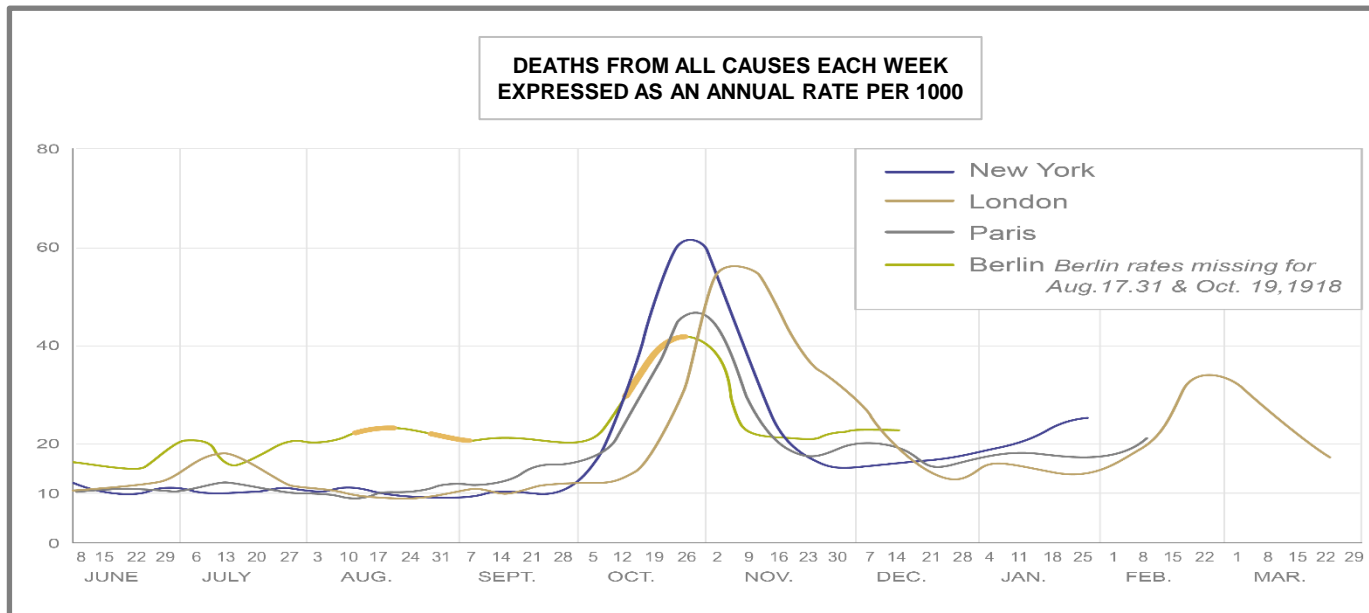
- Antigenic **drift**:
 - **Minor changes** associated with annual outbreaks or epidemics
 - **Impact : updating vaccine yearly to match predicted strains that will be circulating**
- Antigenic **shift**:
 - **Major changes** resulting in new subtype with a new HA protein (and sometimes NA)
 - Can lead to pandemics



Genetic shift can lead to an influenza pandemic



Influenza Pandemic
Mortality in America and Europe during 1918 and 1919



Adapted from: <http://www.edwardianpromenade.com/health-2/living-with-enza-the-spanish-flu-pandemic-1918-1919/>

Antigenic shift

- is the process by which two or more different strains of a virus, or strains of two or more different viruses, combine to form a new subtype having a mixture of the surface antigens of the two or more original strains.
- The term is often applied specifically to influenza, as that is the best-known example, but the process is also known to occur with other viruses, such as visna virus in sheep.
- Antigenic shift is a specific case of reassortment or viral shift that confers a phenotypic change.
- Antigenic shift, however, occurs only in influenza A because it infects more than just humans.
- The most recent 2009 H1N1 outbreak was a result of antigenic shift and reassortment between human, avian, and swine viruses

1. Narayan, O; Griffin, DE; Chase, J (1977). "Antigenic shift of visna virus in persistently infected sheep". *Science*. **197** (4301): 376–

378. [doi:10.1126/science.195339](https://doi.org/10.1126/science.195339). [PMID 195339](https://pubmed.ncbi.nlm.nih.gov/195339/).)

2.^ [Jump up to:](#)^a ^b Treanor, John (15 January 2004). "Influenza vaccine--outmaneuvering antigenic shift and drift". *New England Journal of Medicine*. **350** (3): 218–

220. [doi:10.1056/NEJMp038238](https://doi.org/10.1056/NEJMp038238). [PMID 14724300](https://pubmed.ncbi.nlm.nih.gov/14724300/).

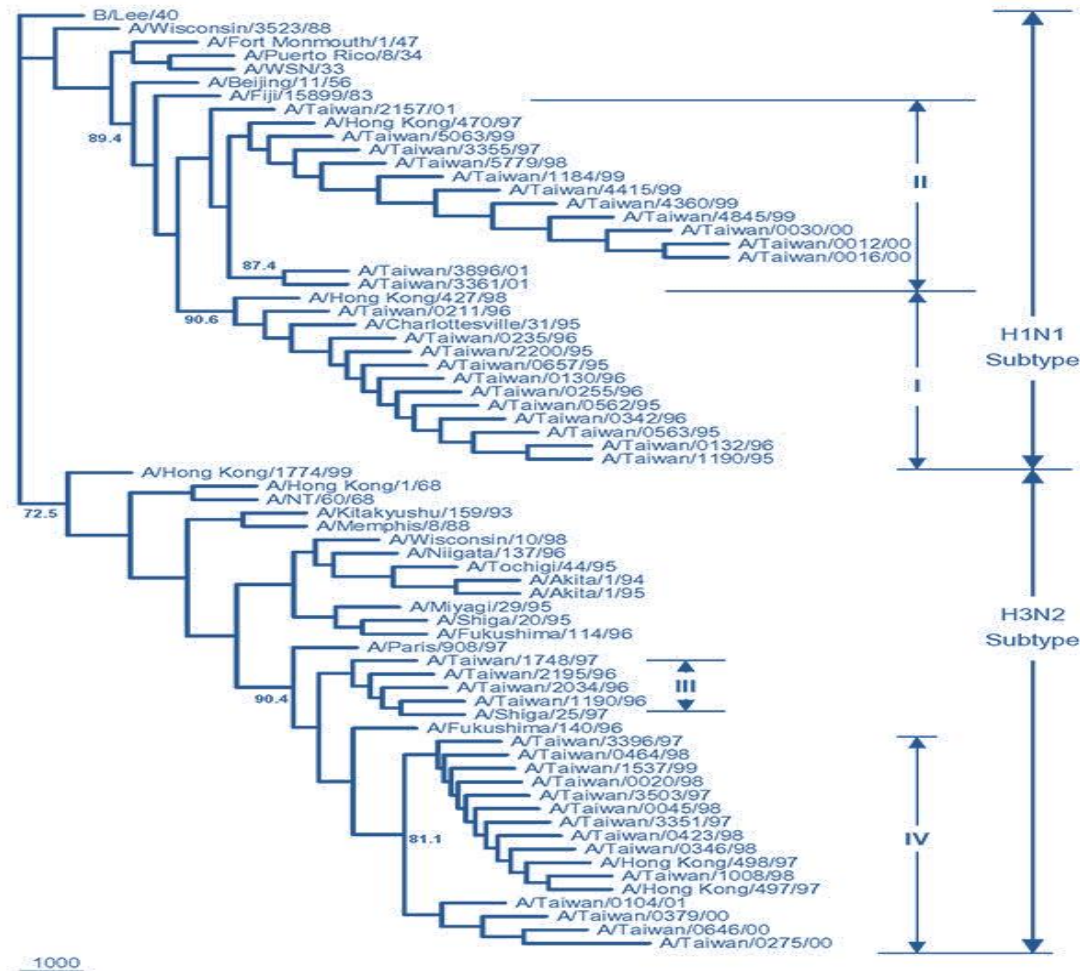
Antigenic drift

- Antigenic shift is contrasted with antigenic drift, which is the natural mutation over time of known strains of influenza (or other things, in a more general sense) which may lead to a loss of immunity, or in vaccine mismatch.
- Antigenic drift occurs in all types of influenza including influenza A, influenza B and influenza C.
- Affected species include other mammals and birds, giving influenza A the opportunity for a major reorganization of surface antigens.
- Antigenic drift has been responsible for heavier-than-normal flu seasons in the past, like the outbreak of influenza H3N2 variant A/Fujian/411/2002 in the 2003–2004 flu season.
- All influenza viruses experience some form of antigenic drift, but it is most pronounced in the influenza A virus.

1. Narayan, O; Griffin, DE; Chase, J (1977). "Antigenic shift of visna virus in persistently infected sheep". [Science](#). **197** (4301): 376–378. [doi:10.1126/science.195339](#). [PMID 195339](#).)

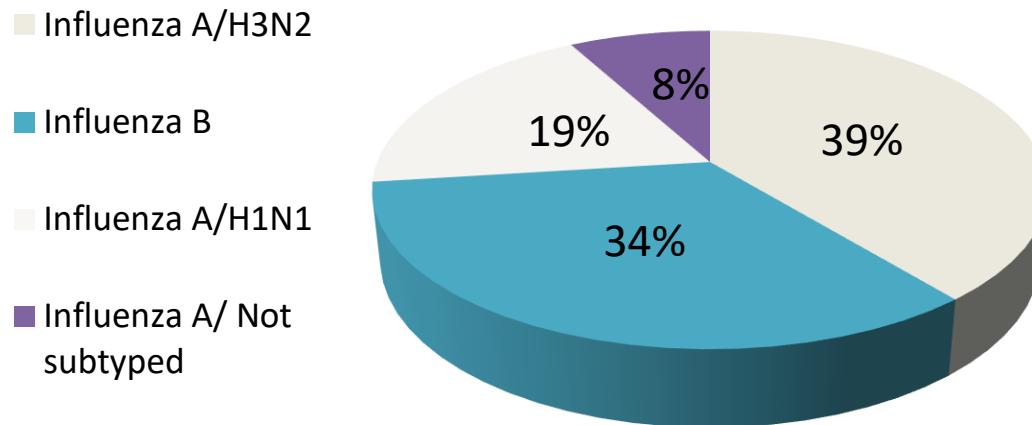
2. ^ [Jump up to:](#) ^a ^b Treanor, John (15 January 2004). "Influenza vaccine--outmaneuvering antigenic shift and drift". [New England Journal of Medicine](#). **350** (3): 218–220. [doi:10.1056/NEJMp038238](#). [PMID 14724300](#).

Rapid and constant evolution of influenza virus...



