# Impact des pandémies

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# Mortalité

SIDA, 1981

Hépatite C, 1989

Grippe

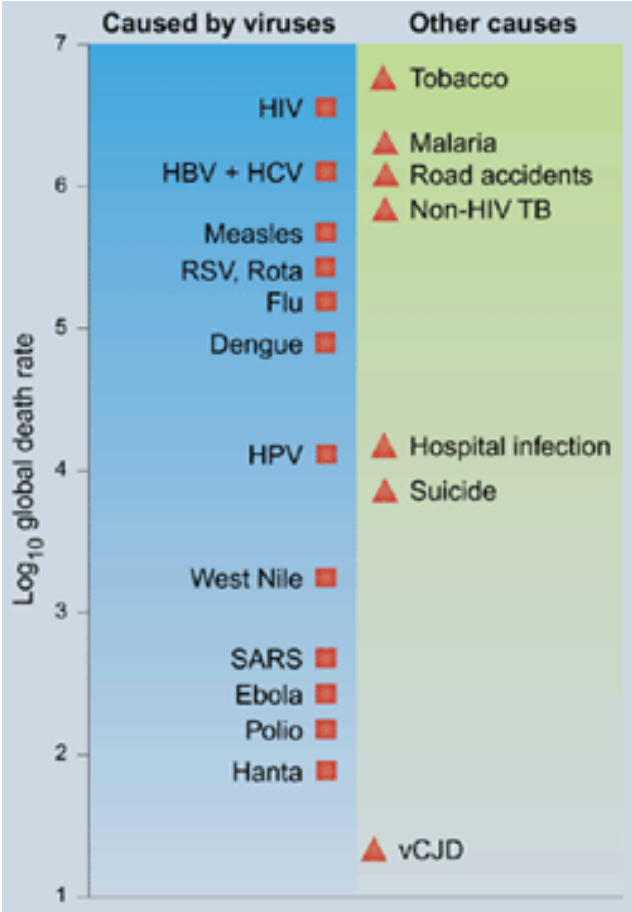
Encéphalite du Nil Occidental, 1999

SRAS, 2003

Ebola, 1976

Hantavirus, 1992

Maladie de Creutzfeld-Jakob (variant), 1995




Weiss RA, Nature Medicine, 2004

# Mortalité

SIDA, 1981

Hépatite C, 1989

Grippe

Incubation courte
Contagieux après le début des symptômes

Encéphalite du Nil Occidental, 1999

SRAS, 2003
Ebola, 1976
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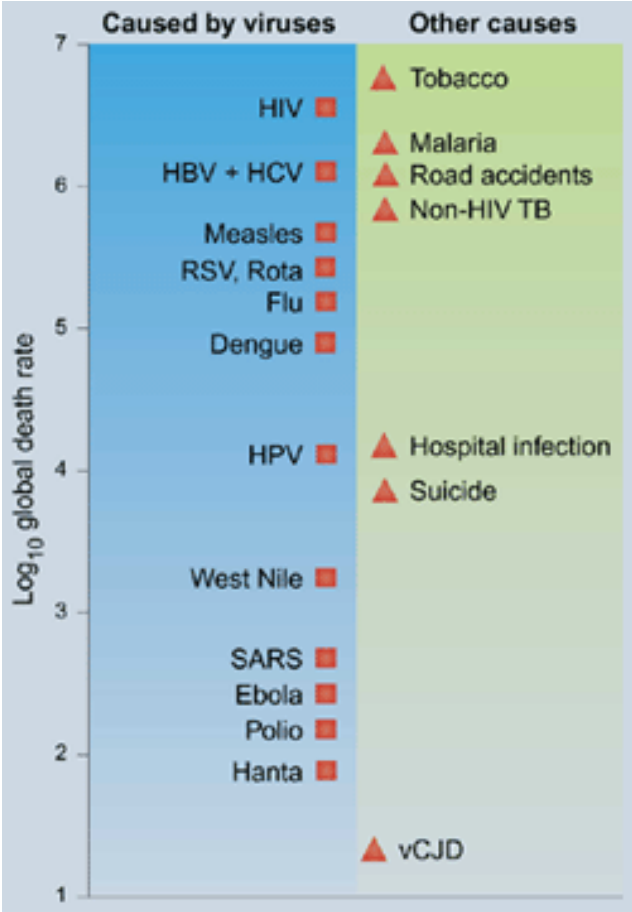


Weiss RA, Nature Medicine, 2004

# Mortalité

Incubation longue
Contagieux avant le début des symptômes

SIDA, 1981 →

Hépatite C, 1989 →

Grippe →

Encéphalite du Nil Occidental, 1999 →

SRAS, 2003 →
Ebola, 1976 →
Hantavirus, 1992 →

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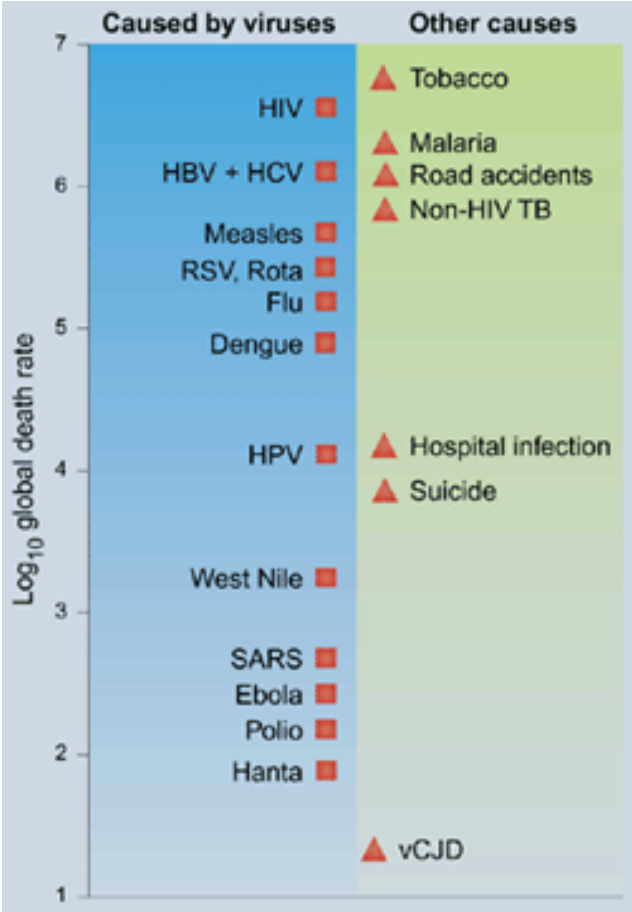
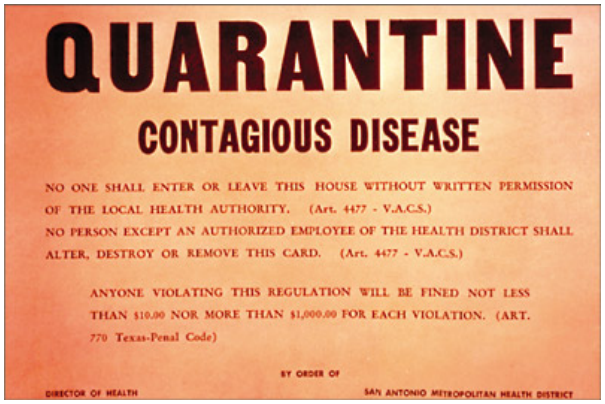



