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The 2009 H1N1 Influenza Pandemic at the Epicenter: Lessons for Global Health Security

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University of Southern Denmark, 26 June 2013

Disclosure

- The author of this presentation, Dr. Hugo López-Gatell, was Assistant Director General of Epidemiology at the Mexican Ministry of Health and National Focal Point for the International Health Regulations in Mexico (February 2008 - April 2012)

- Most of the information presented here was retrieved from publicly available documents of the Ministry of Health or working documents of the author. The views and opinions expressed are the author's and do not necessarily correspond to the current official position of the Federal Government of Mexico

Outline

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- Context
- Early signals of an emerging threat
- Key features of the epidemic
- Epidemiologic surveillance: challenges and response for health security
- Externalities of the epidemic
- Risk communication
- Four lessons for global health security

Mexican United States: summary

http://mexico.america-atlas.com/pictures/mexico-map.jpg

- **LATITUDE:** 32° 43' - 14° 32' N
- **LONGITUDE:** 86° 42' - 118° 22' O
- **POPULATION:** 112,336,538
- **SIZE:** 1,972,550 km^2
- **GDP (USD):** $1.4 trillion
- **AVERAGE ANNUAL INCOME:** $14,340
- **LEADING CAUSES OF DEATH:**

  - Coronary Heart Disease
  - Diabetes
  - Stroke
  - Liver Disease
  - Lung Disease

- **INFANT MORTALITY:** 14 deaths/1,000 live births
- **AVERAGE LIFE SPAN:** Male 73, Female 78
- **HEALTH CARE:** 17.4 clinicians/10,000 inhab.

National Institute of Statistics and Geography (INEGI). National Population Census, 2010

Mexico's National Surveillance System

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- 1888 Health Statistics System and Public Health Bulletin
- 1922 National School of Public Health
- 1940's National Health System and Public Health Surveillance System
- 1995 Contemporary National Surveillance System
  - 114 diseases, 20,000 (89%) reporting units

Epidemiologic transition:
México, 1922 - 2008

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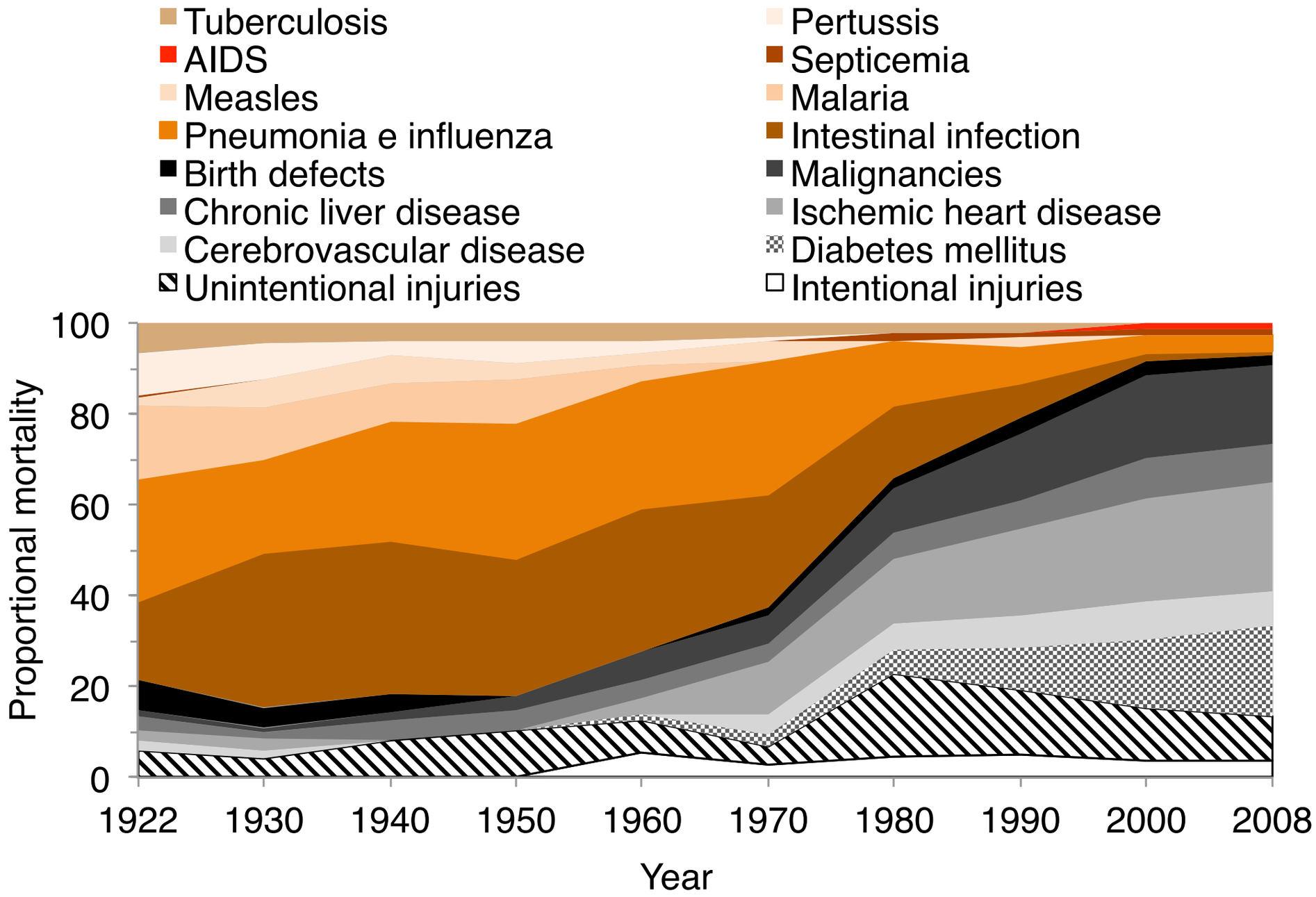

Source: SINAVE/DGE/SSA; Reporting system for new cases of illness; access 15 Dec 2011

Influenza H1N1: early signals. México, January - March, 2009

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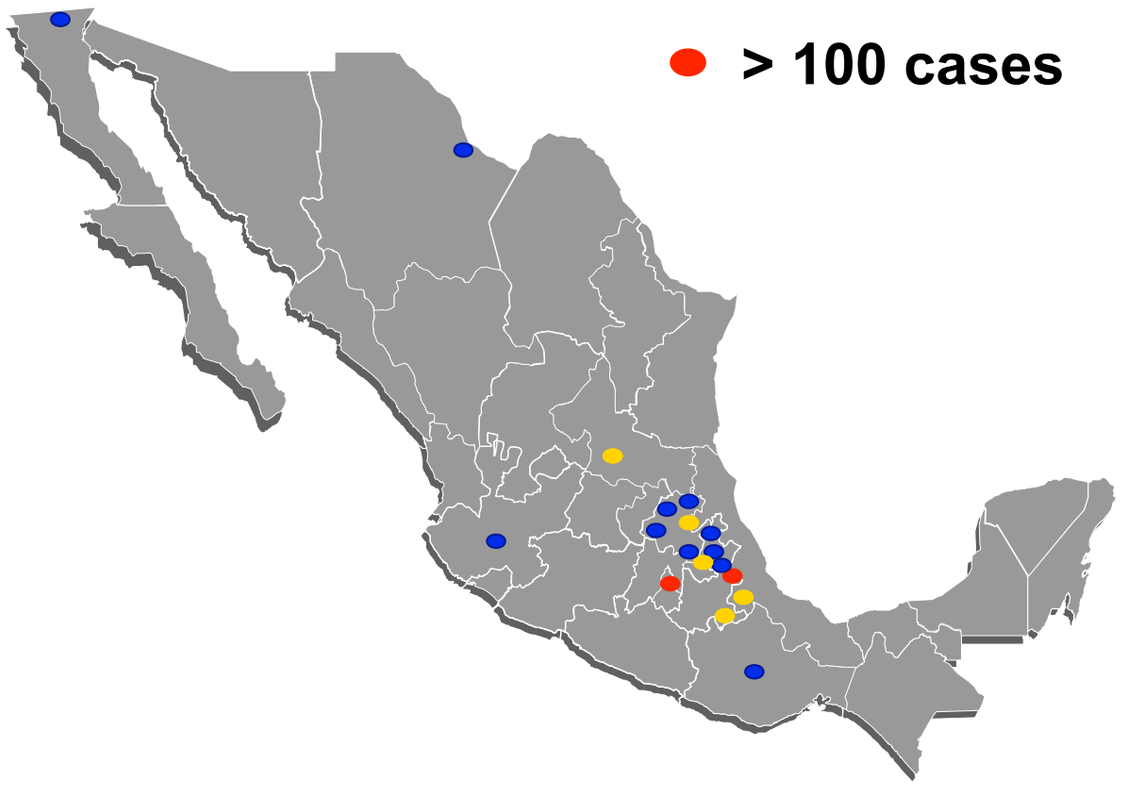
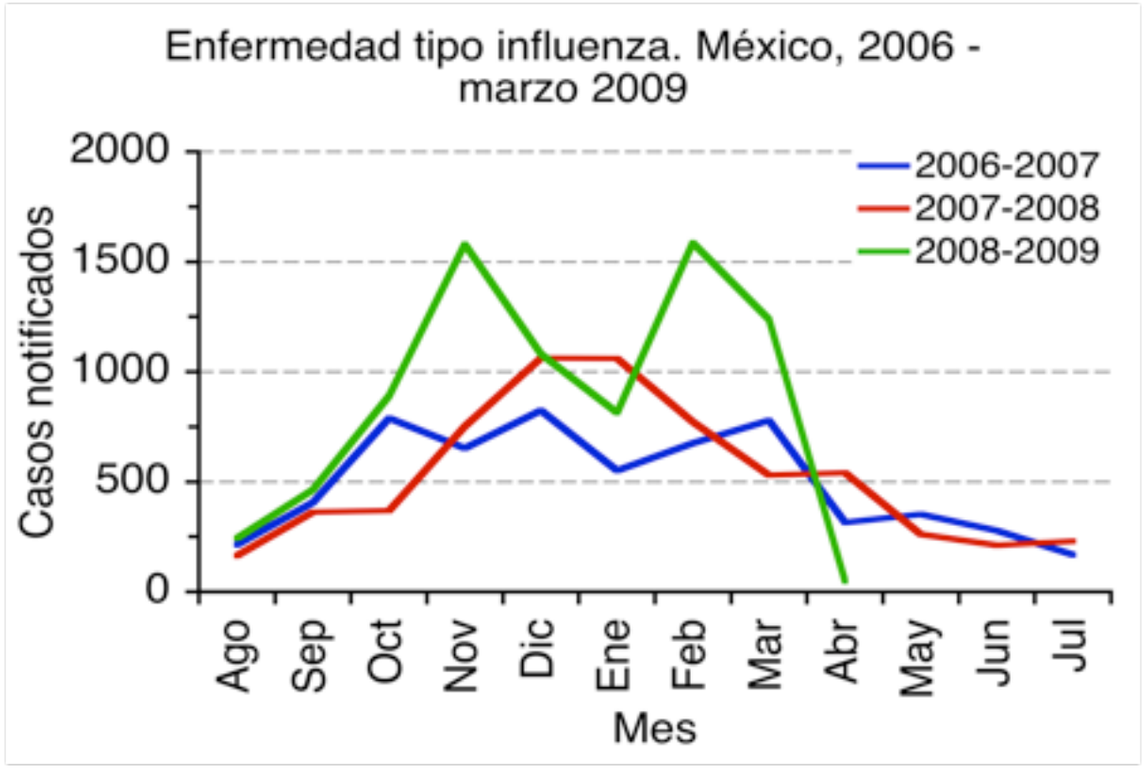
Outbreak size