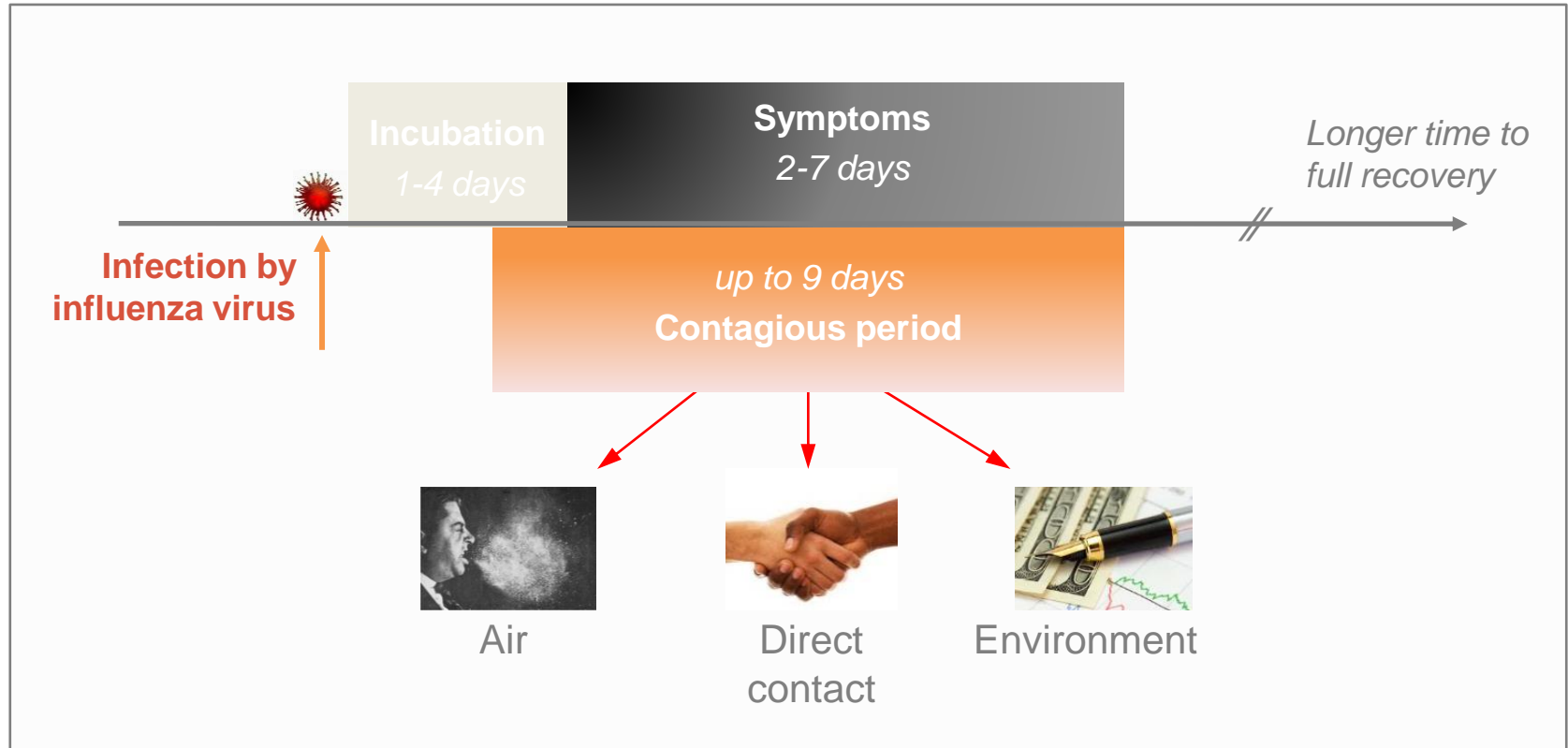
Influenza is caused by A and B virus strains worldwide

Influenza causes by virus type



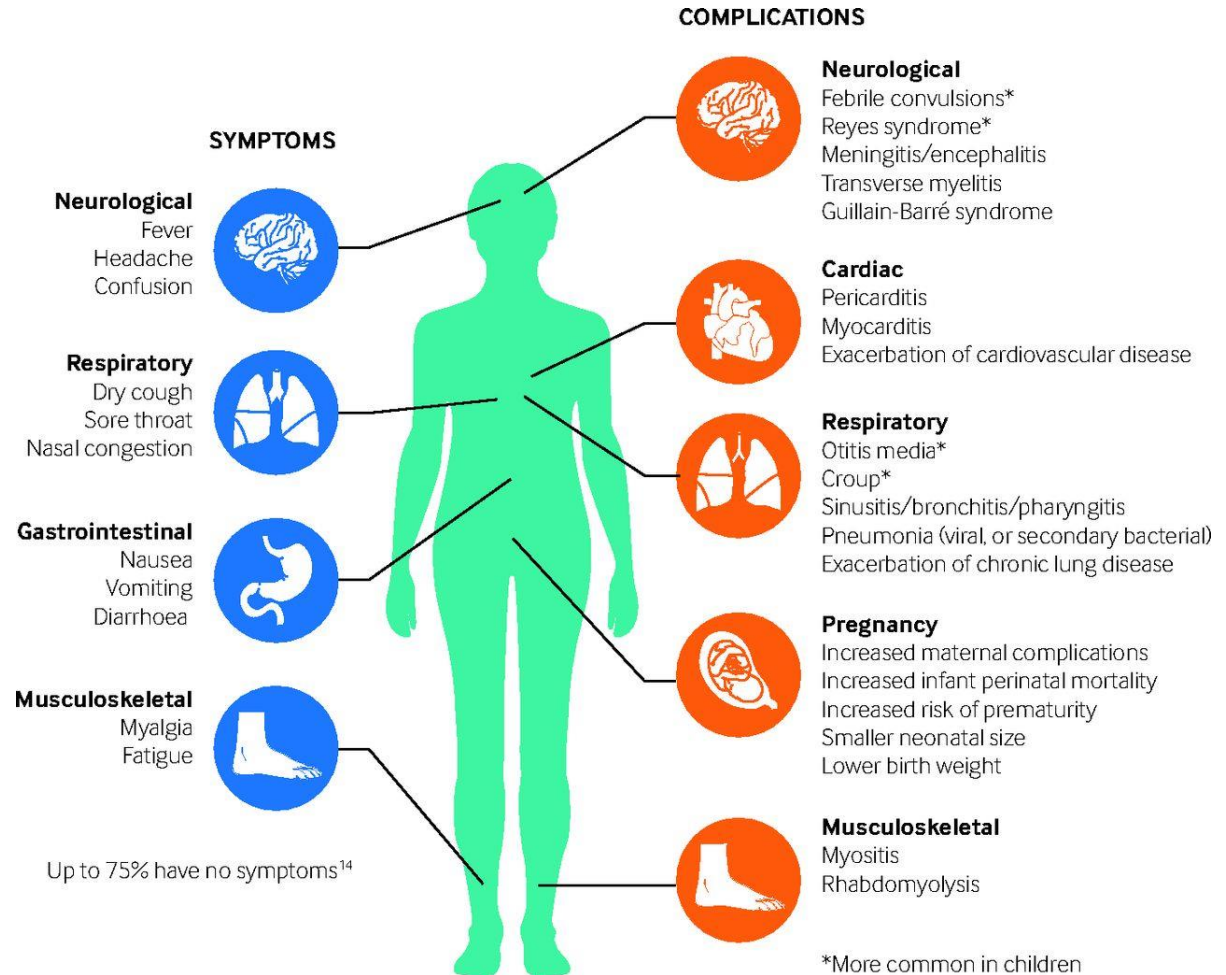
- Global Influenza Surveillance and Response System (GISRS):
 - Analysis of laboratory-confirmed influenza surveillance data by type and subtype (A/H3N2, A/H1N1 and B) from July 2016 to August 2016
 - These latest data were collected from NICs and other national influenza laboratories in 50 countries, areas or territories

Influenza is a highly transmissible viral disease



Symptoms and complications of Influenza

- Influenza is characterized by sudden onset of fever, myalgia, headache, malaise, dry cough, sore throat, and nasal congestion
Gastrointestinal symptoms including nausea, vomiting and diarrhea are also common.
- Influenza can cause severe illness or death, particularly in high risk populations



Clinical symptoms and complications of influenza

- The symptoms¹ of influenza are **similar for influenza A and B²**



Sudden onset of fever,
extreme fatigue



Nasal congestion



Non-productive cough,
sore throat



Headache



Myalgia, especially
of back muscles



Gastrointestinal: abdominal
pain, diarrhoea and vomiting

- Compared with otherwise healthy adults, influenza can cause more serious illness and greater mortality in following **risk groups³**:



Children aged
<2 years



Older adults aged
≥65 years



Pregnant women



Individuals with weakened
immune systems



Individuals with chronic
medical conditions
e.g. heart, lung, kidney, liver,
blood or metabolic diseases

• CDC, Centers for Disease Control and Prevention; WHO, World Health Organization
1. US CDC. [The Pink Book: influenza](#). 2012 (accessed April 2014); 2. Hite LK *et al.* *Int J Infect Dis* 2007;11:40–7; 3. WHO. Influenza (seasonal) 2009. Fact sheet No. 211. Available at: <http://www.who.int/mediacentre/Fact-sheets/> (accessed March 2014).