Weiss RA, Nature Medicine, 2004

# Contrôle de l'épidémie: isolement et quarantaine



http://www.manilatimes.net/ 3/29/03

MERS en France en 2013:
- 1er patient: 163 contacts
- 2ème patient: 39 contacts

# Restriction des déplacements

The international impact of SARS is growing, as are fears of its consequences.

Associated Press

Fearful of the SARS virus, a couple wore masks in the Beijing railway station. Thousands were fleeing the city as China raised the death toll.

J.P. Moczulski/Associated Press

A woman got into a taxi with her newborn outside St. Michael's Hospital in Toronto. The World Health Organization on Wednesday issued a warning against travel to the city.

## Officials warn against travel to Toronto, Beijing

By Rob Stein
*Washington Post*

WASHINGTON, D.C. — The World Health Organization on Wednesday warned travelers to avoid China's capital city of Beijing and Canada's most important metropolis, Toronto, saying the drastic step was needed to halt the spread of SARS, severe acute respiratory syndrome.

And today, a major hospital in Beijing was closed. Patients and more than 2,000 employees from the People's Hospital of Peking University were under observation for the lung disease, an official of the university management office said.

The hospital's Web site says it has 1,020 beds, but the official, who gave his name only as Sun, said he didn't know how many patients were in the hospital at the time.

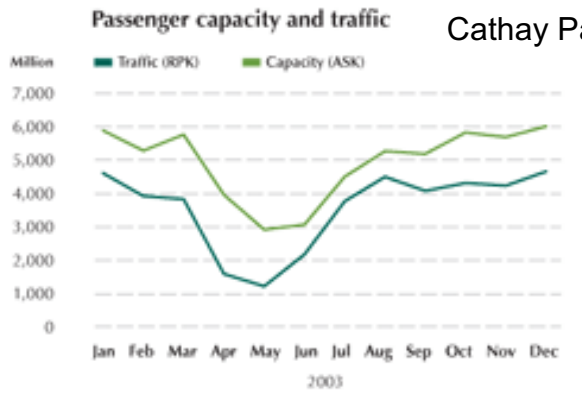
All were transferred to one of six hospitals in Beijing designated to handle SARS cases, Sun said.

The travel warning, the latest indication of rising international alarm about the disease, marked the first time in its 55-year history that WHO has told the public to avoid either the Chinese capital or any locale in North America.

WHO also added Shanxi Province in China to its list, joining Hong Kong and Guangdong Province as SARS danger spots.

**SARS continues on A15:**
— *The Toronto area had 136 probable cases on Tuesday.*
— *City officials were livid about the travel advisory.*