- **< 10 cases**
- **10 - 100 cases**
- **> 100 cases**





Source: SINAVE/DGE/SSA; Influenza surveillance system: access 15 April 2009

Early signals: atypical age distribution

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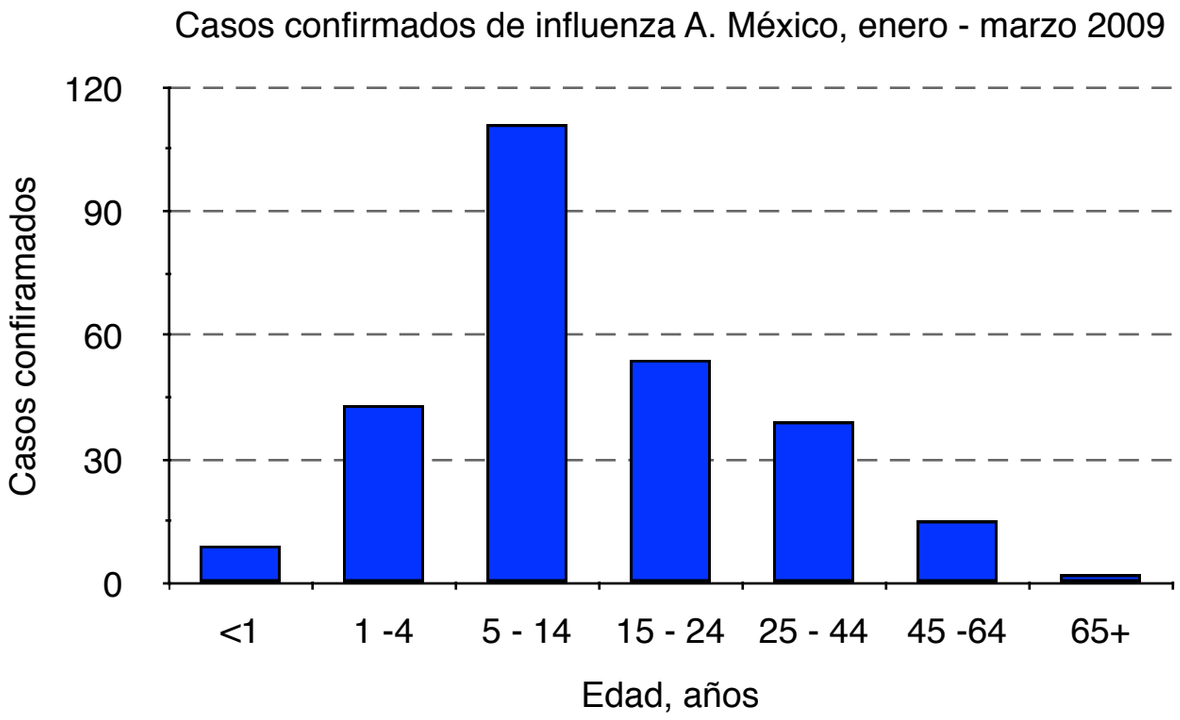
Age distribution of confirmed cases of influenza A and deaths associated with severe pneumonia. México, March - May 2009



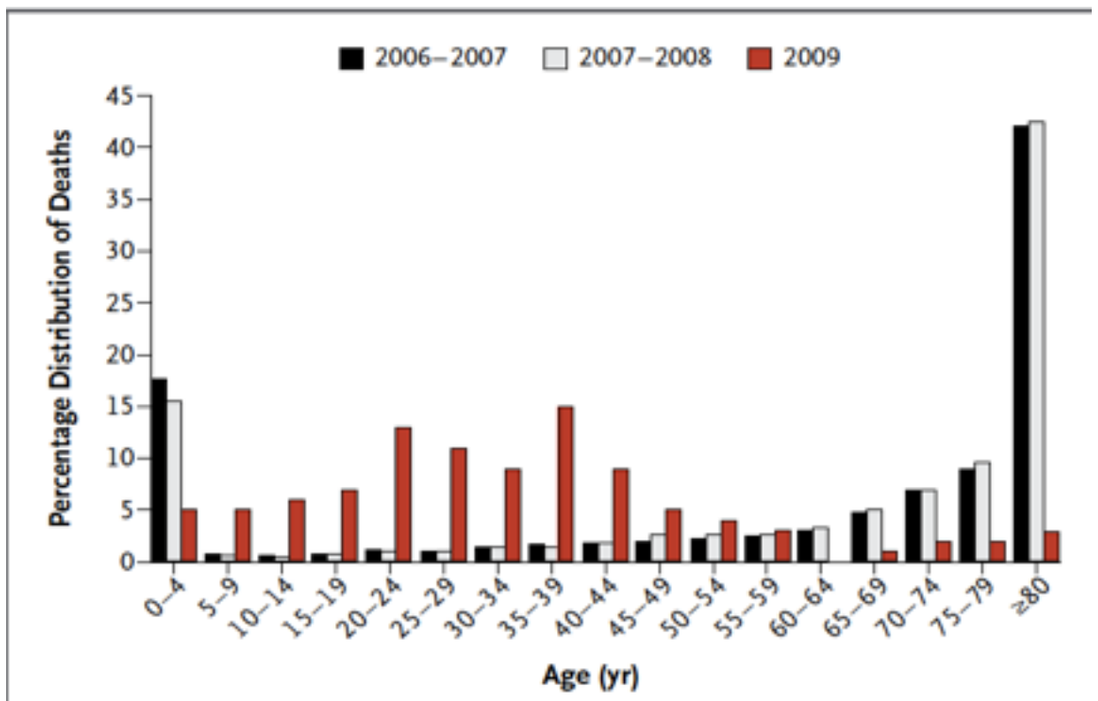


Figure 2. Percentage Distribution of Deaths from Severe Pneumonia during the 2009 Study Period, as Compared with Influenza Seasons from 2006 through 2008, in Mexico, According to Age Group.

Source: SINAVE/DGE/SSA; Influenza surveillance system: access 13 March 2009 &
Chowell et al. N Engl J Med, 2009; 361: 1-6

Identification A(H1N1)/pdm 2009 in Mexico

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- Initial virological diagnosis: unsubtyped influenza A
- 18 April: EUA reports to WHO first detection of a new virus **(influenza A/ California/004/2009)**
- 21 - 22 April: Mexican samples shipped to Canada (NML) and USA(CDC)
- **23 April, 15:00 h:** 26 of 53 samples tested positive for the new virus
  - 22:00 h: Emergency response is activated. School closures were announced in Mexico City Metropolitan area (25 million inhabitants)

A turning point: severe pneumonia

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- March-April 2009: The National Surveillance System (SINAVE, Spanish capitals) alerted in increased incidence of acute respiratory disease and ILI, with some atypical features

- 14 -15 April: Unofficial report by clinicians: **Severe pneumonia** in young, previously health, adults (Mexico City, State of México, Oaxaca, and San Luis Potosí)

- Index case: 39 year-old women in Oaxaca
  - Severe, rapidly evolving pneumonia (14 April 09), Death (15 April 09)
  - 105 hospital contacts: 45 (43%) symptomatic (mild respiratory disease)
  - News reports as suspected SARS case
  - Second WHO inquiry under the International Health Regulations 2005

Active surveillance of SARI hospitalization:

Mexico City, 18 - 20 April 2009

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Health system	Number of hospitals	Cases of SARI	Deaths	Case fatality, %	
				mean	s.d.
PEMEX	1	5	0	0.0	0.0
IMSS	4	22	0	0.0	0.0
ISSSTE	5	24	0	0.0	0.0
City Hospitals	4	16	2	12.5	10.9
Federal	2	7	0	0.0	0.0
Institutes of Health	4	29	2	6.9	6.4
Private	3	17	1	5.9	5.5
TOTAL	**23**	**120**	**5**	**4.2**	**4.0**

Source: DGE-InDRE/SSA. Field investigation on Severe Acute Respiratory Illness; 18 - 20 April 2009

Influenza-like Illness (ILI) in La Gloria, Veracruz. Mexico, 2009

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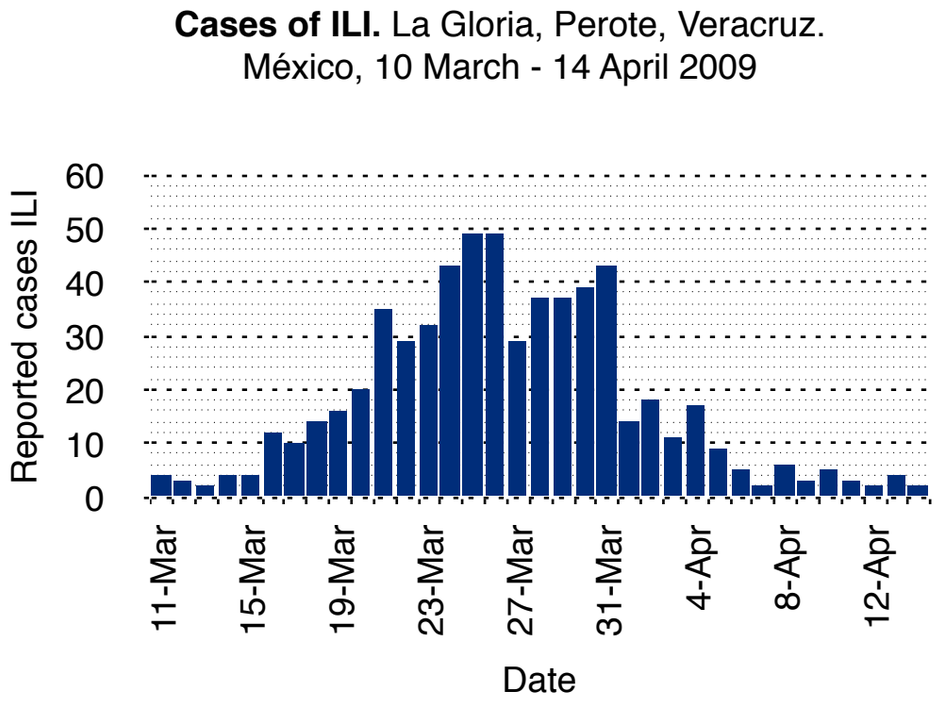
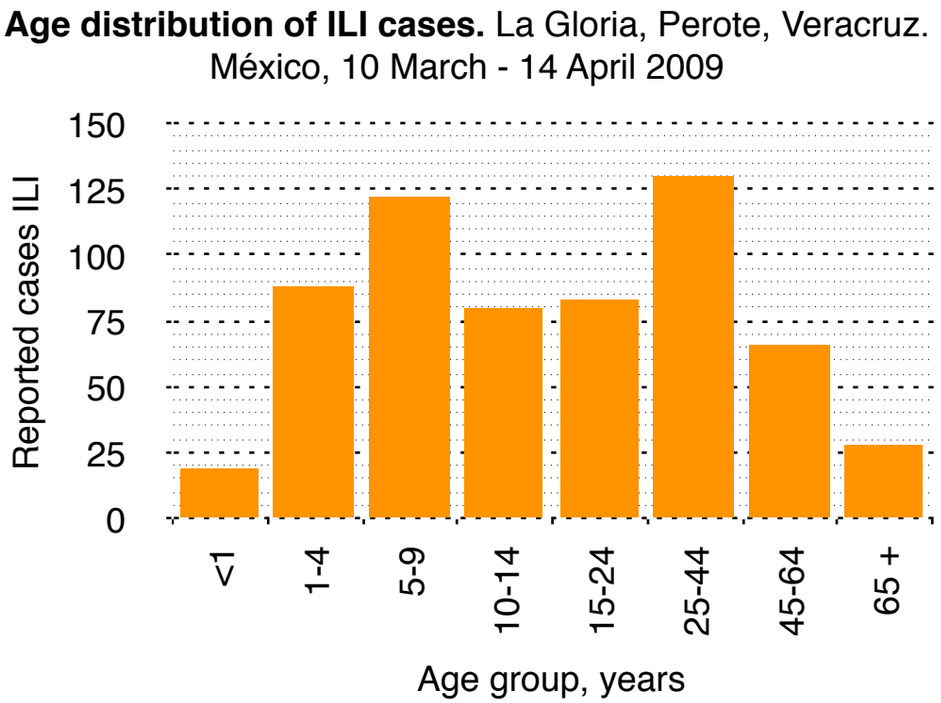
- Outbreak #15 reported in 2009 (10 March - 13 April)
  - Size: 616 cases in 2,155 (29%) inhabitants were affected
  - Atypical age distribution: 5 to 44 years old
- Almost no severe cases or deaths
- Four cases were confirmed as influenza:
  - 3 seasonal influenza (H3N2 or B), one H1N1 pdm/2009 (08 abril)