Influenza B clinically similar to A except for age distribution¹



Age

- All age groups can be infected but 5–14/19 yo olds more susceptible to type B virus²⁻³⁻⁴⁻¹⁰
- Influenza B outbreaks can be observed in nursing homes⁵
- During severe influenza B season, influenza B may represent more than 50% of fatal cases in adults > 60 yo⁹



Symptoms

- Clinical symptoms and outcomes similar for A and B infections¹⁻²
- Minimal and inconsistent differences across age groups²
- Very few differences in clinical presentation of influenza B lineages²
- Knowledge gaps still exist⁷



Hospitalizations

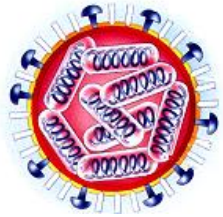
- No difference in frequency of hospital admission between influenza A and B
- Influenza B ranks between A/H3N2 and A/H1N1 in frequency, hospitalization rates, morbidity and mortality⁷
- Similar rate of confirmed pneumonia in patients with influenza A and B¹



Deaths

- Substantial impact on mortality:
 - 25% of all influenza related mortality in the US (1976–1999) attributed to influenza B⁶
 - 22% to 44% of pediatric deaths in the US (2004-2011) attributed to influenza B⁶
 - **Mortality associated with influenza B was greater than that of influenza A in children <16 yo**⁸

- **References:** 1. Irving SA, et al. *Influenza Other Respir Viruses* 2012; 6(1):37. 2. Mosnier A, et al *BMC Infect Dis* 2015; 15:357. 3. Caini S, et al *Influenza Other Respir Viruses* 2015; 9(Suppl 1):3. 4. Heikkinen T, et al *Clin Infect Dis* 2014; 59(11):1519. 5. Camilloni B, et al *Vaccine* 2010; 28(47):7536. 6. Glezen PW, et al. *Am J Public Health* 2013; 103(3):e43. 7. van de Sandt CE, et al. *Future Microbiol* 2015; 10(9):1447. 8. Tran D, et al. *Pediatrics* 2016; 138(3):e20154643. 9. Adhoch, et al. *Eurosurveillance* 2018; 23(13) Accessed date June 12 2018 10. Caini, et al. *Influenza Other Respir Viruses*. 2018



- Influenza global burden of disease

A frequent and serious disease leading to heavy public health burden (WHO data)



ANNUAL ATTACK RATE¹

- 5–10% in adults
- 20–30% in children



3 TO 5 MILLION CASES OF SEVERE ILLNESS²



**290,000 TO 650,000 ESTIMATED
DEATHS EVERY YEAR WORLDWIDE²**

Influenza vaccination and antimicrobial resistance (AMR)

- Any strategies which can reduce the use of antibiotics should be considered as part of a long term portfolio of measures to combat the antibiotic resistance ¹
- Vaccines in general have been shown to have a positive impact on antibiotic resistance and are an important part of control strategies: ²
 - prevent bacterial infections = reduced antibiotic use,
 - reduce viral infections =
 - reduce inappropriate use of antibiotics for viral infections
 - Reduces superinfections that require antibiotic treatment
- However data for influenza vaccines specifically are limited and more data are needed
 - the impact of universal influenza vaccination in the province of Ontario, Canada: a 64% reduction in the prescription of antibiotics for influenza associated respiratory disease ⁽³⁾
 - from a randomized clinical trial in the US where LAIV was used. influenza vaccination program may lead to better health outcomes, while decreasing unnecessary antibiotic use (by 42.9 to 47% in the vaccine group compared to placebo ⁽⁴⁾

Influenza is associated with a high clinical burden

- In the USA, influenza cases account for approximately *334,185 hospitalisations* and *44.0 million days of productivity lost* due to illness annually¹
- About *90%* of influenza-associated deaths occur in adults 65 years and older²
- Influenza can exacerbate chronic heart and lung disease³



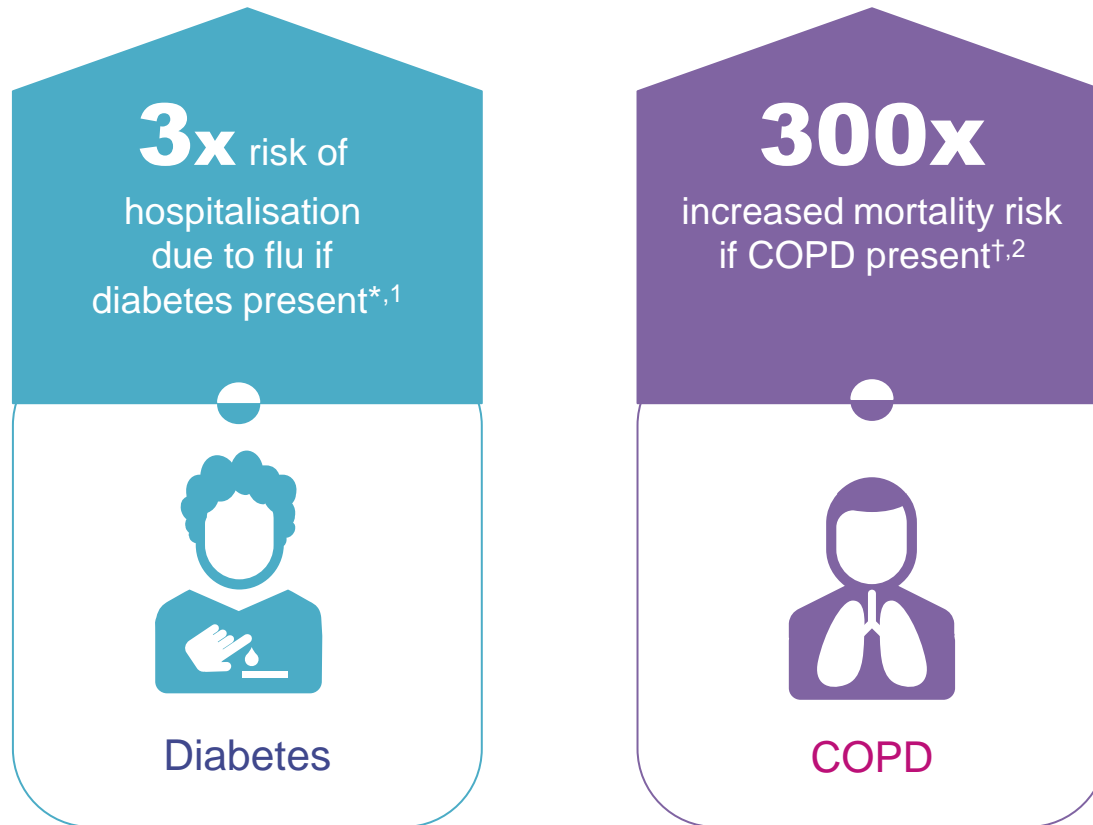
Number needed to vaccinate (NNV) data

- A systematic review of clinical trials of over 70,000 people of all ages found **number needed to vaccinate (NNV) of 71** (95%CI 64–80) to prevent one case of influenza. Vaccination also had an impact on hospitalization (NNV 94, 95%CI 70–1022) and a modest effect on time off work¹
- Another review of published data confirms vaccination reduces the influenza rate when the vaccine is well matched with reported NNV of 12 to 37:²
 - For those aged 16–65 years
 - 17 RCTs in 38,800 adults: **NNV = 37**
 - An RCT involving American factory: NNV = 12
 - For seniors aged **≥65 years**:
 - An RCT in 1838 community-dwelling seniors: NNV **= 40.5**
- For comparison NNV for other diseases³

Rotavirus	NNV=200 (confirmed hospitalizations)
Pneumococcus	NNV=1779 (confirmed vaccine serotype disease)

Concomitant NCDs increase the risk of complications of influenza

For individuals with influenza:









- COPD, chronic obstructive pulmonary disease; NCD, noncommunicable disease
- *Prevalence ratio for diabetes 3.10 (95% CI: 2.04–4.71) in 239 patients hospitalised with influenza A
- †Case fatality rate of influenza in patients with COPD ≥30% compared with 0.05–0.01% in otherwise healthy individuals

Vaccines Evidence Based Approach Summit

WHO recommendations for influenza vaccination



WHO Recommends¹

- People at high risk of complications:
 -  – Pregnant women (highest priority)
 -  – Children aged 6 months to 5 years:
 - Children aged 6–23 months of age
 - Children aged 2–5 years of age
 -  – Elderly people (≥65 years of age)
 -  – People with underlying health conditions (diabetes, asthma, chronic heart or lung diseases, HIV/AIDS)
 - International travelers with any of the above
-  People at high risk of exposure and/or capable of transmitting influenza to those at high risk of influenza related complications:
 - Healthcare workers
- 

Pregnant women are recommended by WHO for influenza vaccination



- Pregnant women have an increased risk of severe disease and death from influenza^{1,2}
- The infection may also lead to complications for the fetus/newborn such as stillbirth, neonatal death, preterm delivery, and decreased birth weight^{2,3}
- Furthermore, infants <6 months of age are also at high risk of influenza, but are too young to be vaccinated³

Elderly are recommended by WHO for influenza vaccination



- Elderly people have an increased risk for influenza because of their aging immune system: immunosenescence¹
- Risk is often heightened in seniors by the presence of one or more chronic medical conditions (heart disease, lung disease, diabetes, etc.)²
- Influenza is one of the 10 major causes of death in the elderly²
- Approximately 90% of influenza-associated deaths occur among individuals aged ≥ 65 years^{1,3}
- Hospitalizations mainly occur in the high risk group such as the elderly^{2,3,4}

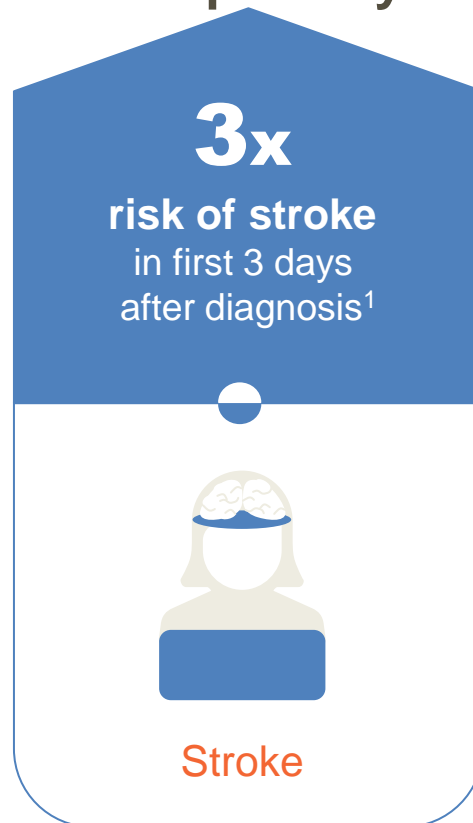
Healthcare workers are recommended by WHO for influenza vaccination



- Health workers are defined as “all people engaged in actions whose primary intent is to enhance health”¹
- Healthcare workers are not at higher risk of a severe outcome from influenza as they are generally healthy adults; however, influenza infections can have a specific impact in this population in different ways^{2,3}
 - High risk of exposure
 - Illness in staff and loss of staff time (economic and health service function)
 - Capable of transmitting influenza to those at high risk of influenza-related complications

Acute respiratory infection increases the risk of developing an NCD

For individuals with a lower-respiratory tract infection:

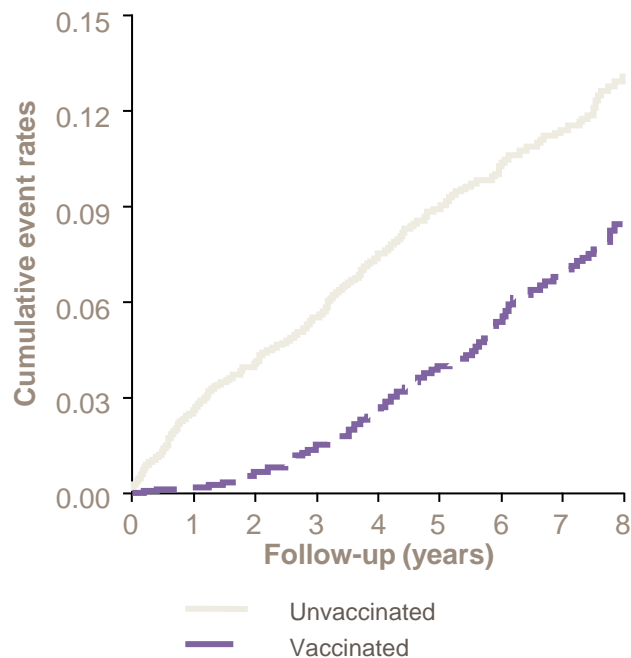


• NCD, noncommunicable disease

• Incidence ratio in days 1–3 after diagnosis of systemic respiratory tract infection 4.95 (95% CI: 4.43–5.53) for myocardial infarction (n=20 921) and 3.19 (95% CI: 2.81–3.62) for stroke (n=22,400)

Influenza vaccination helps to reduce acute coronary syndrome in patients with COPD

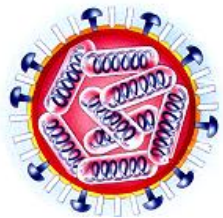
Taiwan, N=7,722; 7-year follow-up period*



*From Jan. 01, 2000 to Dec. 31, 2007

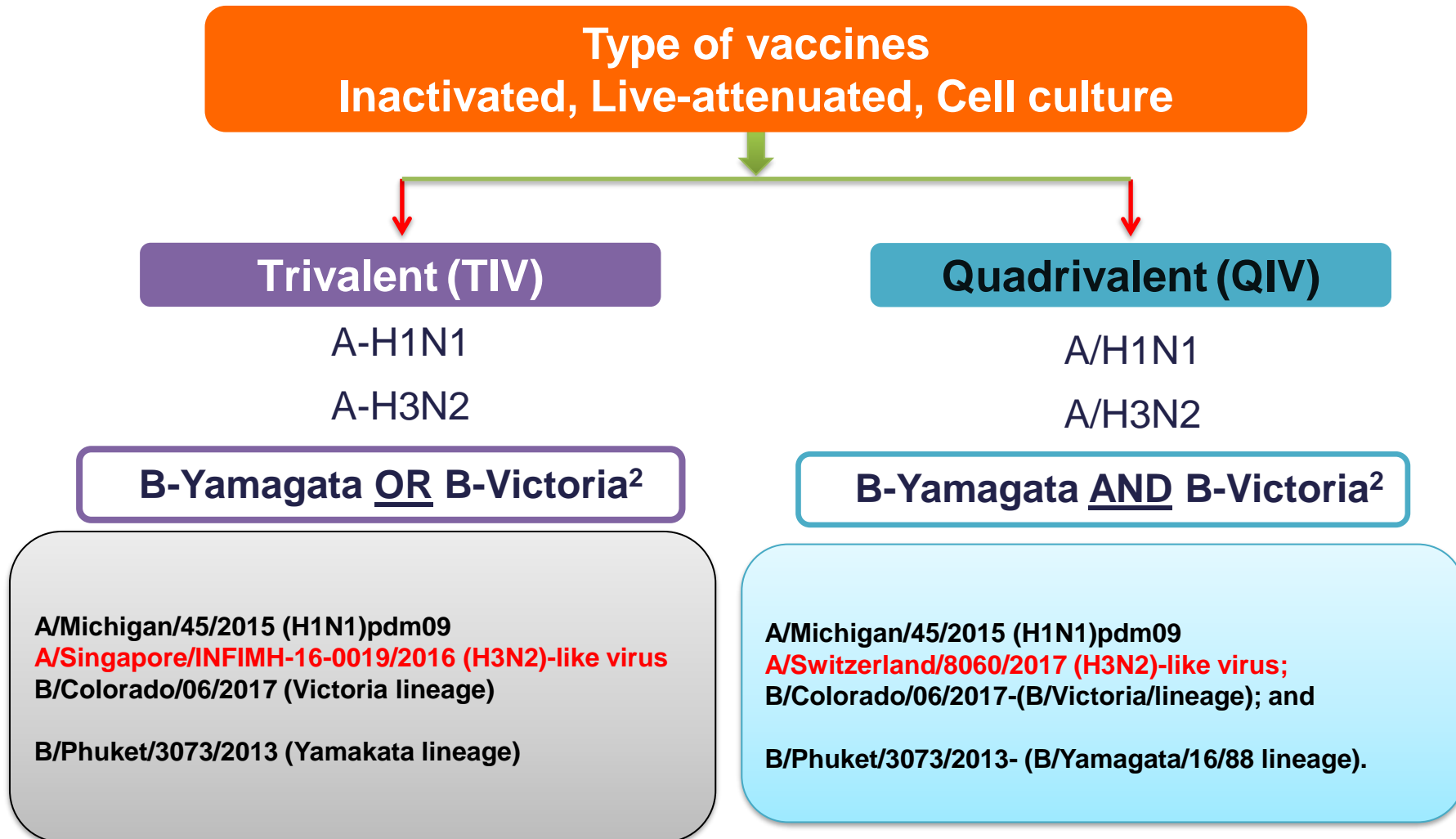
x: vaccination ; Figures reproduced from Sung LC, *et al.* 2014

Sung LC, *et al.* *Vaccine* 2014; **32**: 3843–49



- Influenza vaccination

Types of seasonal influenza vaccine



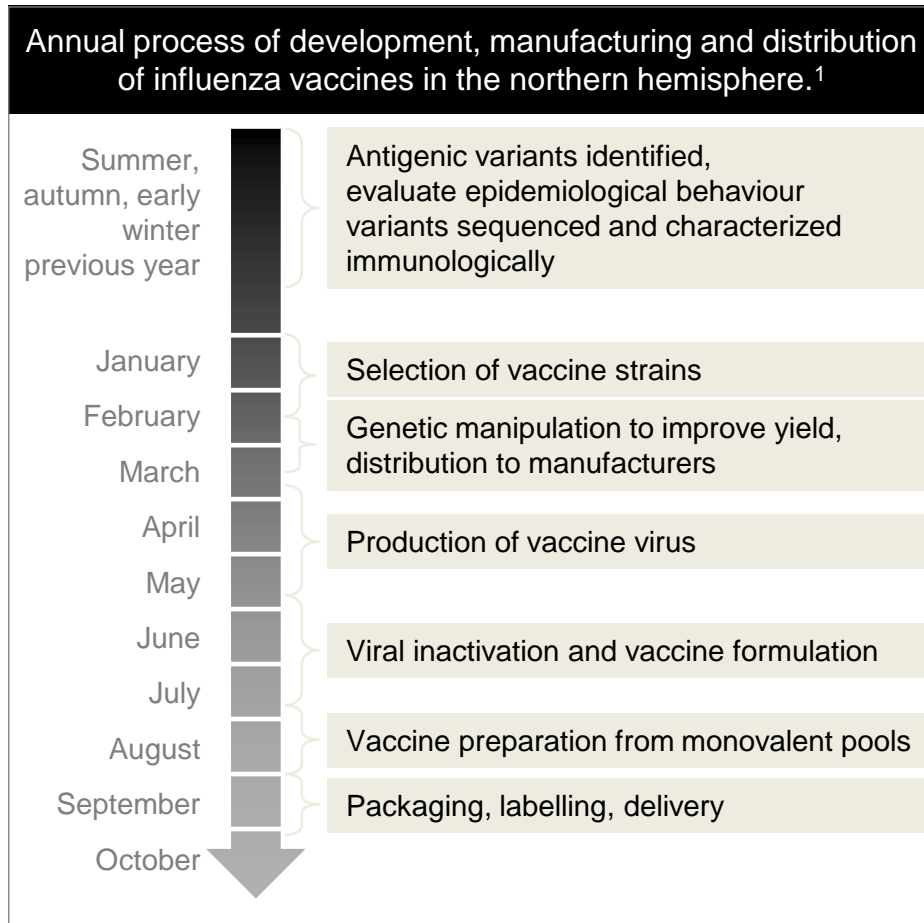
WHO: vaccine composition for 2022–23 season¹



- The WHO recommends that quadrivalent vaccines for use in the 2022–2023 northern hemisphere influenza season contain the following: Egg-based vaccines
 - an A/Victoria/2570/2019 (H1N1)pdm09-like virus;
 - an A/Darwin/9/2021 (H3N2)-like virus;
 - a B/Austria/1359417/2021 (B/Victoria lineage)-like virus; and
 - a B/Phuket/3073/2013 (B/Yamagata lineage)-like virus. 25 February 2022
- Cell culture- or recombinant-based vaccines
 - an A/Wisconsin/588/2019 (H1N1)pdm09-like virus;
 - an A/Darwin/6/2021 (H3N2)-like virus;
 - a B/Austria/1359417/2021 (B/Victoria lineage)-like virus; and
 - a B/Phuket/3073/2013 (B/Yamagata lineage)-like virus. * The A(H3N2) component was recommended on 21