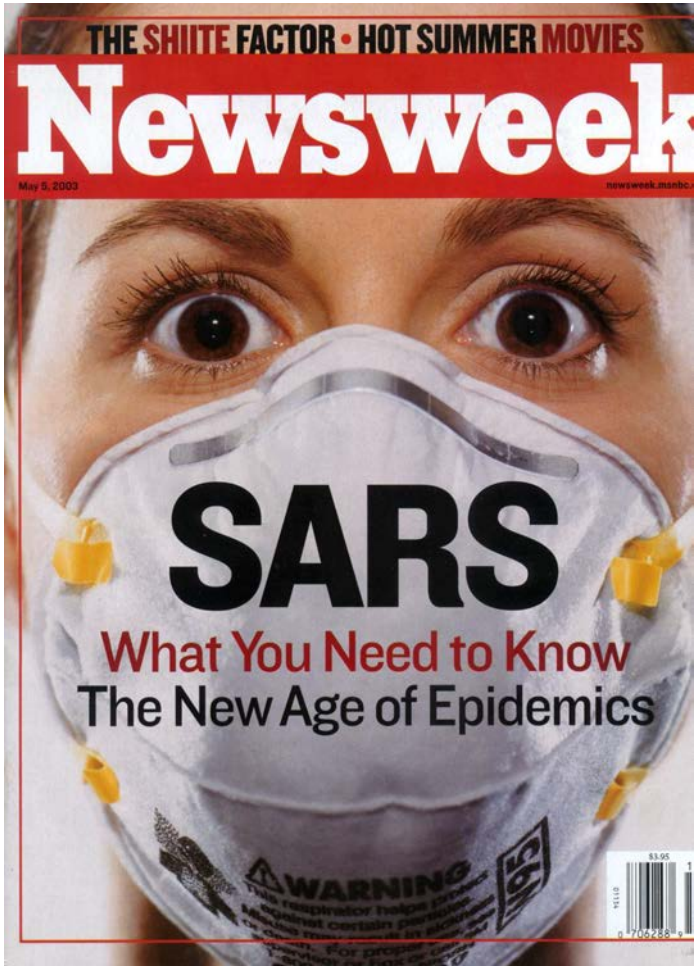
Mpls Star-Tribune  Apr 24,2003

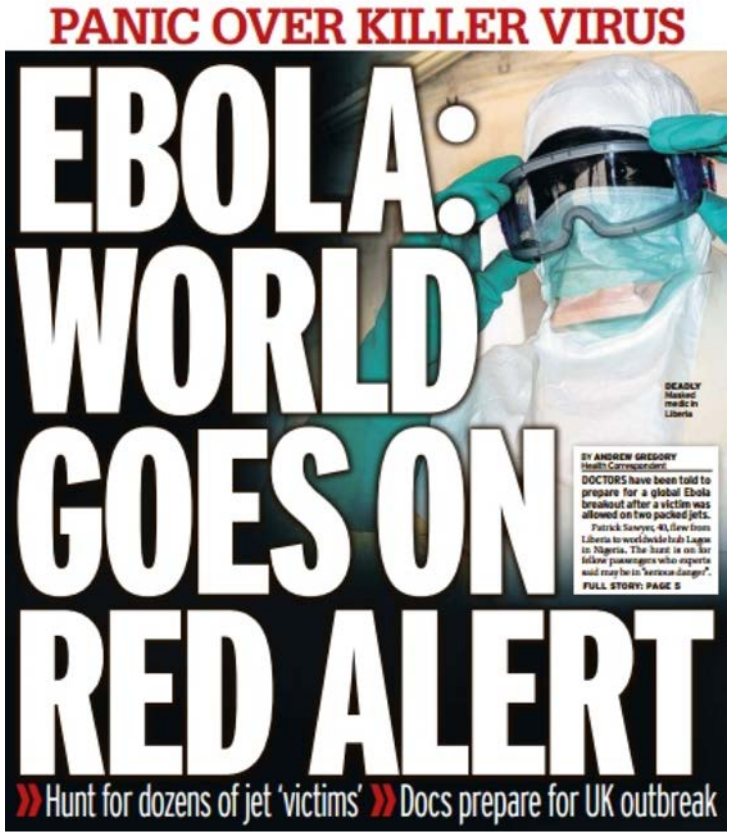



Cathay Pacific

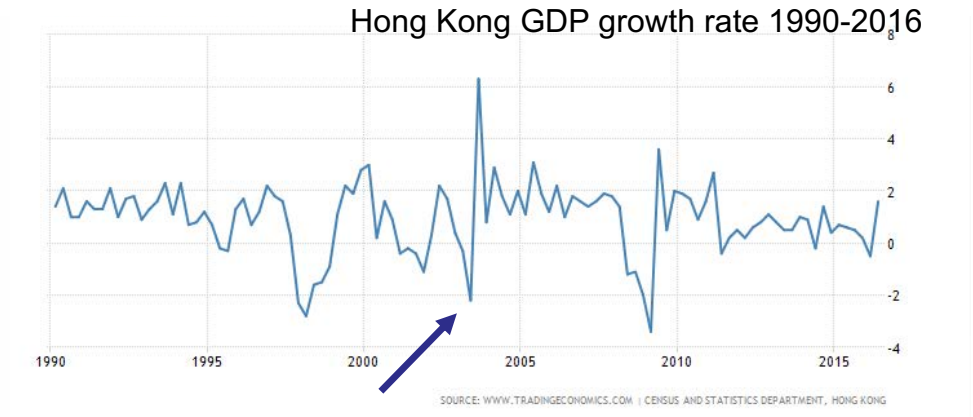
# SRAS et Ebola:
# transmission dans les centres de soins

# Les médias


THE SHIITE FACTOR • HOT SUMMER MOVIES
Newsweek
May 5, 2003
SARS
What You Need to Know
The New Age of Epidemics
WARNING


PANIC OVER KILLER VIRUS
EBOLA: WORLD GOES ON RED ALERT
DEADLY Masked medic in Liberia
BY ANDREW GREGORY
Health Correspondent
DOCTORS have been told to prepare for a global Ebola breakout after a victim was allowed on two packed jets.
Patrick Sawyer, 40, flew from Liberia to worldwide hub Lagos in Nigeria. The hunt is on for fellow passengers who experts said may be in "serious danger".
FULL STORY: PAGE 5
Hunt for dozens of jet 'victims'
Docs prepare for UK outbreak

# Impact économique du SRAS - 2003




- Impact sur les transports, le secteur touristique, hôtelier, restaurants,…
- Absentéisme, baisse de production
- Coût total pour la région estimé à 40 milliards US$

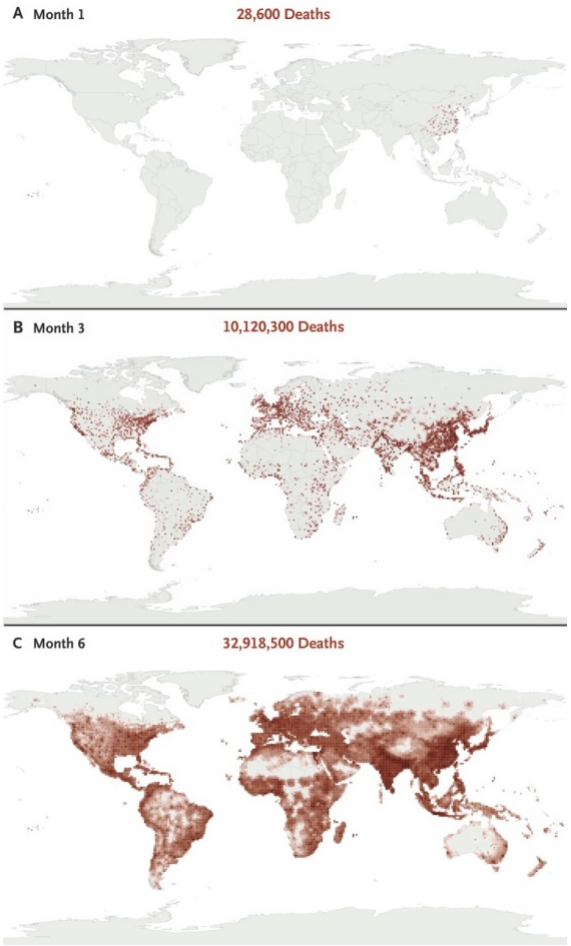
Lee & McKibbin (2004) Estimating the global economic costs of SARS. *Preparing for the Next Disease Outbreak Workshop Summary*

Quelle est la plus grande menace?