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Key epidemiological features of influenza A(H1N1) 2009 in México

Severe respiratory illness: excess hospitalization

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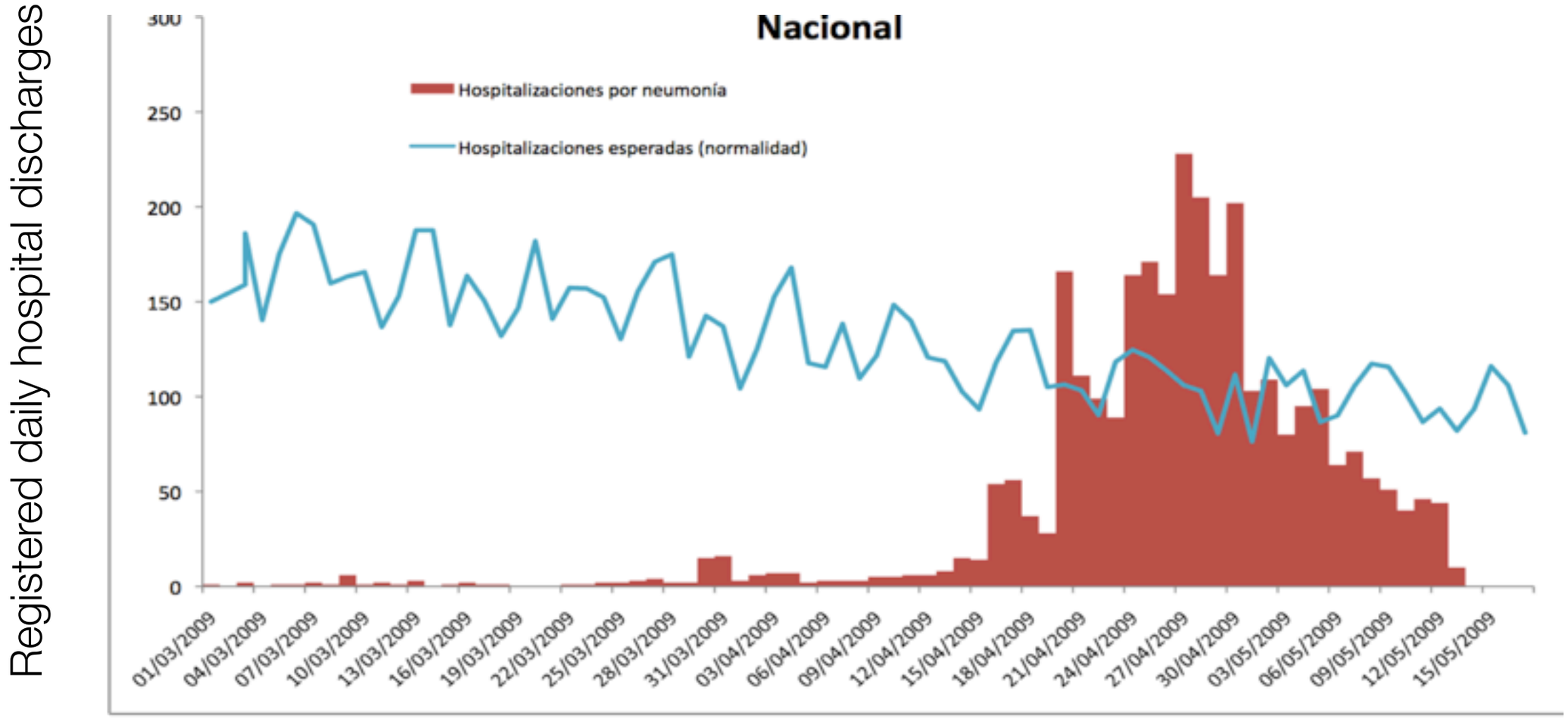
Expected and observed number of inpatients due to severe respiratory illness. México 01 March - 15 May 2006 - 2009



Sources: SINAVE/DGE/SSA 2009; SINAIS/DGIS/SSA 2006 - 2008; National Hospital Discharge Registry, 15 May 2009

Influenza viruses identified:
México Jan 2009 - Jul 2010

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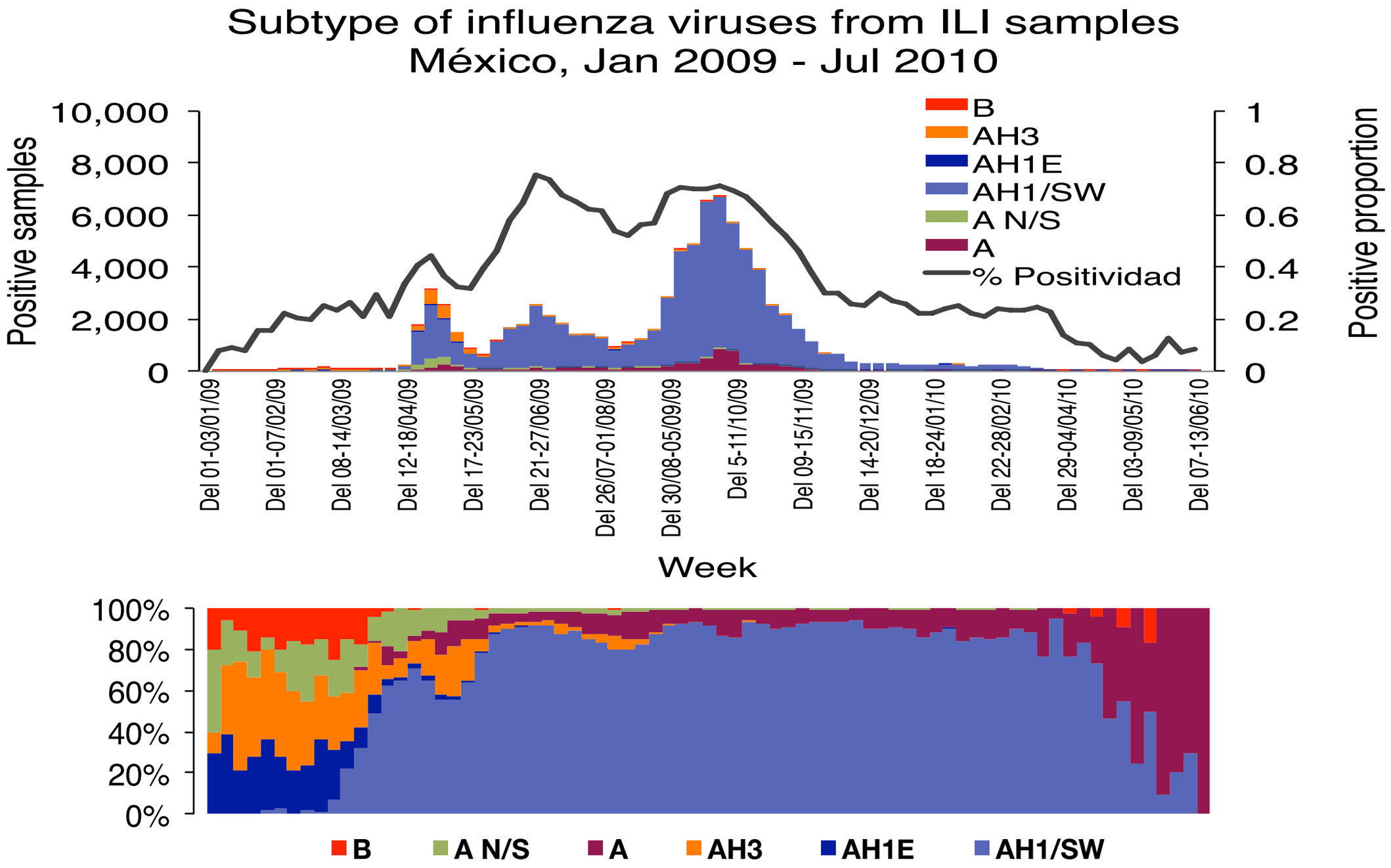