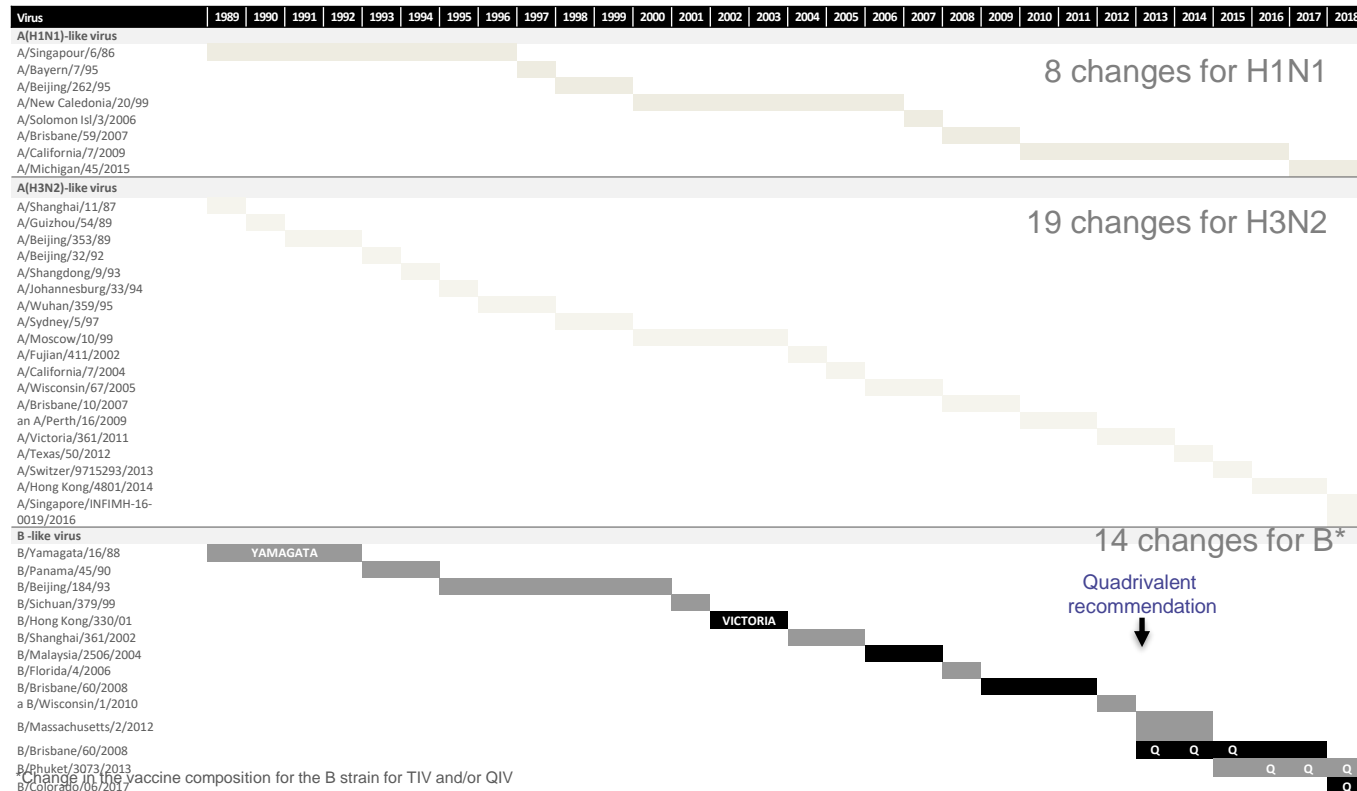
March 2019.

Annual process of development, manufacturing and distribution of influenza vaccines in the northern hemisphere



- Since 1999, two vaccine compositions recommended annually:²
 - Mid-February – recommendation for the following northern hemisphere
 - September – recommendation for the following southern hemisphere
- WHO provides guidance on which B strain, based on epidemiological data¹
- The choice does not always reflect the circulating strain in the following season, leading to mismatch¹

41 different influenza vaccine strains recommended for northern hemisphere composition since 1989



References: 1. Hay AJ, et al. *Philos Trans R Soc Lond B Biol Sci* 2001; 356(1416):1861. 2. www.who.int/influenza/vaccines/vaccinerecommendations1/en/index13.html (2001–2010). 3. www.who.int/influenza/vaccines/virus/recommendations/en/ (2010–2019)

41 different influenza vaccine strains recommended for northern hemisphere composition since 1989



2013–14

WHO recommended
quadrivalent vaccine
composition³

1989

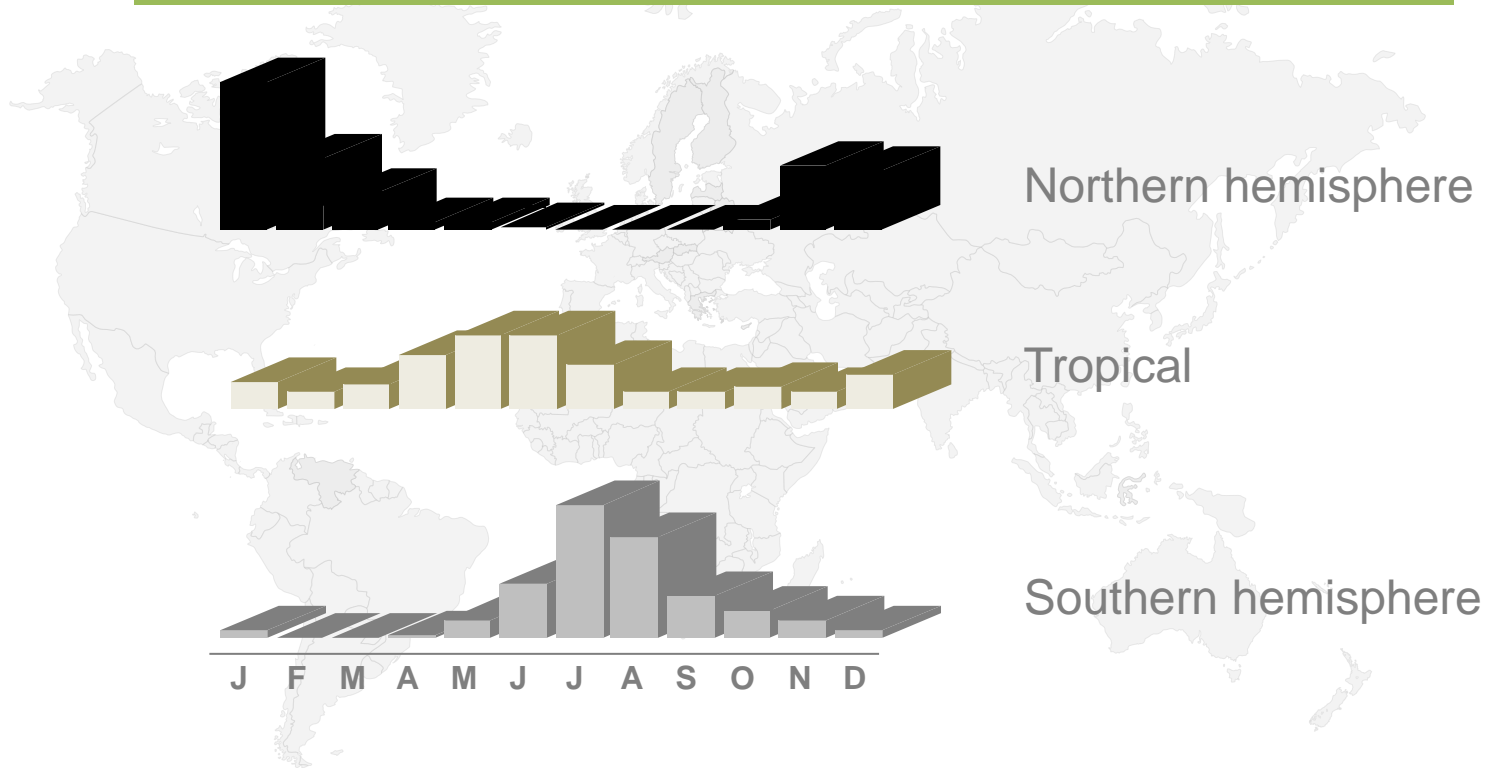
2019

- 9 changes for H1N1
- 20 changes for H3N2
- 14 changes for B

When should I get vaccinated? ¹

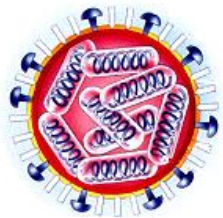
Influenza seasonality

Influenza activity and occurrence in different climates¹



Temperate climates: yearly winter epidemics

Tropical climates: year-round transmission with several peaks



- Influenza vaccination efficacy/effectiveness

Vaccine efficacy and vaccine effectiveness

Efficacy

Does the influenza vaccine work?

Randomized controlled trials explore the “best case scenarios” of vaccine protectiveness under controlled conditions

Effectiveness

Does using the vaccination help people?

Is vaccination worthwhile for individuals and society?

Vaccine effectiveness measurement can assess the net balance of benefits and adverse effects of a vaccination program, rather than the vaccine alone, in real world conditions


Thank you!

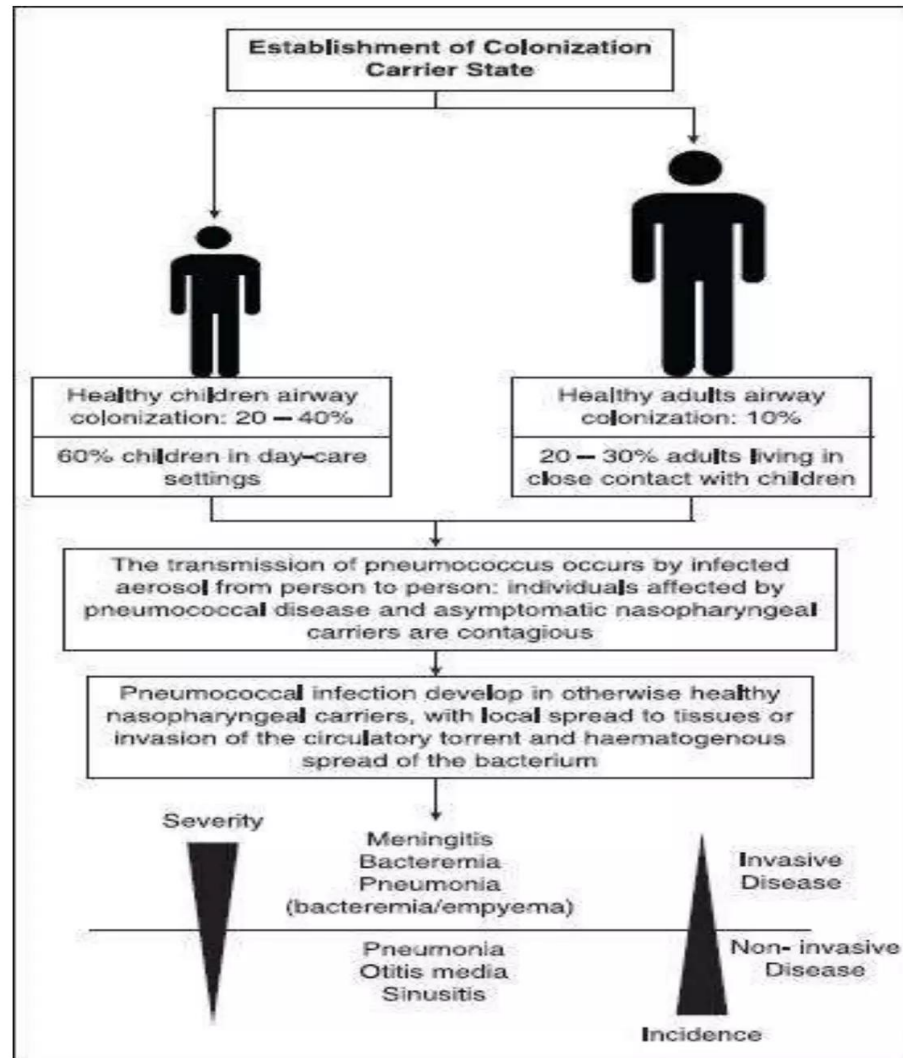
Global burden of pneumococcal diseases

- Major cause of mortality and morbidity worldwide
- The most common cause of community acquired pneumonia requiring hospitalization, accounting for up to 50% of these cases
- CDC data: most common pediatrics infection for which antibiotics are routinely prescribed.