# Un virus…

- Transmis par voie respiratoire
- Hautement contagieux (R0>2)
- Taux de létalité > 1/1000
- Temps de génération <3 jours
- Contagieux avant les symptômes

→ Grippe

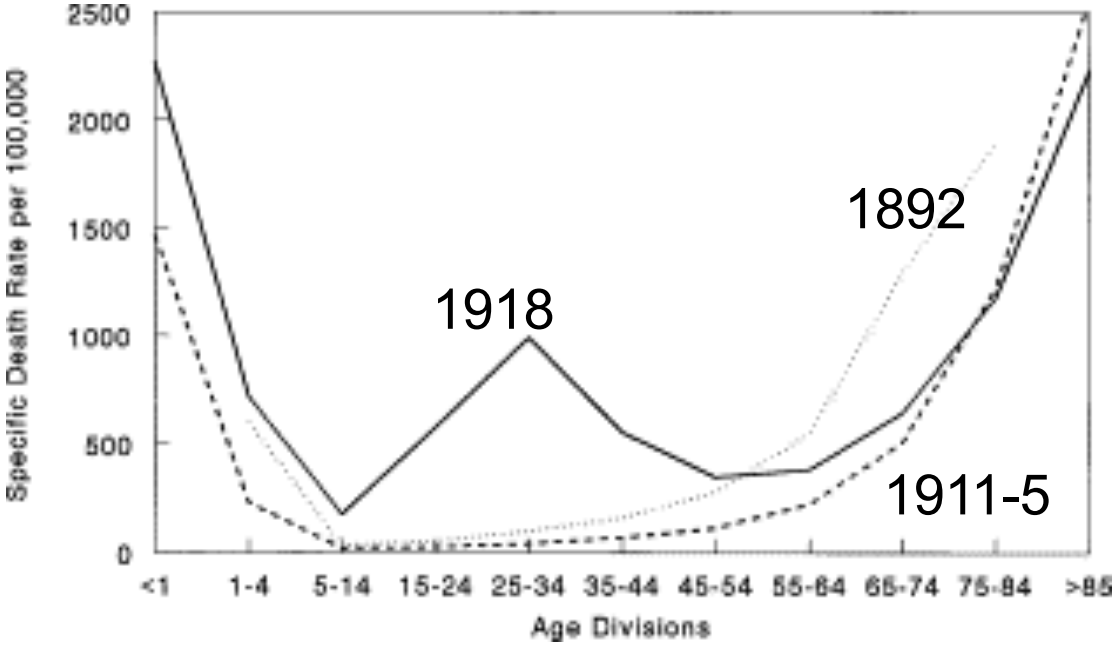



(Gates B, NEJM, 2018)

# Que savions-nous des pandémies grippales en 2009?

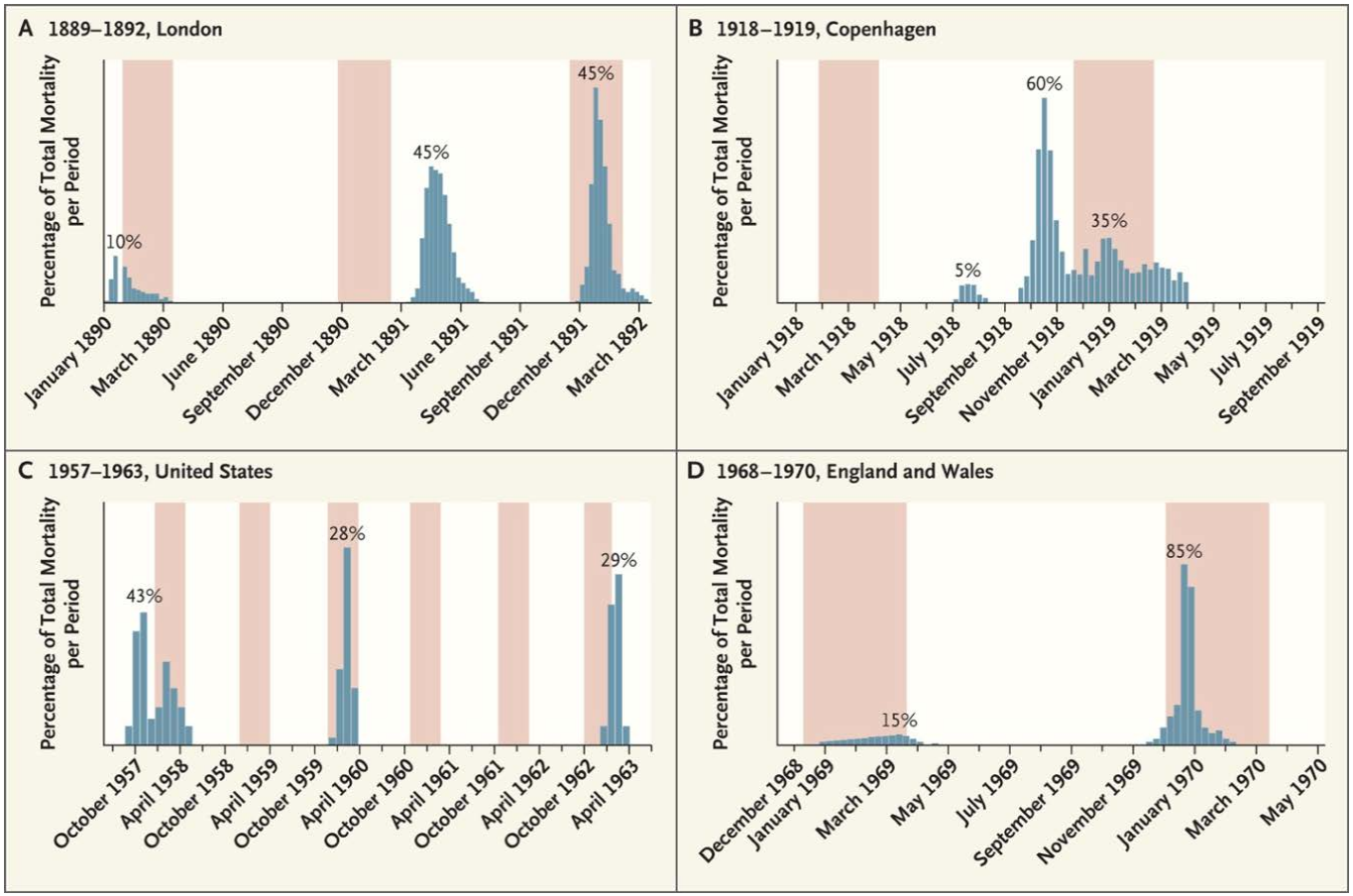
- Dues à un nouveau sous-type
- Plus contagieuses (taux d'attaque):
  - Grippe saisonnière: 20% des enfants, 5% des adultes
  - Grippe pandémique: 20% to 50% de la population
- Mortalité plus élevée, notamment parmi les adultes jeunes (taux de létalité):
  - Grippe saisonnière: <1‰, notamment jeunes enfants et 65+
  - Grippe pandémique: 1 ‰ (1957 & 1968) à 1% (1918), âge médian 20 ans
- Plusieurs vagues (mois à années)