Source: SINAVE/InDRE/SSA; Laboratory of respiratory viruses; 12 March 2010

Phylogeny of influenza H1N1/pdm 09 viruses

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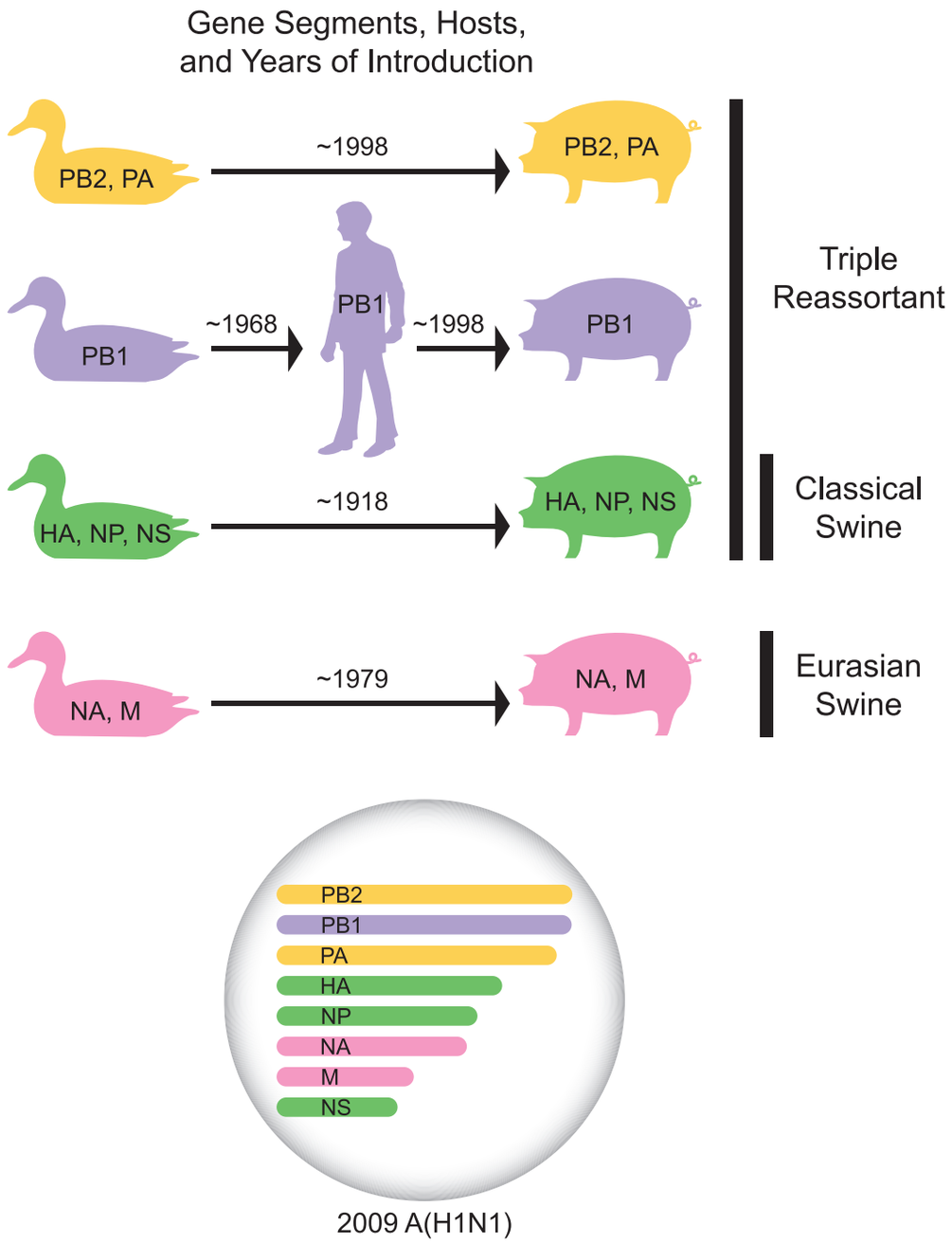
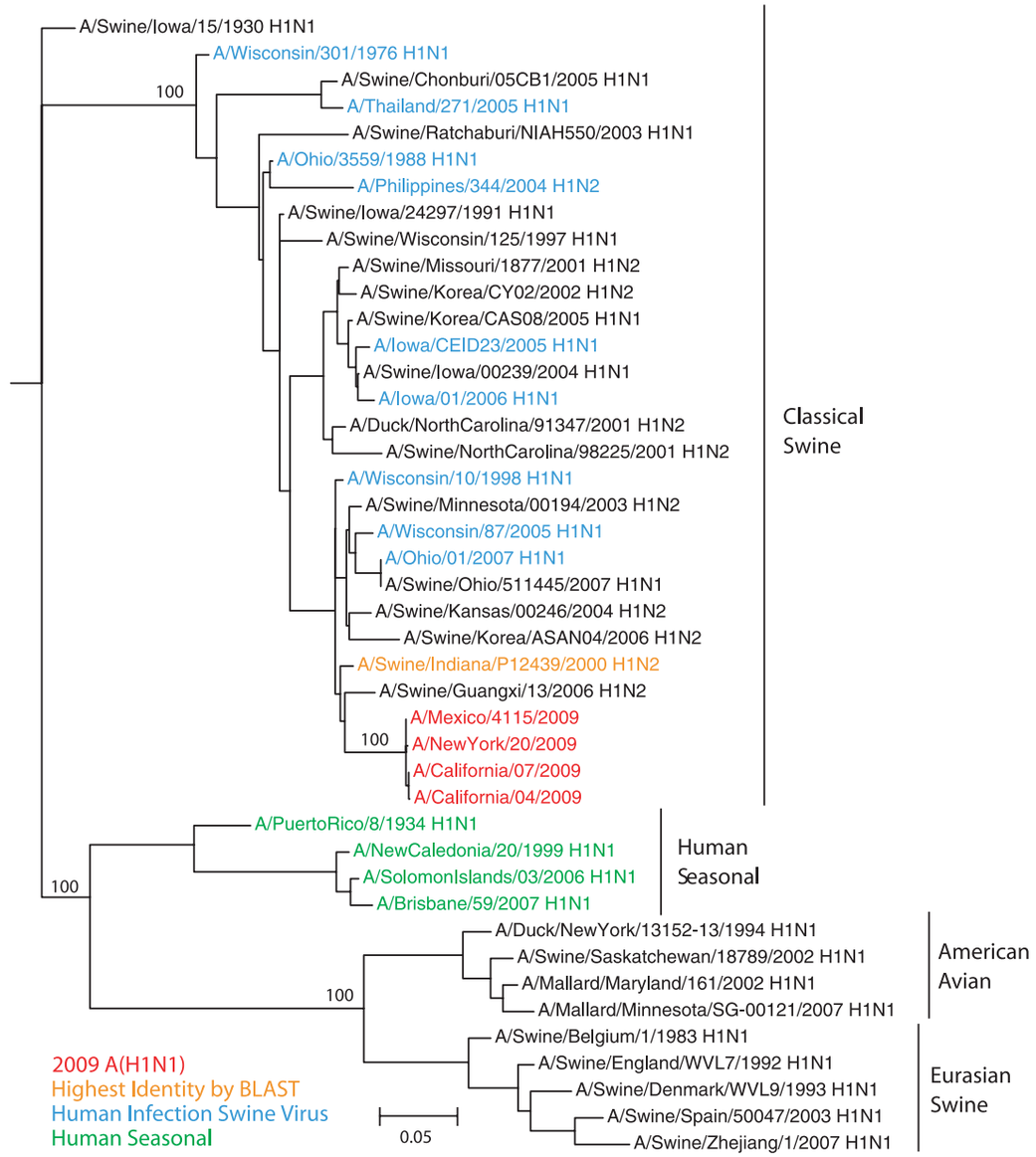


A maximum likelihood phylogenetic tree for nucleotide sequences of the HA gene of selected influenza viruses



Garten, RJ, et al. 2009. Science, 325 (5937):197–201.

Influenza H1N1/pd09: estimated transmissibility

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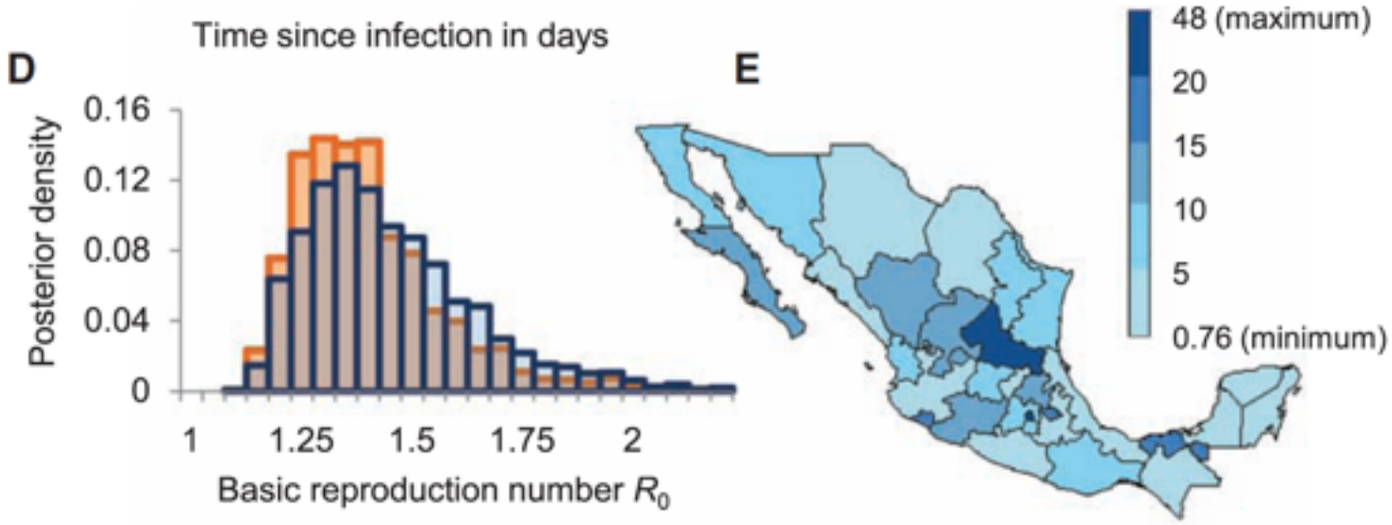
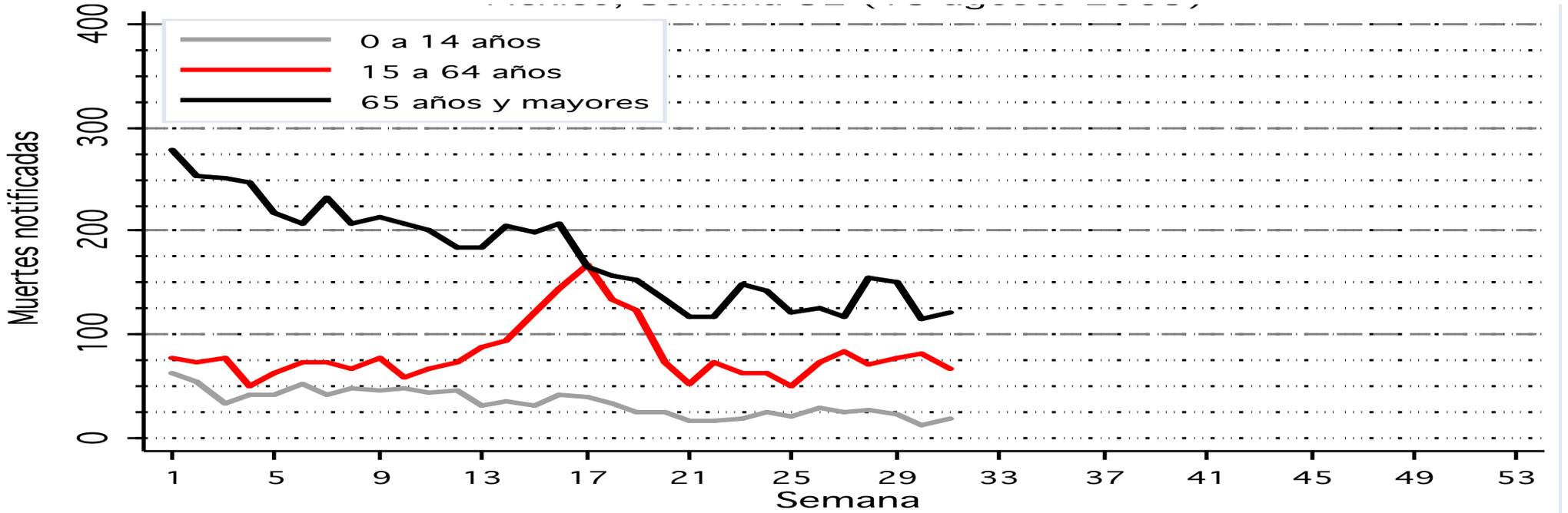


	Best estimate	95% confidence interval	Description
R_0	1.58	1.34–2.04	Basic reproduction number
T_g	1.91	1.30–2.71	Mean generation time (days)
p_{symp}	86%	69–100%	Proportion of cases that are symptomatic and ascertained
ρ_{child}	2.06	1.60–3.31	Susceptibility of children relative to adults
θ	0.50	0.00–0.72	Assortativity of mixing between children and adults (0 = random, 1 = fully assortative)
	Assumed value		
f_L	1/3	Assumed	Fraction of the generation time that is latent (uninfectious)
ϕ_{child}	1	Assumed	Infectiousness of children relative to adults

Fraser, et al. Science, 2009; 324 : 1557-61

Mortality by age group:
influenza & pneumonia (ICD - 10: J09 - J18)



Age group	Reported deaths 1 Jan - 15 Ago			Difference (% change)	
	2008	Average 1998-2008	2009	vs. 2008	vs. (1998 - 2008)
All ages	9,175	7,845	9,318	143 (+1.6%)	1,473(+18.8%)
15 to 64 years	1,588	1,194	2,230	**643 (+ 40.4%)**	**1,036 (+ 86.8%)**