Pneumococcal diseases burden

- Pneumococcal disease describes a group of infections such as meningitis, pneumonia, septicemia, sinus infections and ear infections caused by the *Streptococcus pneumoniae*.
- Acute respiratory infections kill an estimated 2.6million children under five years of age annually.
- **Strep. Pneumonia causes over 1 million of these deaths**, most of which occur in developing countries

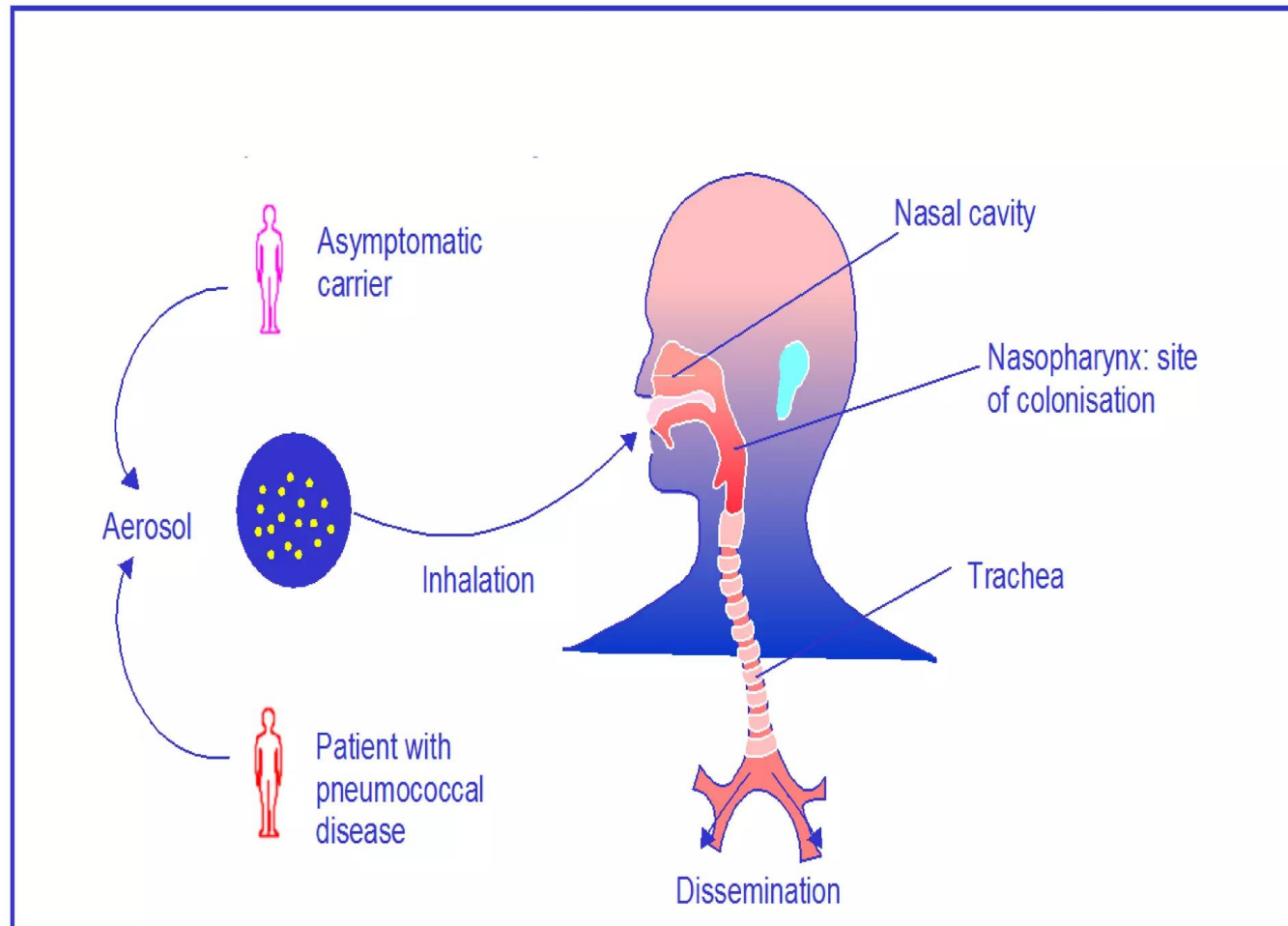
- 
- **Pneumococci are common inhabitants of the respiratory tract and may be isolated from the nasopharynx of asymptomatic human carriers , There is no animal or insect vector.**
 - **Many people, especially children, have the pneumococci in their nostrils, pharynx, or throats without manifesting signs or symptoms of ill health or developing invasive disease , this is called asymptomatic carriage .**





Pneumococcal colonisation

- Pneumococcal disease may take place when two situations coincide:
 1. The host is colonized with a pneumococcal strain against which immunity has not yet been established .
 2. An alteration of the natural barriers or host immune system has occurred.



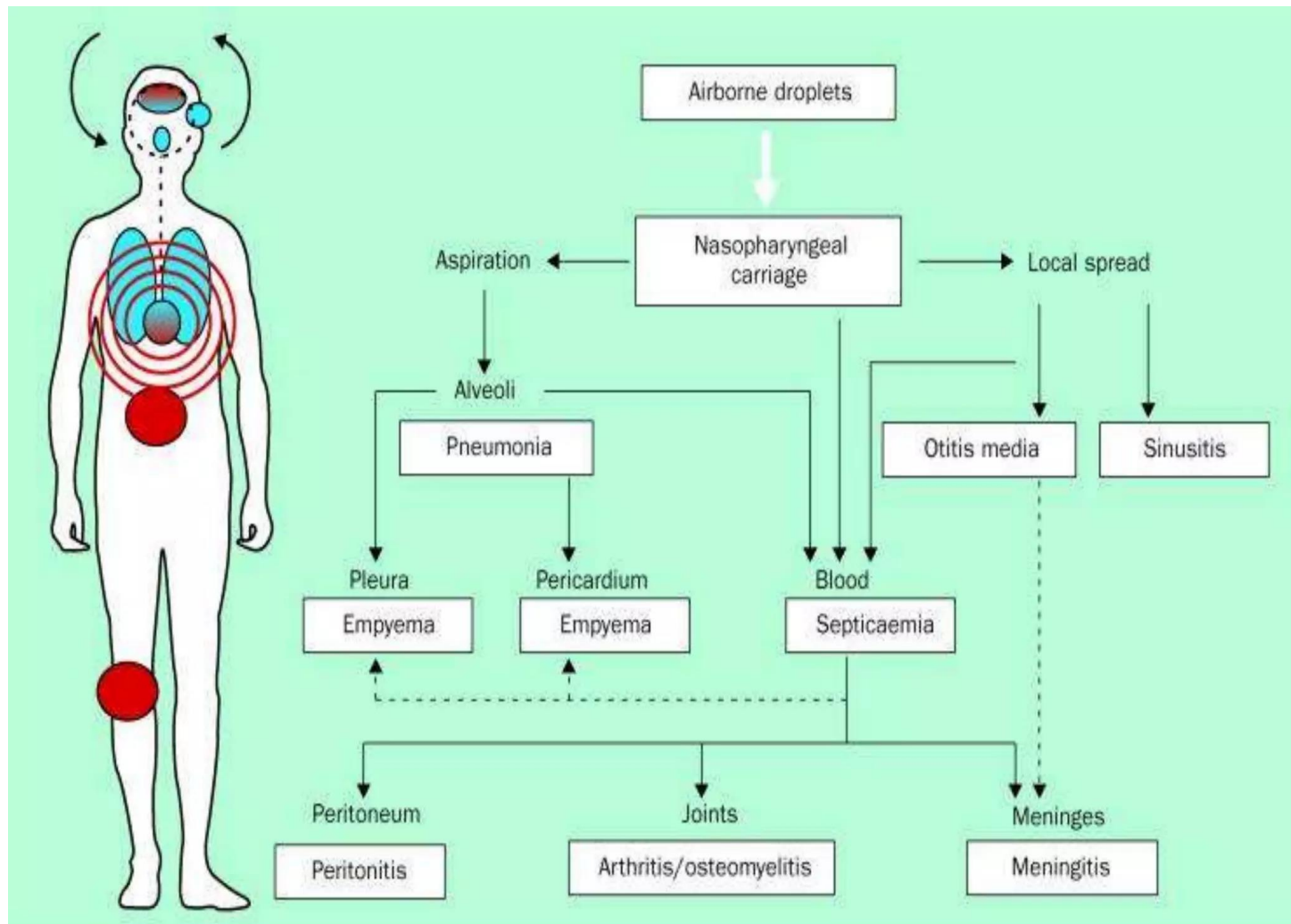


Table 1 - Diseases caused by pneumococcus

Non-invasive diseases

Acute otitis media

Sinusitis

Conjunctivitis

Bronchitis

Pneumonia

Invasive diseases*

Bacteremia

Bacteremic pneumonia / empyema

Meningitis

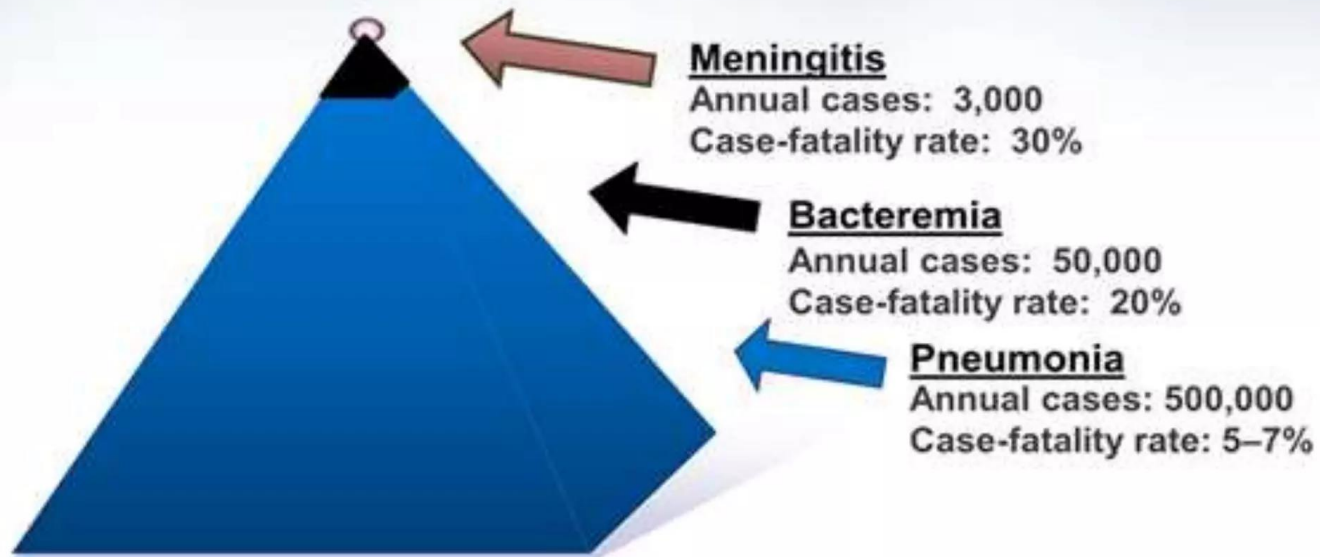
Sepsis

Peritonitis

Arthritis / osteomyelitis

* Invasive diseases: isolation of pneumococcus from usually sterile sites (blood, cephalorachidian, pleural or sinovial liquid).