# Taux de mortalité par âge, infections respiratoires basses, Etats-Unis, 1892-1918




Reid et coll., Microbes and Infection, 2001

# Vagues pandémiques



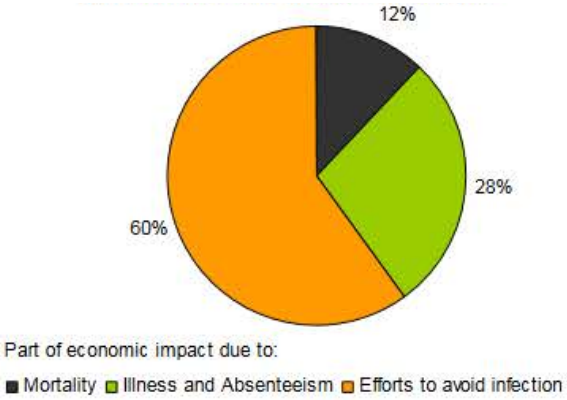

Miller et coll., NEJM, 2009

# Impact économique d'une pandémie grippale

**Table 2 Possible economic impacts of flu pandemic**

| *(% change in GDP, first-year)* | Mild | Moderate | Severe |
|---|---|---|---|
| World | -0.7 | -2.0 | -4.8 |
| High-income | -0.7 | -2.0 | -4.7 |
| Developing | -0.6 | -2.1 | -5.3 |
| East Asia | -0.8 | -3.5 | -8.7 |
| Europe and Central Asia | -2.1 | -4.8 | -9.9 |
| Middle-East & North Africa | -0.7 | -2.8 | -7.0 |
| South Asia | -0.6 | -2.1 | -4.9 |
| Deaths (millions) | 1.4 | 14.2 | 71.1 |

*Source:* World Bank calculations based on McKibbin & Sidorenko (2006).




Pandémie sévère:

- 70 millions de décès
- Chute de 5% du PIB mondial
- Coût: 3000 milliards US$

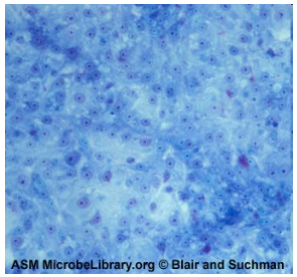
Burns, van der Mensbrugghe, & Timmer (2008) Evaluating the Economic Consequences of Avian Influenza. *World Bank Development Economics*

Jonas (2013) Pandemic Risk. *World Bank Development Report*

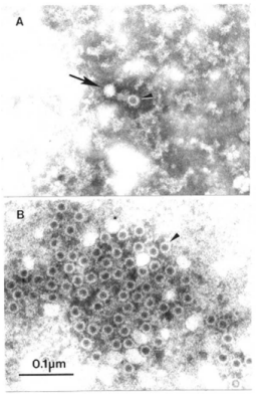
# Que faire?

# Comment étaient identifiés les nouveaux virus dans le passé?

Échantillon



Amplification

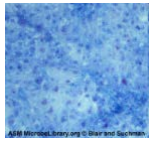



Microscopie électronique

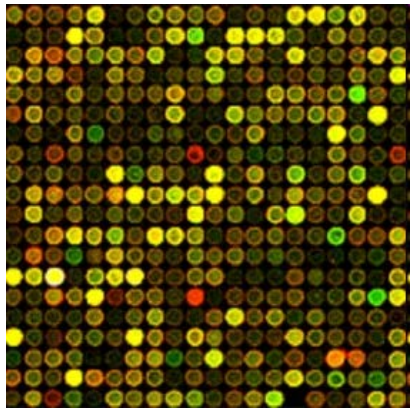
RT-PCR

# Comment le sont-il aujourd'hui?

Échantillon



Amplification ?



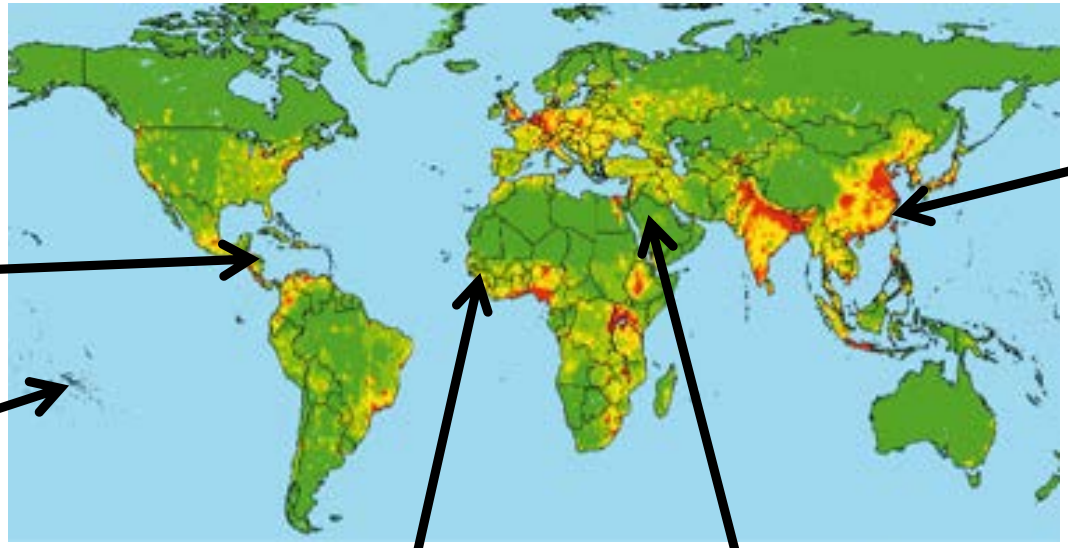
Puces à ADN

Séquençage haut-débit

# Anticiper l'émergence:
# le « Global Virome Project »

- Identifier 99% des virus animaux représentant une menace pour la santé humaine
- 10 ans (2016-2026)
- Coût estimé: 3,5 milliards de dollars
- Lancé par USAID