Source: SINAVE/DGE/SSA. National Death Index; 23 November 2009

Influenza H1N1/ pdm 2009: risk of severe disease by age

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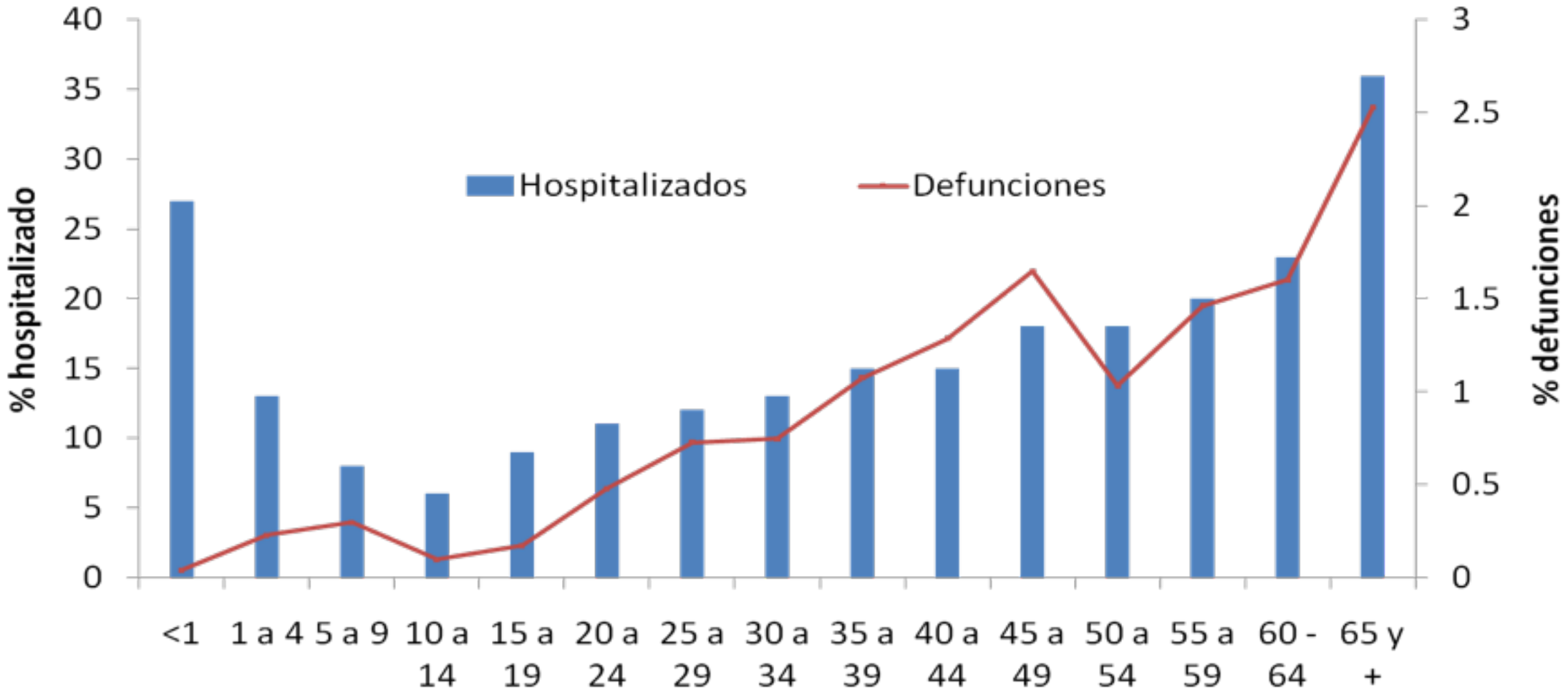
Proportions of severe cases and case fatality, by age group.
México, March - September, 2009



Source: SINAVE/DGE/SSA; Influenza surveillance system: 24 September 2009

Populations at risk: pregnant women

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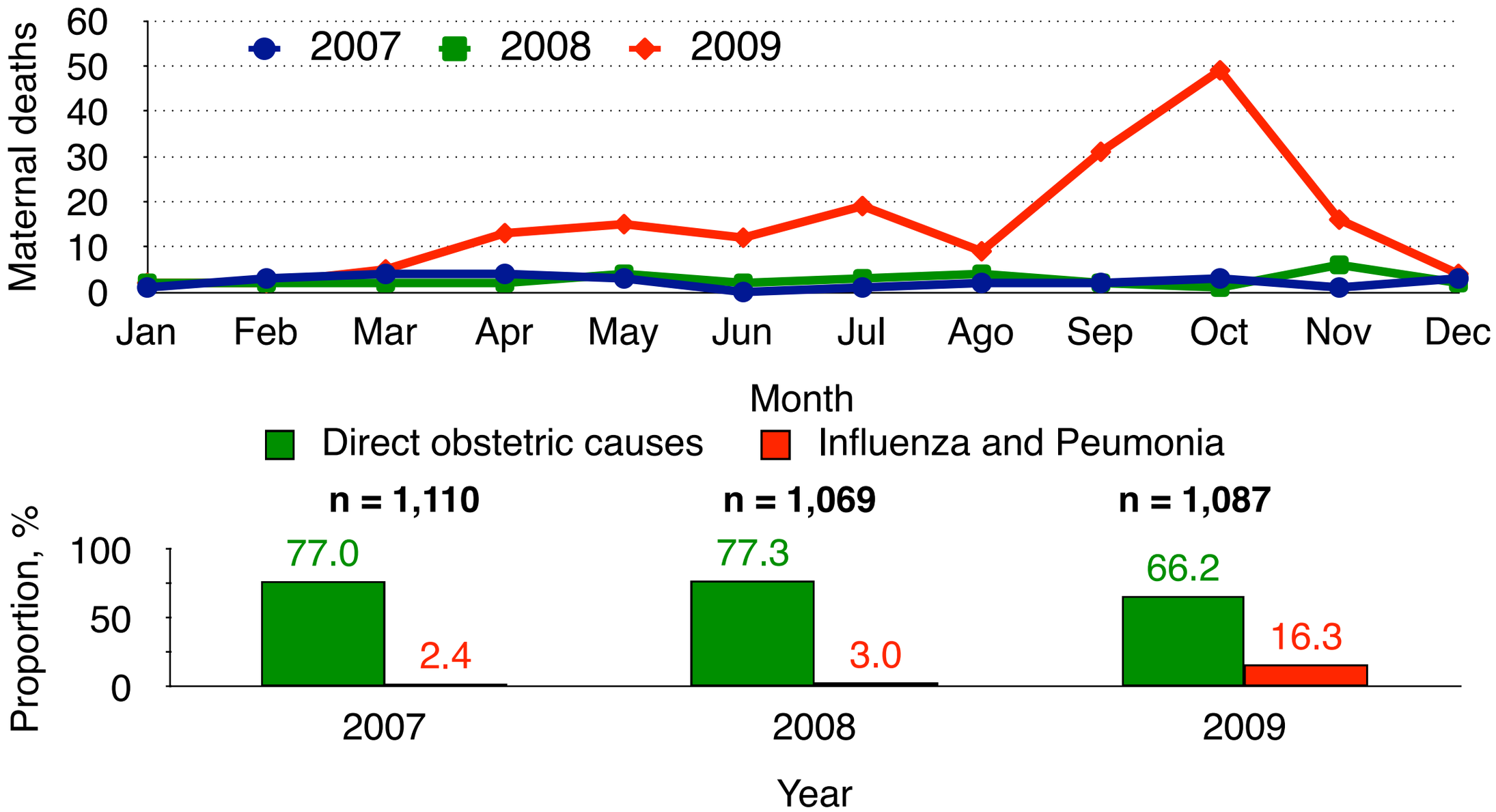
Maternal deaths associated to influenza and pneumonia (ICD-10: J10.0-J18.9)
México, 1 January - 30 December, 2009



Source: SINAVE/DGE/SSA. Immediate reporting of maternal death; 30 Dec 2009

Maternal mortality: México, 2009

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Proportional maternal mortality. México, 1 January - 30 December 2009

Cause	Number of deaths	MMR*	Proportion, %
Preeclampsia-Eclampsia	315	16.2	29
Postpartum hemorrhage	181	9.3	16.7
Acute severe respiratory disease**	**177**	**9.1**	**16.3**
Septicemia	48	2.5	4.4
Abortion	47	2.4	4.3
Placental abnormalities	35	1.8	3.2
Obstetric trauma	28	1.4	2.6
Pulmonary embolism	26	1.3	2.4
Other direct obstetric causes	43	2.2	4
All other causes	171	8.8	15.7
Unspecified	16	0.8	1.5
Total	**1,087**	**56**	**100**

Source: SINAVE/DGE/SSA. Immediate report of maternal deaths; access 30 December 2009
* RMM: Maternal mortality ratio per 100,000 live births
** includes influenza, acute respiratory failure and SIRDS

Influenza H1N1: impact of treatment delays. México, April - September 2009

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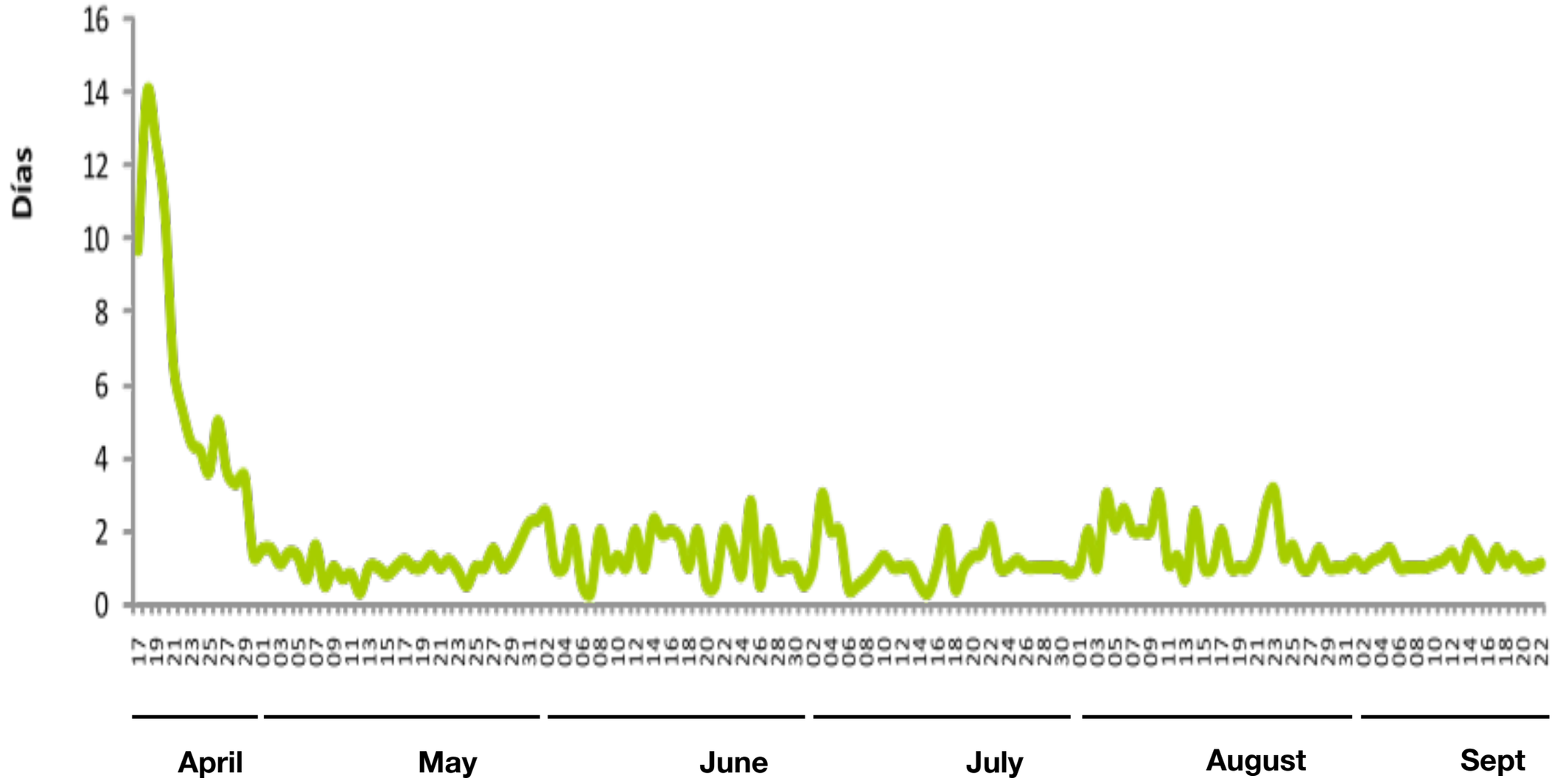
Mean time from the onset of symptoms to hospitalization in cases of SARI. México, 17 April - 22 September 2009



Source: Coordinación Vigilancia Epidemiológica/IMSS; 24 Sept 2009

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Epidemiologic surveillance for Health Security