Pneumococcal Disease: Major Clinical Syndromes



**Less severe diseases (sinusitis, otitis media):
Millions of cases annually**

1.CDC. The Pink Book, 10th ed. Washington DC: Public Health Foundation, 2007.

2.CDC. *MMWR Morb Mortal Wkly Rep.* 2005;54(RR-5):1–11.

- 
- In young children, bacteraemia accounts for 50 to 70% of all episodes of IPD, followed by pneumonia (15 to 25%) and meningitis (4%).
 - In adults, bacteraemic pneumonia accounts for 50 to 80% of all episodes of IPD.




Non-invasive disease

- Acute otitis media and pneumonia (without bacteraemia) are classified as non-invasive disease for surveillance purposes.
- Pneumococcal pneumonia is the most common clinical presentation of pneumococcal disease among adults.
- Pneumococcus is estimated to account for over a third of all community-acquired pneumonia in adults.



- Middle ear infections are the most frequent reasons for pediatric office visits in the United States, resulting in more than 20 million visits annually.
- Complications of pneumococcal otitis media may include mastoiditis and meningitis.

- 
- Anyone can get pneumococcal disease, but some people are at greater risk for disease than others.
 - Being at extremes of age or having some medical conditions OR immunocompromised can put you at increased risk for pneumococcal disease.

Conditions That Increase Risk for Invasive Pneumococcal Disease

Table 2. High-risk conditions for severe or recurrent pneumococcal disease in childhood and adolescence

Risk group	Disease or condition
Immunocompetent children	Chronic pulmonary disease: severe asthma, bronchopulmonary dysplasia, cystic fibrosis, α 1-antitrypsin deficiency, bronchiectasis
	Chronic heart disease, especially congenital cyanotic heart disease or conditions that can lead to heart failure or hemodynamic alterations
	Down syndrome ¹
	Diabetes mellitus
	Chronic liver disease
	Subarachnoid space fistulas
	Children with cochlear implants
Children with asplenia ² (anatomic or functional)	Sickle-cell anaemia and other hemoglobinopathies
	Congenital or acquired asplenia, or splenic dysfunction
Immunocompromised children ²	HIV infection
	Primary immunodeficiencies (excluding isolated IgA deficiency)
	Chronic kidney failure and nephritic syndrome
	Diseases that require treatment with immunosuppressive drugs or radiotherapy (including leukaemia, lymphoma, bone marrow or solid organ transplant)

ACIP risk groups for pneumococcal infection

- (ACIP) recommends vaccination of:
 - All adults aged 65 years and over
 - Adults aged 19-64 years with the following underlying medical conditions:

1- Immunocompetent persons

- Chronic heart disease
- **Chronic lung disease**
- Diabetes mellitus
- Cerebrospinal fluid leaks
- Cochlear implant
- Chronic liver disease

Cigarette smoking

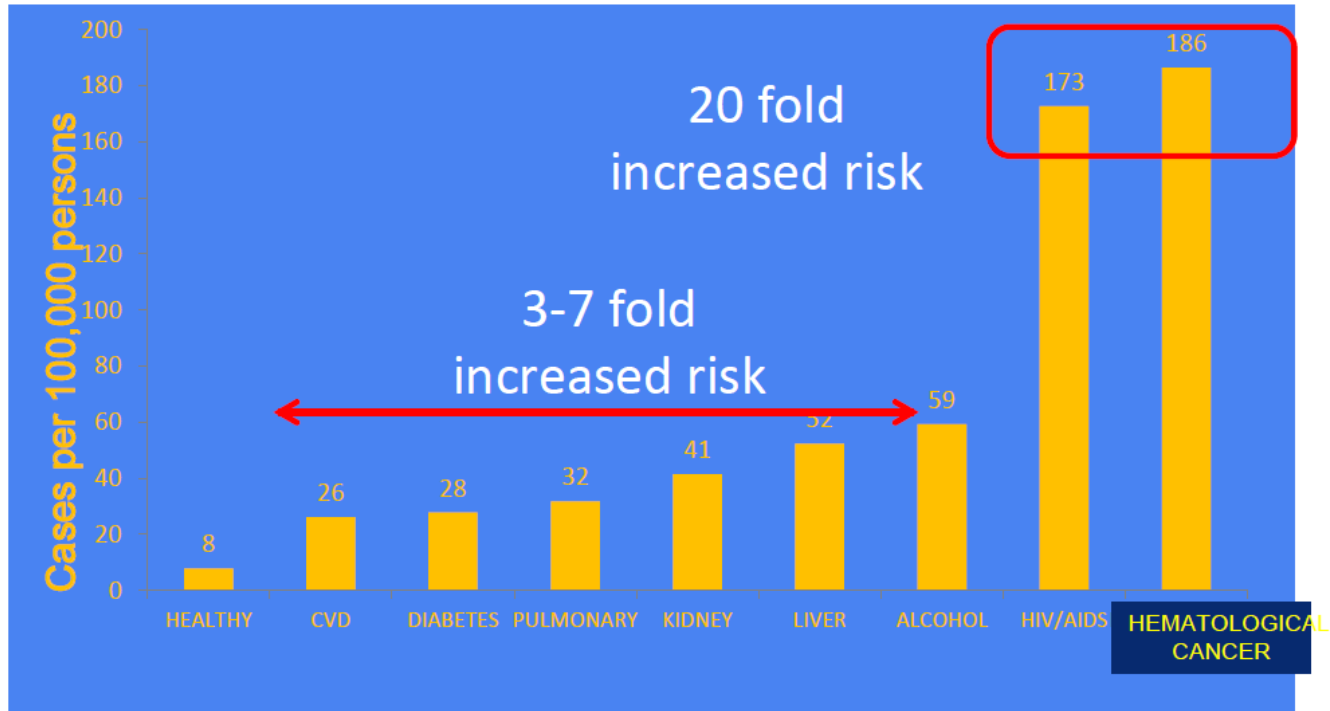
2- Functional or anatomic asplenia

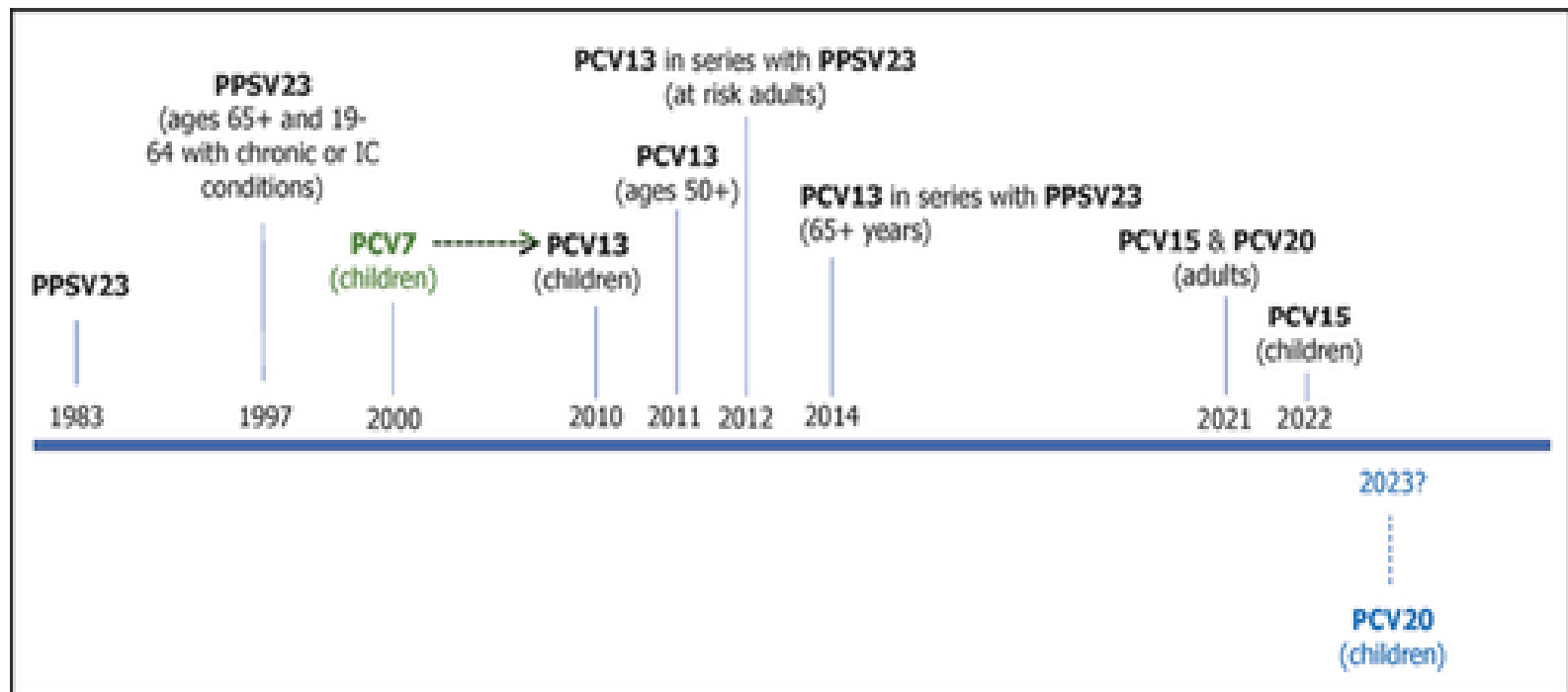
- Sickle cell disease
- Splenectomy
- congenital or acquired asplenia

3-Immunocompromised persons

- Congenital or acquired (HIV) immunodeficient
- C R F & Nephrotic
- Leukaemias & Lymphomas
- Generalised malignancy
- *Diseases treated with immunosuppression(steroids >1 m or Biologics*
- Solid organ transplantation

Incidence of IPD in Adults Aged 18-64 Years with Selected Underlying Conditions, United States, 2009





Box 1: Summary of current pneumococcal vaccines licensed for use

PCV-7

4, 6B, 9V, 14, 18C, 19F, and 23F

PCV-10

PCV-7 plus 1, 5, and 7F

PCV-13

PCV-10 plus 3, 6A, and 19A

PCV-15

PCV-13 plus 22F and 33F

PCV-20

PCV-15 plus 8, 10A, 11A, 12F, and 15



Article

Epidemiology of *Streptococcus pneumoniae* Serotypes in Jordan Amongst Children Younger than the Age of 5: A National Cross-Sectional Study

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<https://www.mdpi.com/journal/vaccines>

Situation in Jordan

- No published data from Jordan on burden of strep. pneumonia or distribution of serotypes leading to invasive pneumococcal diseases (IPD) for children <5
- Vaccination against pneumococcal infections is not included in the National vaccination program neither for children under five as part of the national vaccination program nor for children at high risk
- Currently pneumococcal vaccine is given routinely only to splenectomy patients and sporadically for selected high risk groups in Jordan

Study DESIGN

Cross-sectional study

- To assess the burden of strep. pneumonia using molecular technique as qPCR and compare it with the routine culture results.
- To identify common serotypes of strep. pneumonia for children aged below 5 years hospitalized with invasive pneumococcal diseases (IPD):
 - pneumonia, septicemia and meningitis during study duration in representative areas of Jordan.