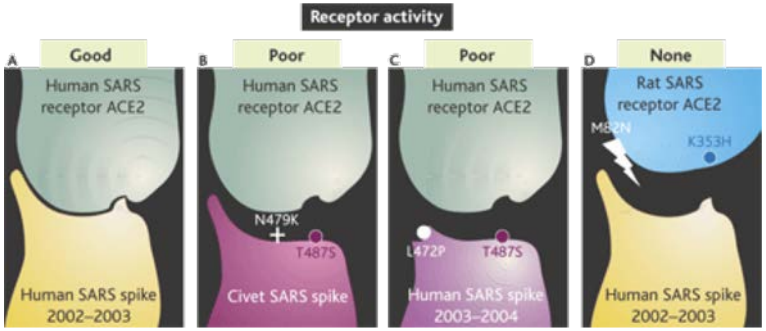
# Caractère imprévisible des émergences




(Adapté de Jones, Nature, 2008)

# EPISARS – Emergence du SRAS

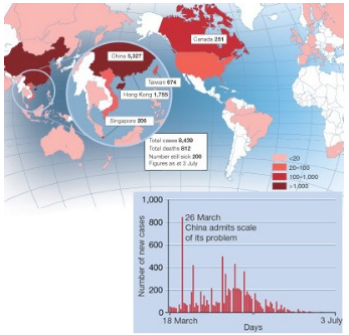
Réservoir chauve-souris
(Li et coll., Science, 2005)




Adaptation du virus au récepteur humain ACE2
(Qu et coll. J. Biol. Chem. 2005; Figure from Holmes, Science, 2005)

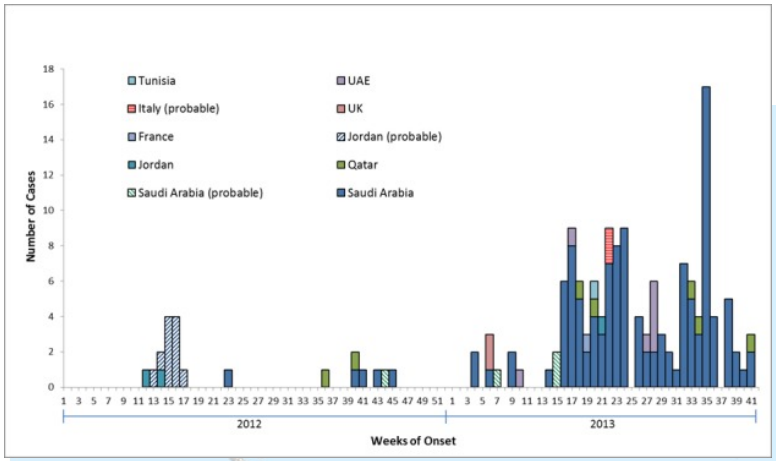
?

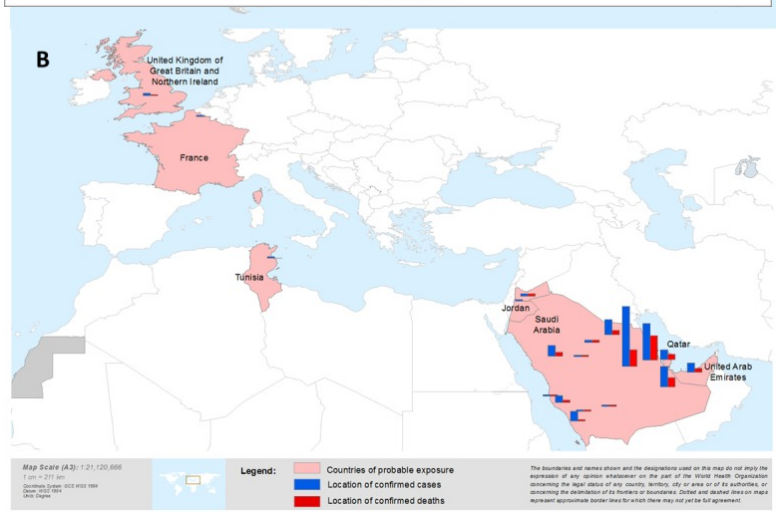
Civette palmiste masquée
(Song et coll, PNAS, 2005)

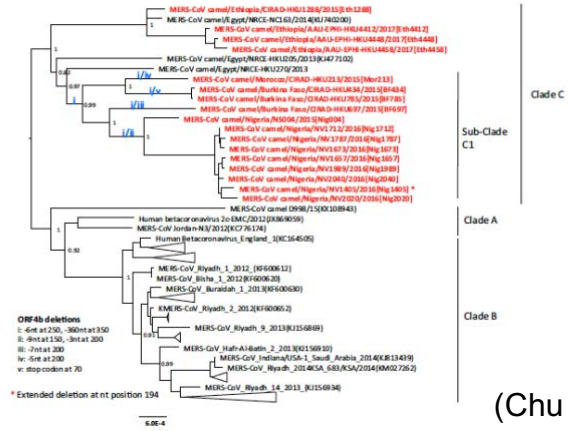



Epidémie mondiale

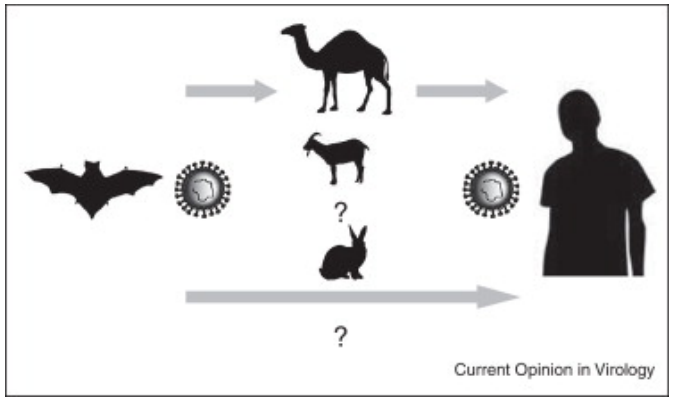
# Syndrome respiratoire du Moyen-Orient 2012-présent




(Chu et coll. PNAS, 2018)




(Raj et coll. Current Opin Virol, 2014)