Public health value of information and social expectations of knowledge

Global Health Care Capabilities

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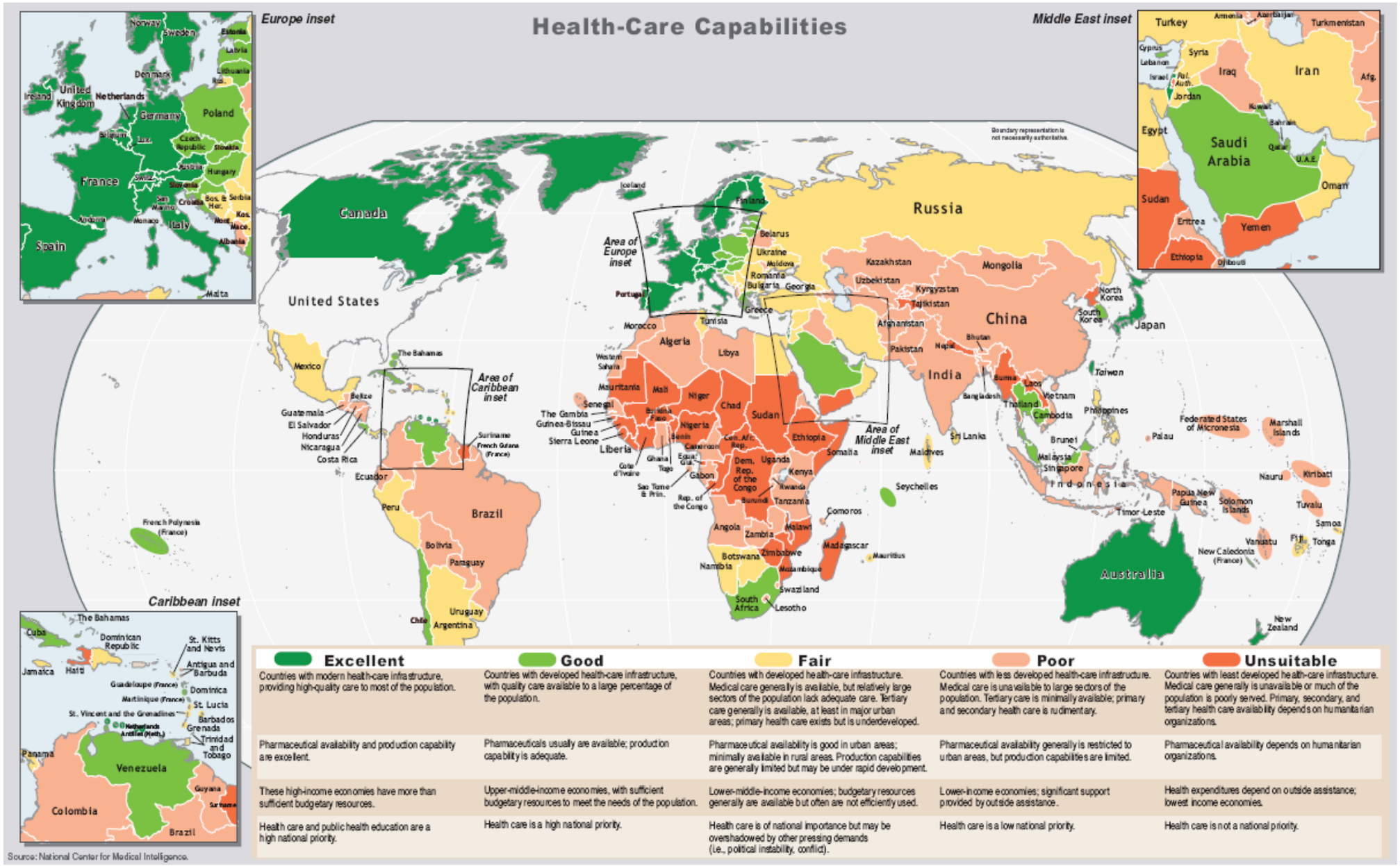

IOM. Infectious Disease Movement in a Borderless World. Washington, 2010. Nat Acad Press

International Health Regulations 2005: instrument for global health security

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"International public health security is both a collective aspiration and a mutual responsibility. The new watchwords are diplomacy, cooperation, transparency and preparedness."

Dr Margaret Chan
Director-General, WHO

World Health Organization
August 07

WHO

International Health Regulations 2005:
a new paradigm for global public health security

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Feature	Conventional public health surveillance	New paradigm of Health Security
Focus	Restricted list of infectious diseases	Public Health Emergencies of International Concern (PHEIC)
Monitoring and Surveillance	Official sources validated by National Health Authorities	Epidemic Intelligence: information from official and unofficial sources Aim: risk assessment
Opportunity for Disease Control	Border control	Contention at the source
Public Health Response	Disease-specific, pre-structured	All-hazard preparedness, adaptive responses
Responsibility of Response	Country capabilities	International cooperation
International Communication	Diplomatic ways	National Focal Point for IHR

World Health Organization, 2009. International Health Regulations 2005. 2ª ed. Geneva, Switzerland

Health Security: convergent challenges, convergent opportunities

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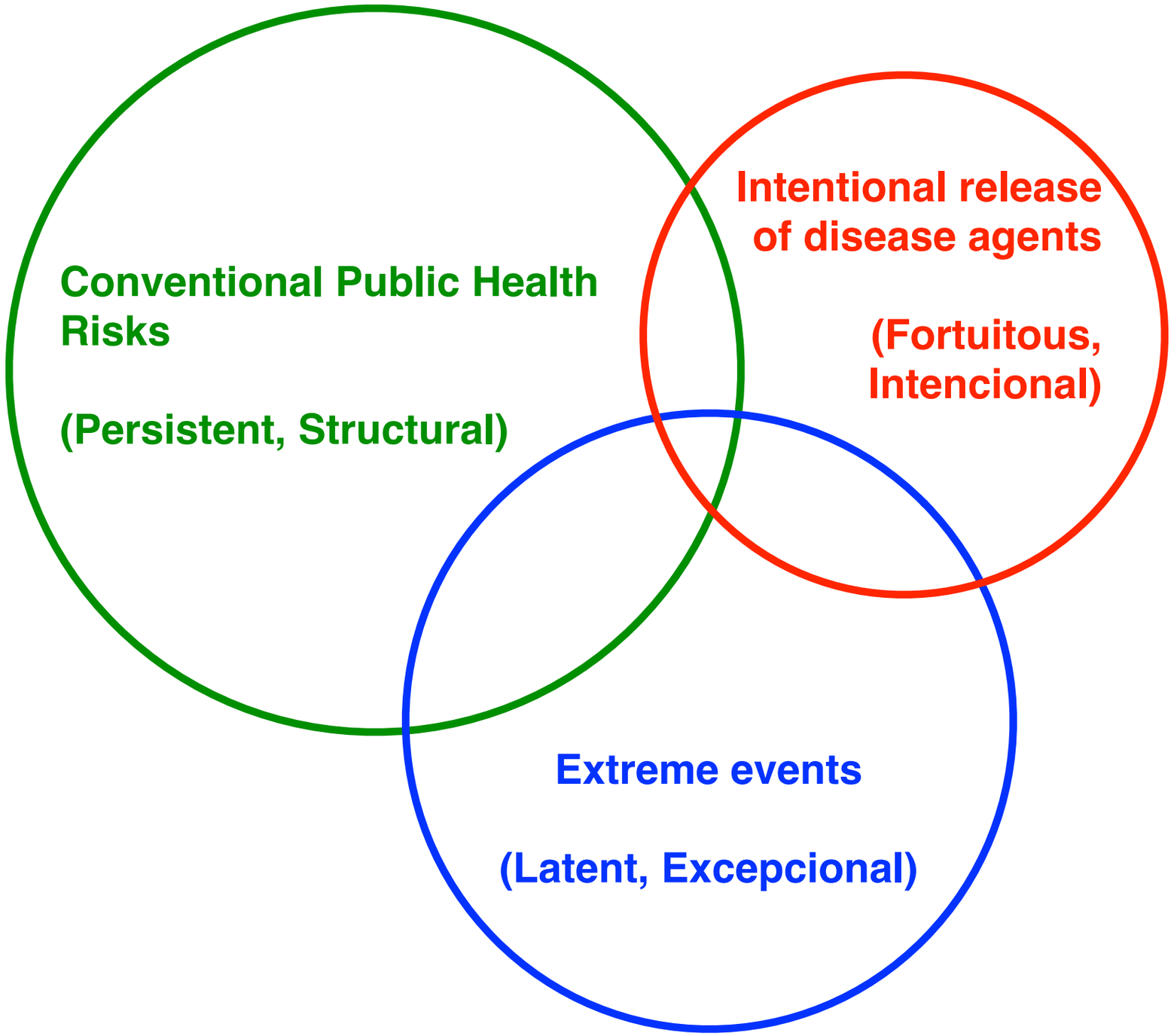

Epidemiological surveillance: conventional case-based model in Mexico

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- Fragmented and rigid
- Focus on predefined conditions
- Limited technical infrastructure and human resources
- Mostly oriented to generate statistics and address local outbreaks
- Lacking protocols for systematic risk assessment

- **Acute challenges during the H1N1 pandemic**
  - False expectations regarding what epidemiological information could be generated
  - Insufficient understanding of sentinel surveillance

Epidemiological surveillance:
hidden targets

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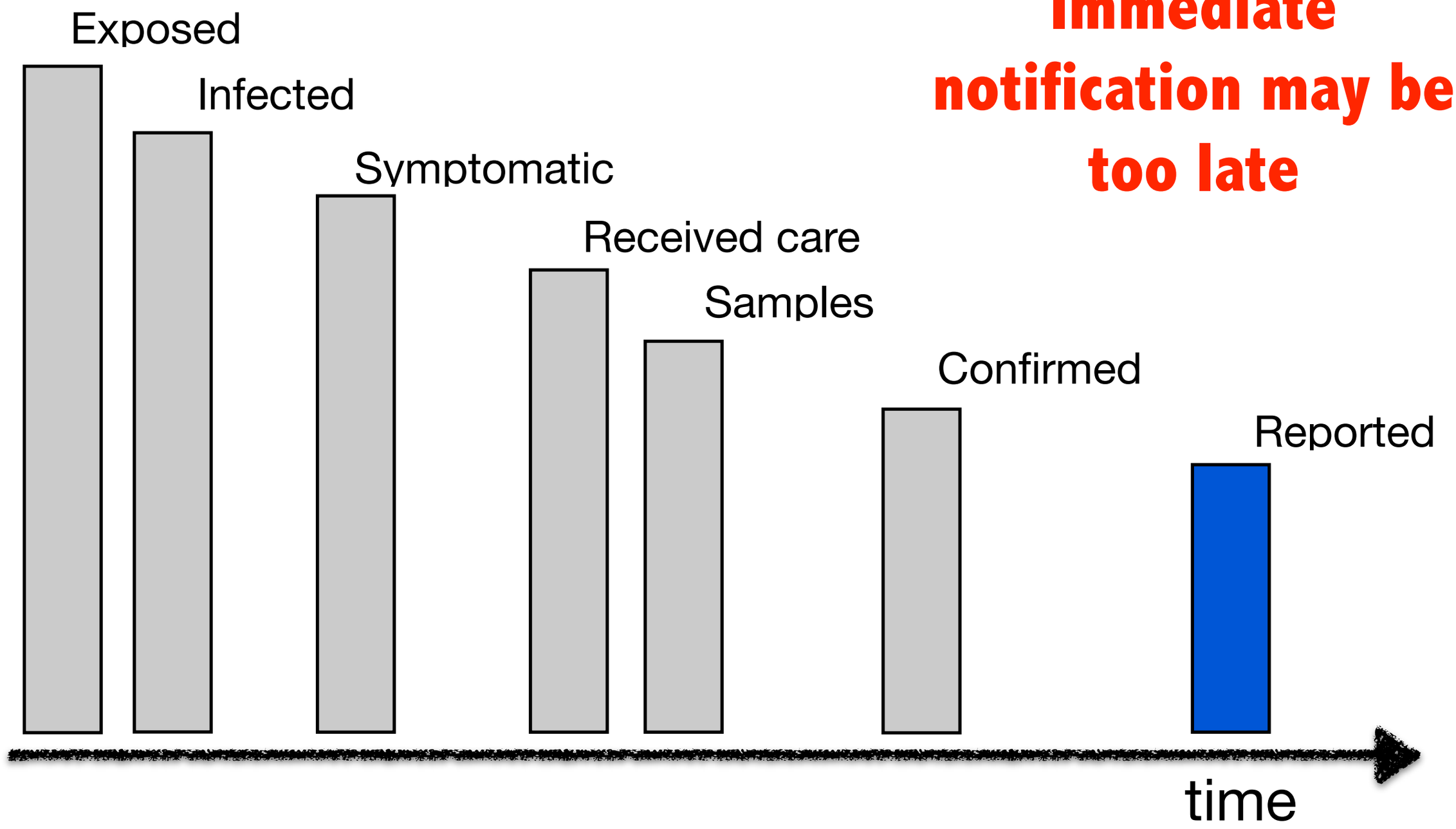