INCLUSION/EXCLUSION

Inclusion criteria:

- All children younger than age of 5
- living in study locations for more than 6 months
- diagnosed with invasive pneumococcal infection during the study duration.

Exclusion criteria:

- Children receiving routine pneumococcal vaccination. (one case)
- Not permanently resident in study area

Results1

- **Analysis of serotypes of 1015 strep. pneumonia cases.**
- Lobar pneumonia final diagnosis for 1006 cases
- **The PCR positivity rate was 91.8%** based on the serum samples of cases with radiological findings suggestive of lobar pneumonia.

Results1

- Only 23 culture-positive cases were identified in comparison to 992 PCR-positive but culture-negative cases.
- 6 Cases were diagnosed with meningitis, 3 cases with sepsis and the remaining 14 cases with pneumonia complicated with septicemia.

Variable		Category	N (%)
Have you received antibiotics within a week of admission		No	802 (79.0%)
		Yes	213 (21.0%)
Previous hospitalization	No		795 (78.3%)
		Yes	220(21.7%)
Patient receives regular medications		No	956 (94.2%)
		Yes	59 (5.8%)
Fever		No	300 (29.6%)
		Yes	715 (70.4%)
Blood culture		Positive	23 (2.2%)
		Negative	987 (97.3%)
		Not done	5 (0.5%)
Chronic illness Complications during admission		No	898 (88.5%)
		Yes	117 (11.5%)
Asthma Required ICU admission		Not admitted	774 (76.2%)
		Admitted & intubated	95 (9.4%)
Any of family members is smoker		Admitted not intubated	146 (14.4%)
WBC (Leukocytosis)		Negative	255 (25.1%)
		Positive	760 (74.9%)

Hospital			Albashir hospital	
			10.11%	103
	Karak hospitals (122 MoH, 17 cases RMS)	% within Hospital		
		Count	13.73%	139
	Alzarqa hospital	% within Hospital		
		Count	11.04%	112
	Jordan University Hospital	% within Hospital		
		Count	1.58%	16
	King Abdullah I University Hospital	% within Hospital		
		Count	2.32%	24
	Princess Rahmeh hospital	% within Hospital		
		Count	51.39%	522
	Prince Rashid hospital/Iydoun	% within Hospital		
		Count	8.53%	87
	Queen Rania Hospital for Pediatrics.RMS hospital	% within Hospital		
		Count	1.30%	13
	Total	% within Hospital		
		Count	100.00%	1015

Serotype	Frequency for all participant	Frequency for cases <2 year of age, N=754	Mean age	age SD	Presence of Congenital disease	Presence of chronic illness	Percentage in pneumonia cases
PCV-10	45.32%	45.23%	15.5	16.2	1.77%	7.09%	44.63%
1	3.84%	3.32%	19.6	18.3	0.30%	0.89%	3.74%
4	0.79%	0.66%	16.5	17.9	0.00%	0.20%	0.79%
5	0.99%	0.93%	17.0	14.5	0.00%	0.10%	0.99%
6B	16.45%	15.65%	16.2	16.9	0.49%	2.86%	16.45%
7F	0.30%	0.40%	8.6	12.5	0.00%	0.10%	0.30%
9V	0.10%	0.13%	1.0	0.0	0.00%	0.00%	0.10%
14	12.12%	12.60%	14.5	16.3	0.59%	1.38%	11.72%
18C	1.08%	1.19%	12.7	16.1	0.00%	0.10%	1.08%
19F	8.18%	8.62%	15.3	14.5	0.30%	1.18%	8.08%
23F	1.48%	1.72%	9.7	12.6	0.10%	0.30%	1.38%
PCV-13	61.87%	61.54%	15.5	16.6	2.76%	8.57%	60.79%
3	1.18%	0.93%	20.0	17.5	0.10%	0.10%	1.08%
6A	13.60%	14.06%	14.5	17.6	0.79%	1.28%	13.50%
19A	1.77%	1.33%	18.7	17.9	0.10%	0.10%	1.58%
PCV-15	64.14%	63.79%	15.5	16.6	2.76%	8.77%	63.05%
22F	1.58%	1.59%	15.7	16.6	0.00%	0.20%	1.58%
33F	0.69%	0.66%	15.9	17.0	0.00%	0.00%	0.69%
PCV-20	68.47%	68.44%	15.3	16.6	2.96%	9.36%	67.39%
8							
10A	0.20%	0.13%	34.5	29.0	0.00%	0.00%	0.20%
11A	1.77%	1.86%	12.9	15.9	0.00%	0.30%	1.77%
12F	1.87%	1.99%	11.9	15.9	0.00%	0.10%	1.87%
15B	0.49%	0.66%	4.4	6.2	0.20%	0.20%	0.49%

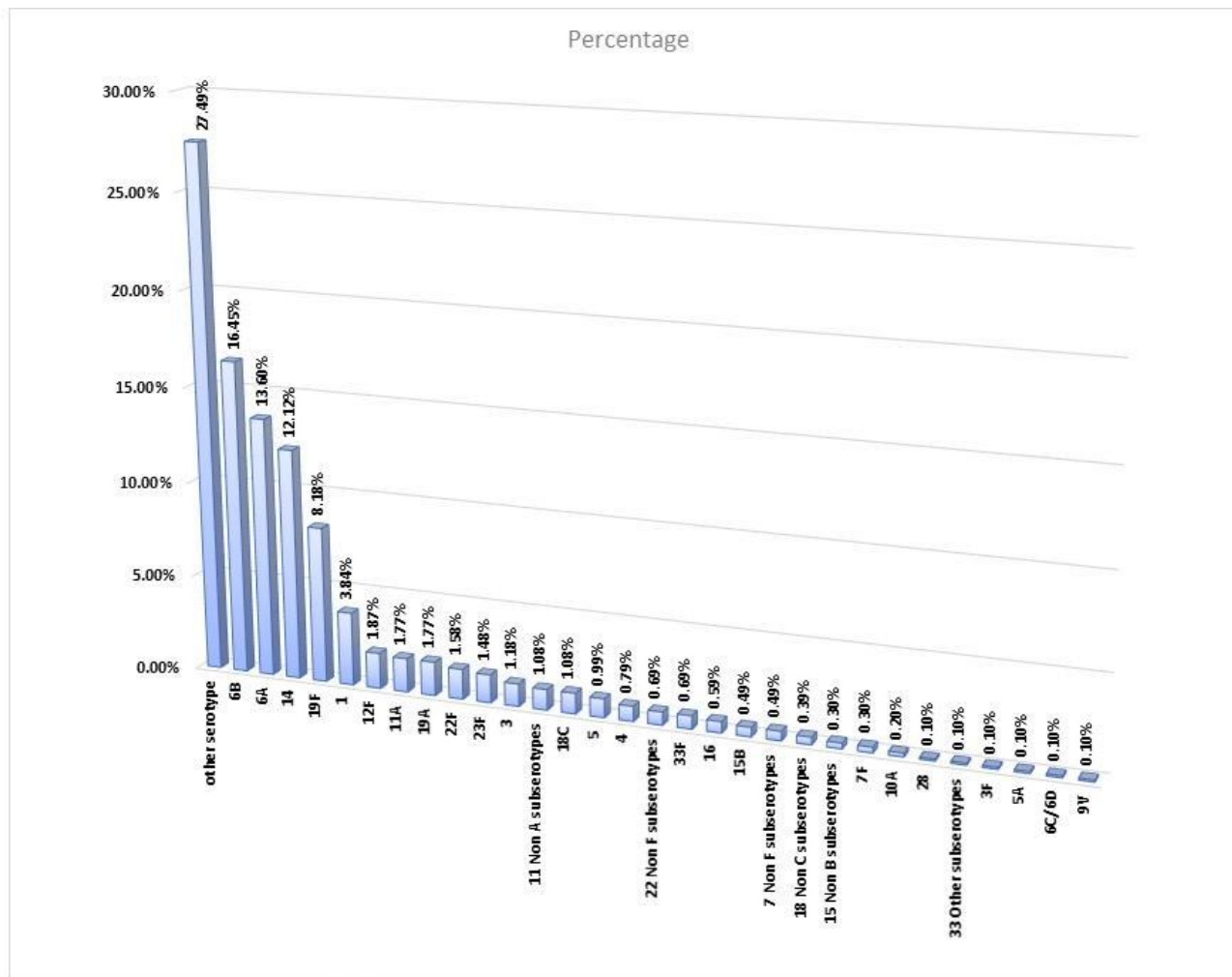


Figure 1: frequency of detected serotypes for strep. pneumonia

DISCUSSION1

- This is largest study from the Middle East and one of the largest prospective studies worldwide showing the serotypes of strep. pneumonia using molecular techniques through quantitative Polymerase Chain Reaction (qPCR) and the classical culture based Quellung reaction.
- Study revealed consistent findings with global data that strep. pneumonia contributed to 50% of community acquired pneumonia amongst hospitalized children younger than the age of 5.

DISCUSSION1

- This study presented serotypes of strep. pneumonia for 1015 IPD cases. Most of cases (992; 97.7%) would have been missed through the routine surveillance based on the culture outcomes that identified only 23 cases
- Majority of cases were identified through qPCR for blood samples of patients with lobar pneumonia.
- Data also revealed that counting on the routine culture techniques will largely underestimate the true burden of strep. pneumonia infections and other bacterial infections highlighting the importance of molecular techniques in the assessment of the burden of different pathogens in developing countries.

Thank you