# Surveillance mondiale - OMS

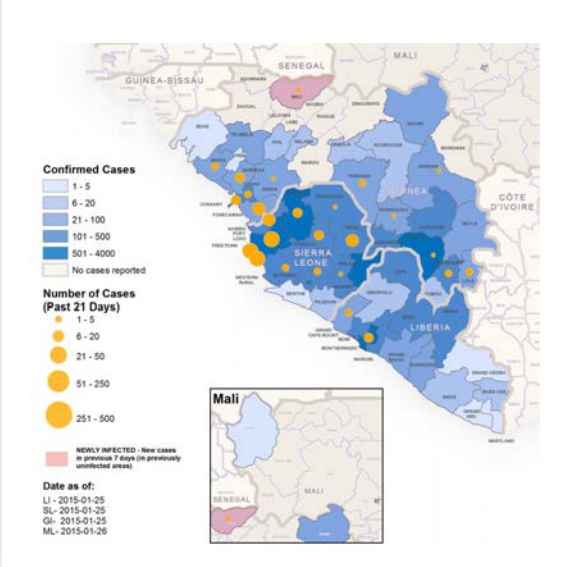
GOARN
Global Outbreak Alert and Response Network

- Formel:
Règlement Sanitaire International

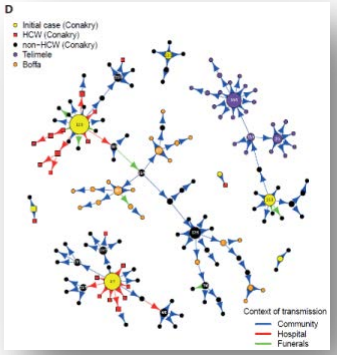
- Informel : Internet, media ...
➔ “Web-crawler”
  - Surveille les mots-clés sur internet
  - 24h/24 - 7j/7
  - Multilangues
  - 2 principaux :
    - Gphin (developpé par Health Canada pour l’OMS)
    - MedISys (Commission Européenne)
  - Autres (ProMed, Biocaster, etc.)

# Epidémie d'Ebola Afrique de l'Ouest

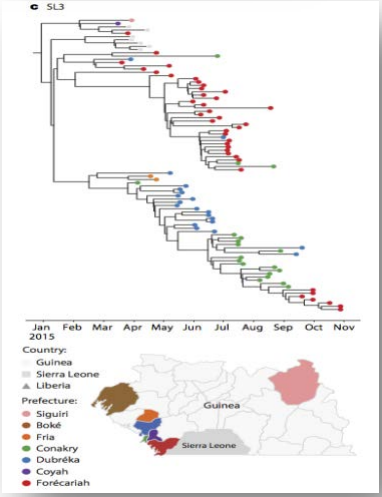
**Centre de Traitement Ebola de la Croix-Rouge française et Laboratoire Pasteur**