Immediate notification may be too late

Biovigilance and Epidemic Intelligence:
guiding and assessing public policy

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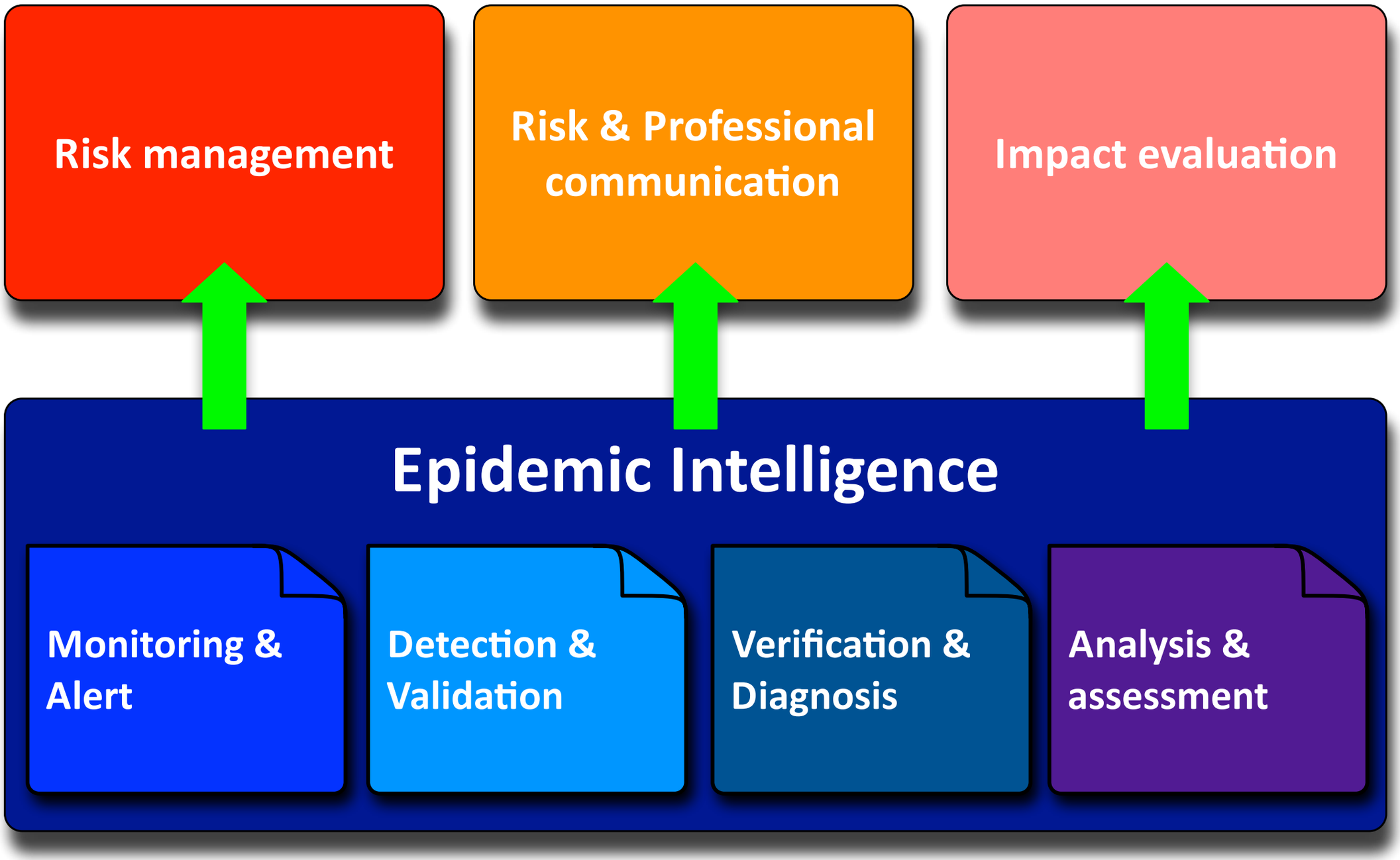

Adaptado de Paquet C. Eurosurveillance, 2006.

Epidemic intelligence: European model

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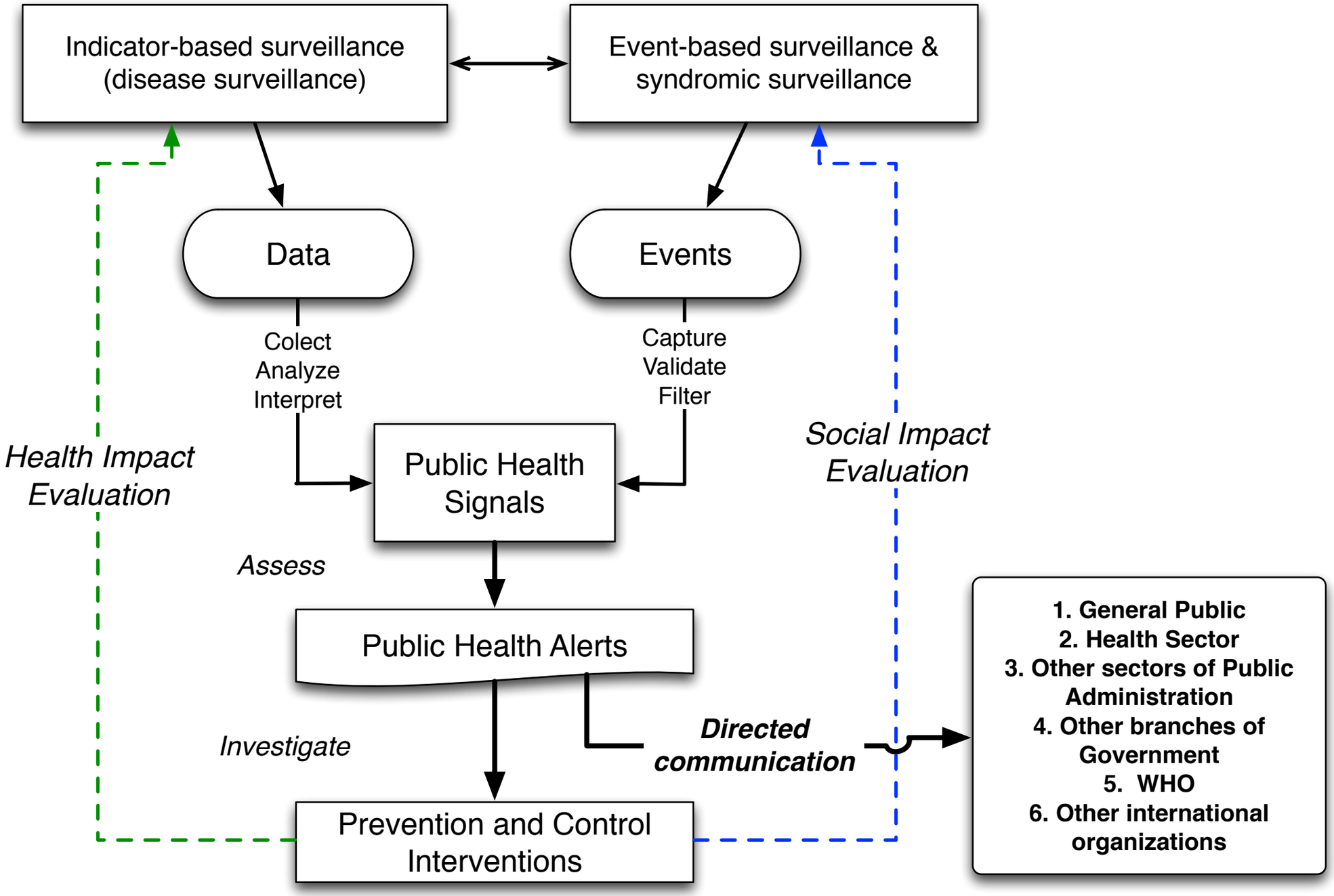

Adapted from: Paquet, C, et. al. Eurosurveillance, 2006; 11(12): 212-4

Decreasing returns of expanding coverage

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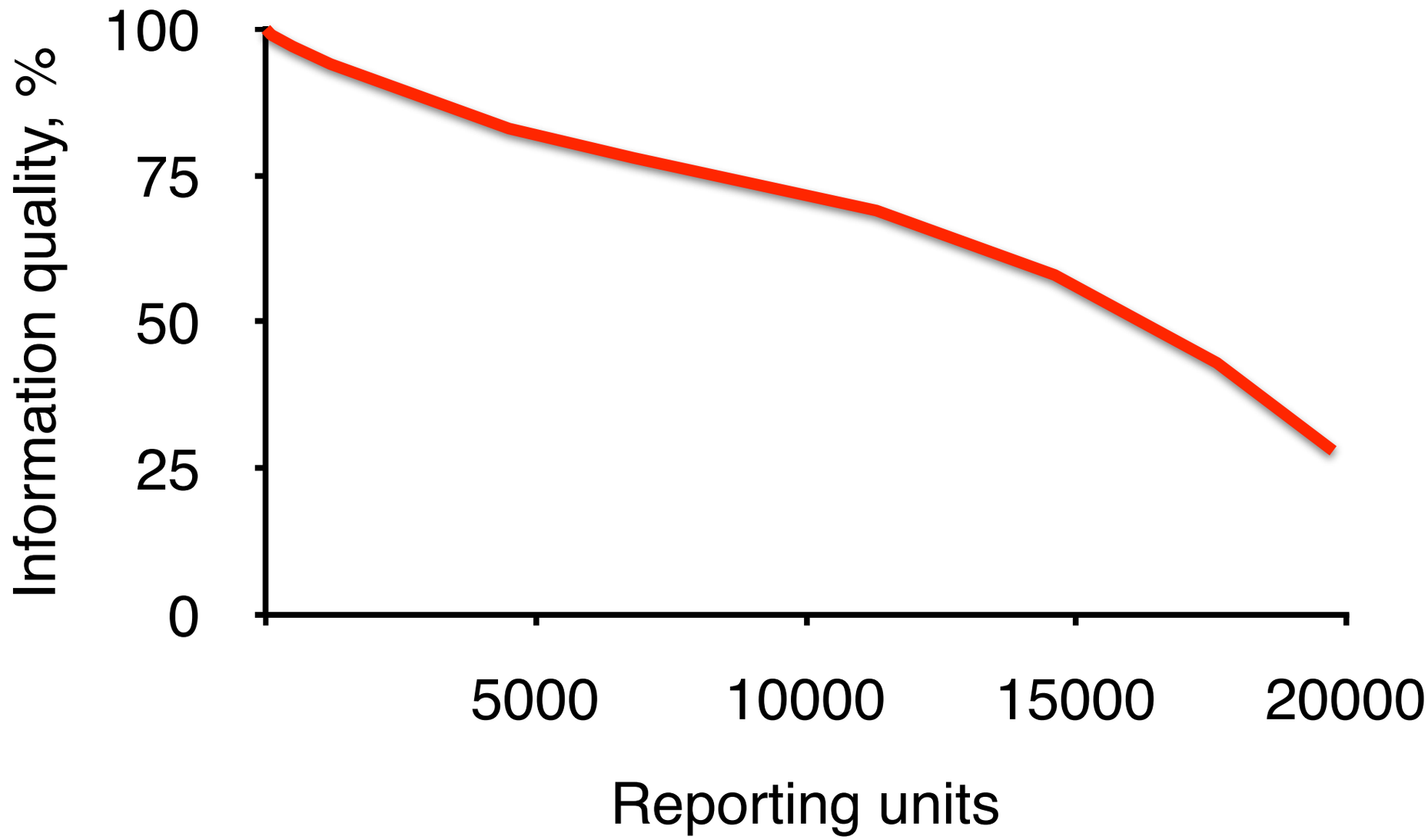
Hypothetical relation between information quality and detection coverage in surveillance systems