*Pictures from CIBU and K VIctoir*




*Faye et al Lancet ID 2015*

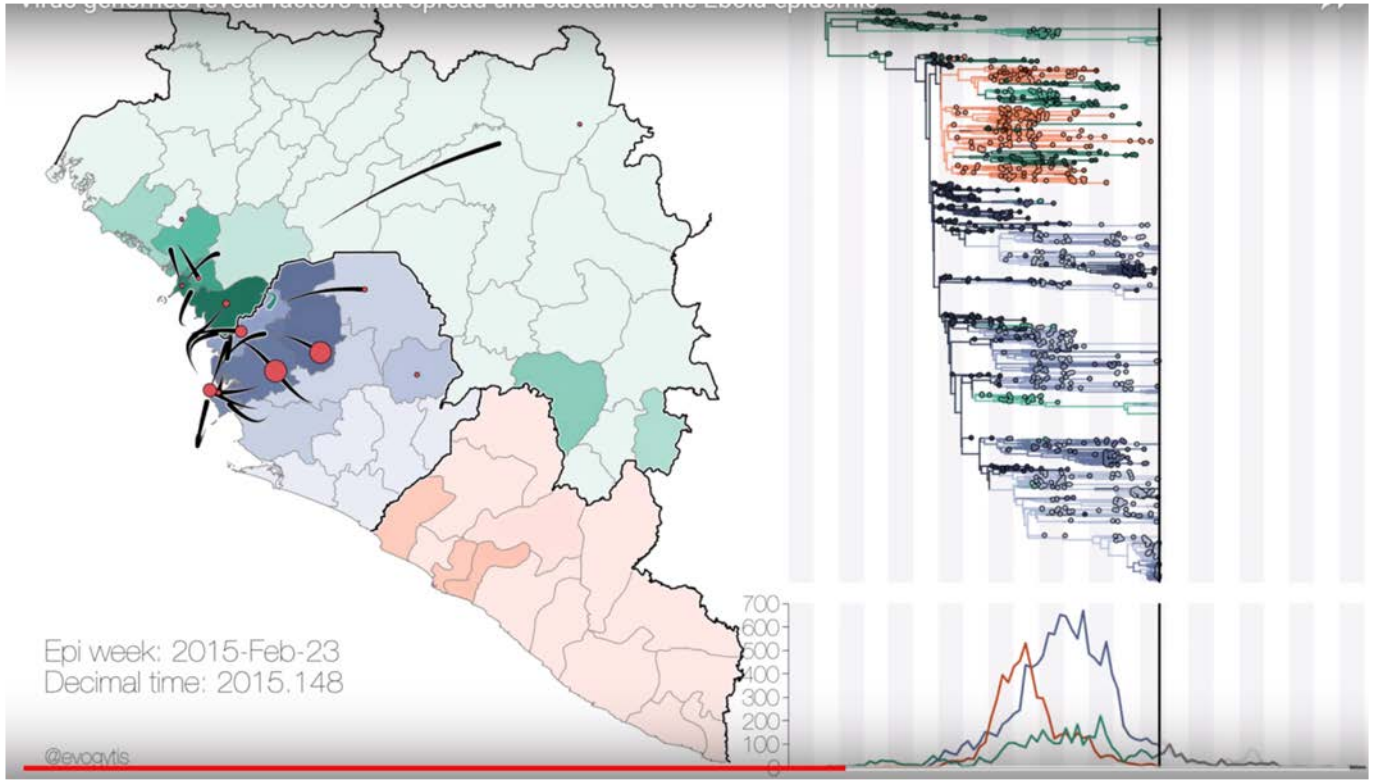



*Simon-Loriere et al Nature 2015*

# Suivi d’épidémie à l’ère du numérique

Ebola, Afrique de l’Ouest, 2014-2015

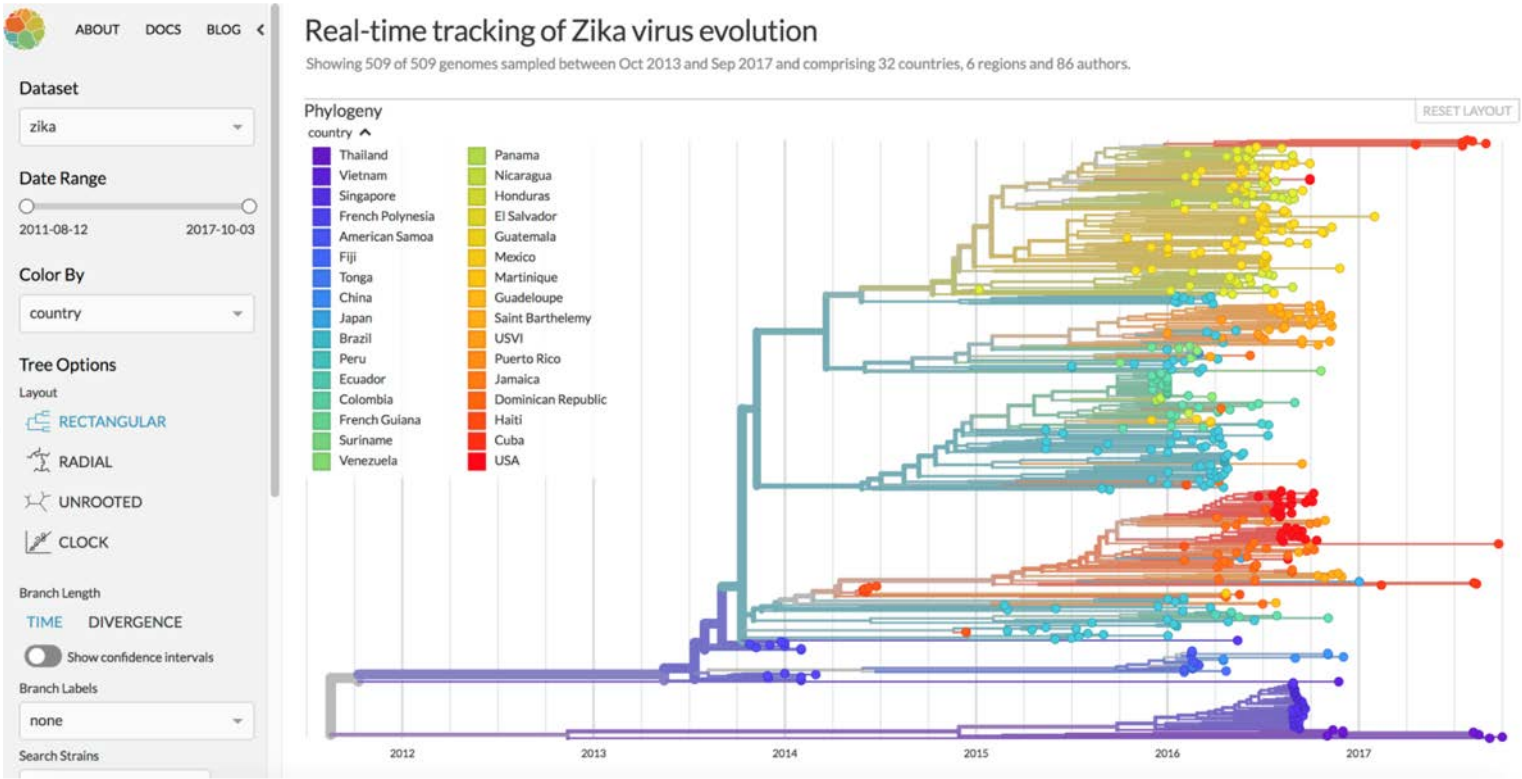
https://youtu.be/j4Ut4krp8GQ



# Suivi d’épidémie à l’ère du numérique

## Analyse phylogénétique en temps réel, virus Zika

https://nextstrain.org/zika




Nextstrain is built by Trevor Bedford, Richard Neher, James Hadfield Barney Potter, John Huddleston, Sidney Bell, Colin Megill, Emma Hodcroft, Pavel Sagulenko and Charlton Callender

# Pré-positionnement de vaccins pour expérimentation humaine

Coalition for Epidemic Preparedness Innovations (CEPI)

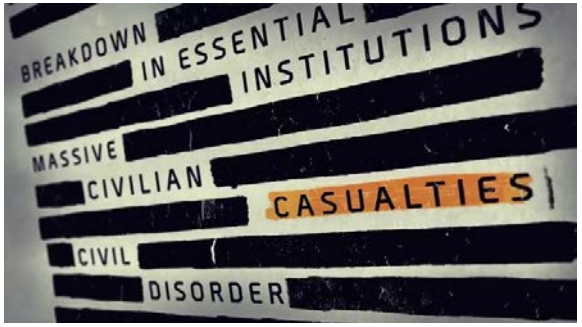
Partenariat public-privé

Développement de vaccins jusqu'à phase 2/3:

- Chikungunya
- Coronavirus (SARS, MERS)
- Filovirus (Ebola)
- Fièvre de la vallée du Rift
- Fièvre du Nil Occidental
- Lassa
- Nipah
- Fièvre paratyphoide A
- Peste
- Fièvre de Crimée-Congo
- Zika

© Ken Garrett

# Plans de préparation – Exercices de simulation
# Operation Dark Winter – Juin 2001




Exercice de simulation:
- Anciens membres du gouvernement + journalistes
- Epidémie de variole

→ Manque de coordination de la réponse gouvernementale
Incapacité à augmenter les chaines de production de vaccin
Communication désastreuse avec les médias
Emeutes, intervention de l'armée, …

# Autres temps, autres moeurs…

« On n'avait pas le temps de sortir les morts. On les entassait dans une salle au fond du service de réanimation. Et on les évacuait quand on pouvait, dans la journée, le soir. Les gens arrivaient en brancard, dans un état catastrophique. Ils mouraient d'hémorragie pulmonaire, les lèvres cyanosées, tout gris. Il y en avait de tous les âges, 20, 30, 40 ans et plus. Ça a duré dix à quinze jours, et puis ça s'est calmé. Et étrangement, on a oublié».

Pr. Pierre Dellamonica, alors externe en réanimation,
Service du professeur Jean Motin, à l'hôpital Edouard-Herriot de Lyon,
hiver 1969-70.

Corinne Bensimon, Libération, 17 décembre 2005

Grippe de Hong-Kong: surmortalité estimée à 31 226 morts en France en 1969-70

Merci pour votre attention