Surveillance Tracing Nuclei (NuTraVE):
Cluster Surveillance of Severe Acute Disease

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- A flexible model of **syndromic surveillance**
- Aims at **detecting and assessing** and early **etiologic diagnosis emerging threats**
- **Clusters of health facilities** representing different complexity care
- **Coordination and communication** to collate data and assessing risk
- Formal identification of **catchment areas**
- **Patterns of reference** for health care
- **Laboratory surveillance** - public health and clinical laboratories

NuTraVE structure

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Coordinating Center

Public Health Laboratory

Clinical Laboratories

Reference Hospital

General Hospitals

Ambulatory care facilities

Expanded surveillance NuTraVE

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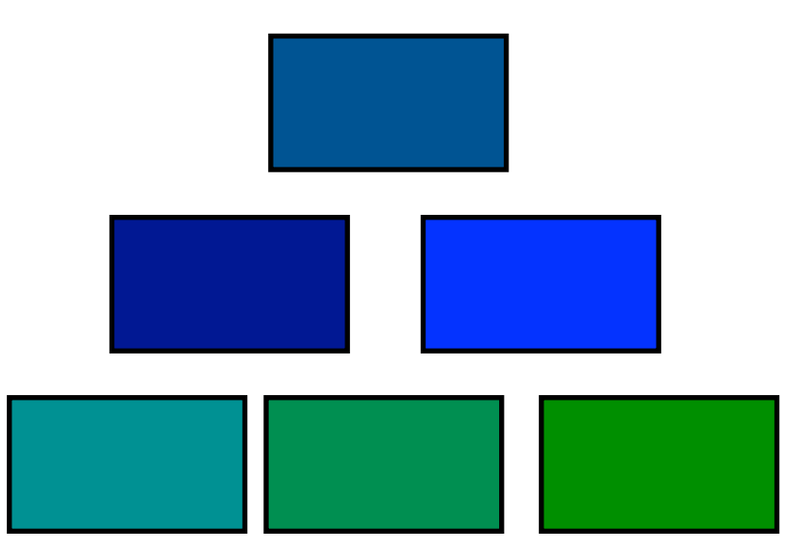
School absenteeism

Job absenteeism

Prescription patterns

Impact evaluation



Animal surveillance

Food and drug safety

Health care seeking patterns

Surveillance at touristic areas

Formal assessment of catchment areas

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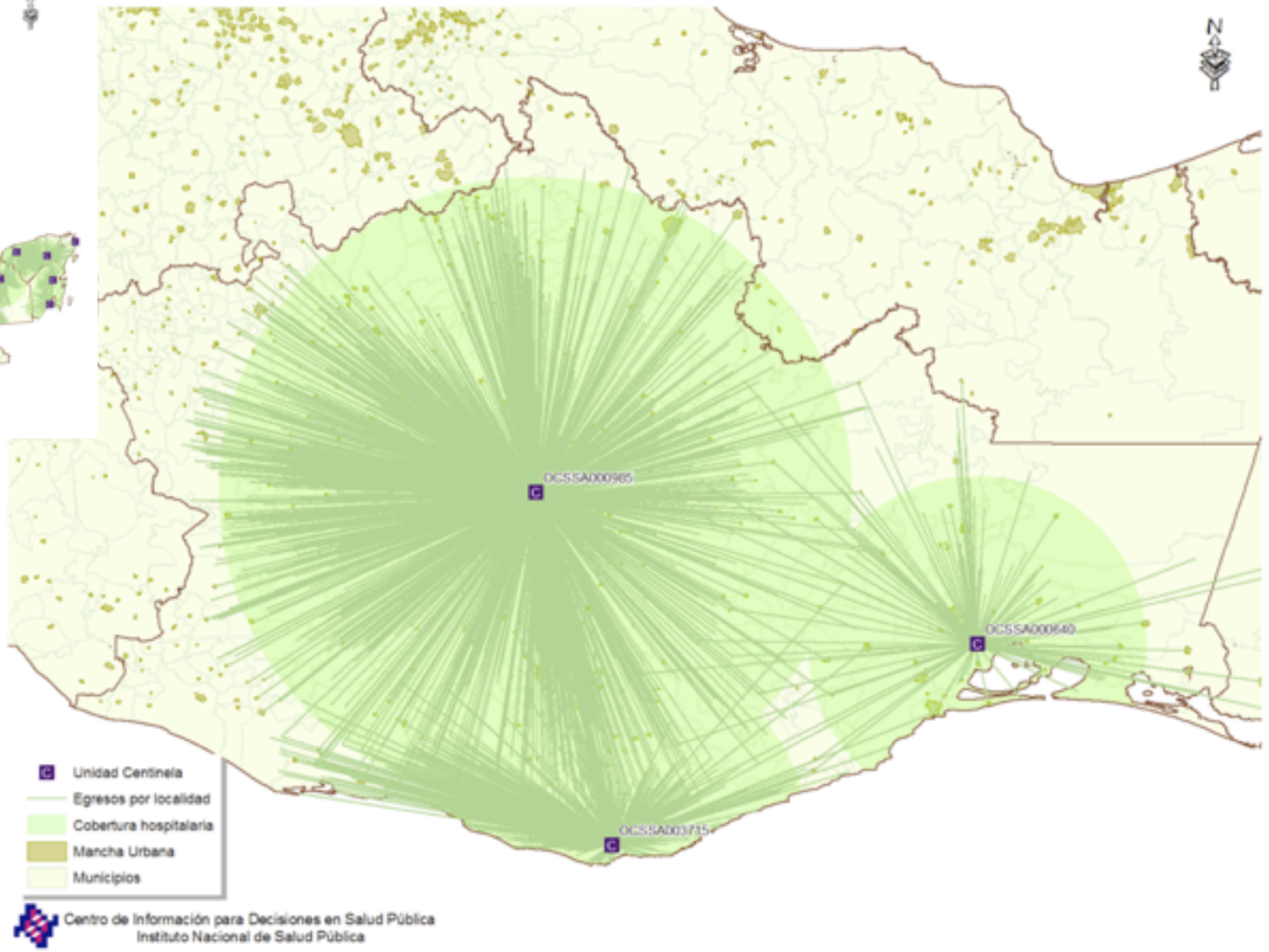

Sentinel vs. monitor surveillance

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Feature	Sentinel	Monitor
Primary Aim	Early detection	Estimation, patterns, trends
Surveillance targets	Defined	Defined or undefined
Reporting units	High probability location	Geo or Demo Representativity
Duration	Temporal	Permanent
Main capacity	Detection	Analysis and Assessment
Collected data	Basic	Advanced
Laboratory	Target diagnosis	Discriminatory diagnosis

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Risk communication

Challenges of perception and behavioral change

Influenza H1N1: community mitigation

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- **School closures** (absolute in Mexico City metropolitan area, 10 days)
- Closure of non-essential **commercial activities**
- **Cancelation of massive crowding** in sport or cultural events
- **Cleaning of public spaces** and transportation in Mexico City
- **Health promotion messages** in mass media, billboards and flyers
- Screening for influenza like illness in **airports, schools, and public places**

Influenza H1N1: community mitigation

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Generalized health promotion messages

Community mitigation interventions or panic relieving measures

Influenza H1N1: community mitigation

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Reported community mitigation efforts to protect against influenza H1N1.
México, May 2009

	D.F.		SLP		Querétaro	
	% (IC 95)		% (IC 95)		% (95CI)	
Frequent hand washing	89	(87, 92)	81	(79, 83)	76	(73, 79)
Wearing a mask	63	(60, 66)	65	(61, 69)	50	(45, 55)
Using hand sanitizer/gel	30	(26, 35)	30	(26, 35)	27	(22, 33)
Covering cough/sneeze	22	(18, 26)	14	(12, 16)	16	(13, 19)
Avoiding crowds	20	(16, 24)	30	(26, 33)	24	(20, 28)
Ventilating the home	20	(16, 24)	17	(15, 20)	15	(12, 19)
Avoid hand shake & kiss	12	(10, 14)	16	(13, 20)	19	(16, 22)
Avoid contact with cases	10	(7.8, 14)	11	(8.5, 15)	12	(8.9, 16)
Self medication	0.7	(0.2, 2.5)	0.3	(0.1, 0.9)	0.9	(0.4, 1.8)
Leaving town	0.6	(0.2, 1.7)	0.2	(0.0, 1.2)	0.4	(0.2, 0.9)
Did not do anything	2.3	(1.6, 3.2)	1.5	(0.9, 2.7)	6.5	(4.3, 9.7)

Aburto NJ, Pevzner E, Lopez-Ridaura R, et al. Am J Preventive Medicine, 2010; 39(5): 395 – 402

Community mitigation interventions or panic relieving measures

Social & Risk communication: access

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Means for which population learned about possible protective measures against influenza H1N1. México, May 2009

		D.F.		SLP		Querétaro
		% (IC 95)		% (IC 95)		% (IC 95)
TV	93	(91, 95)	95	(94, 96)	95	(94, 96)
Radio	37	(34, 40)	31	(27, 35)	38	(34, 43)
Newspaper	17	(12, 21)	11	(8.2, 13)	8.4	(5.5, 11)
Family/friends	13	(10,15)	18	(16, 21)	11	(9.1, 13)
Internet (Other)	11	(6.4,16)	7.5	(4.9,10)	11	(8.2,13)
Internet (MoH)	6.3	(4.5, 8.0)	6.3	(4.4, 8.1)	6.6	(3.7, 9.4)
Billboards/flyers	11	(8.3,13)	19	(16, 21)	4.6	(2.4, 6.8)
Healthcare provider	4.2	(0.9, 5.4)	8.7	(7.1, 10)	2.8	(1.7, 3.9)
Received no information	2.8	(1.7, 3.8)	8.6	(6.6, 11)	6.1	(3.7 - 8.6)

Aburto NJ, Pevzner E, Lopez-Ridaura R, et al. Am J Preventive Medicine, 2010; 39(5): 395 – 402. Unpublished data

Influenza H1N1: community mitigation

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Screening and thermal screening at airports

Risk communication: challenges

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- **Population perception of risk is highly influence by context and uncontrollable expossures**
  - mass-media, social media, science, surveillance information
  - values, social norms, cultural environment, emotional drivers, rumors, etc.
- **Spokespersons may influence risk perception**
  - Increasing or decreasing trust
- **Risk communication is a challenging and moving target**
  - Uncertainty: origin, context, consequences, duration, etc.

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Externalities of the influenza H1N1 epidemic in México

The cost of transparency

International collaboration

- International Health Regulations (IHR, 2005)
- Global Helath Security Initiative (GHSI)
- North American Plan for Avian and Pandemic Influenza 2007 (revised in 2012)
- Various technical collaboration agreements:
  - US/CDC, US/DHHS, Canada PHAC

National Preparedness and Response Plan for Avian and Pandemic Influenza

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1. Intersectoral Political coordination

2. Health promotion and risk communication

3. Surveillance and Laboratory

4. Health care delivery

5. Strategic stockpile: drug, vaccines and suplies

6. Research

Influenza H1N1: impact on aerial transportation to México

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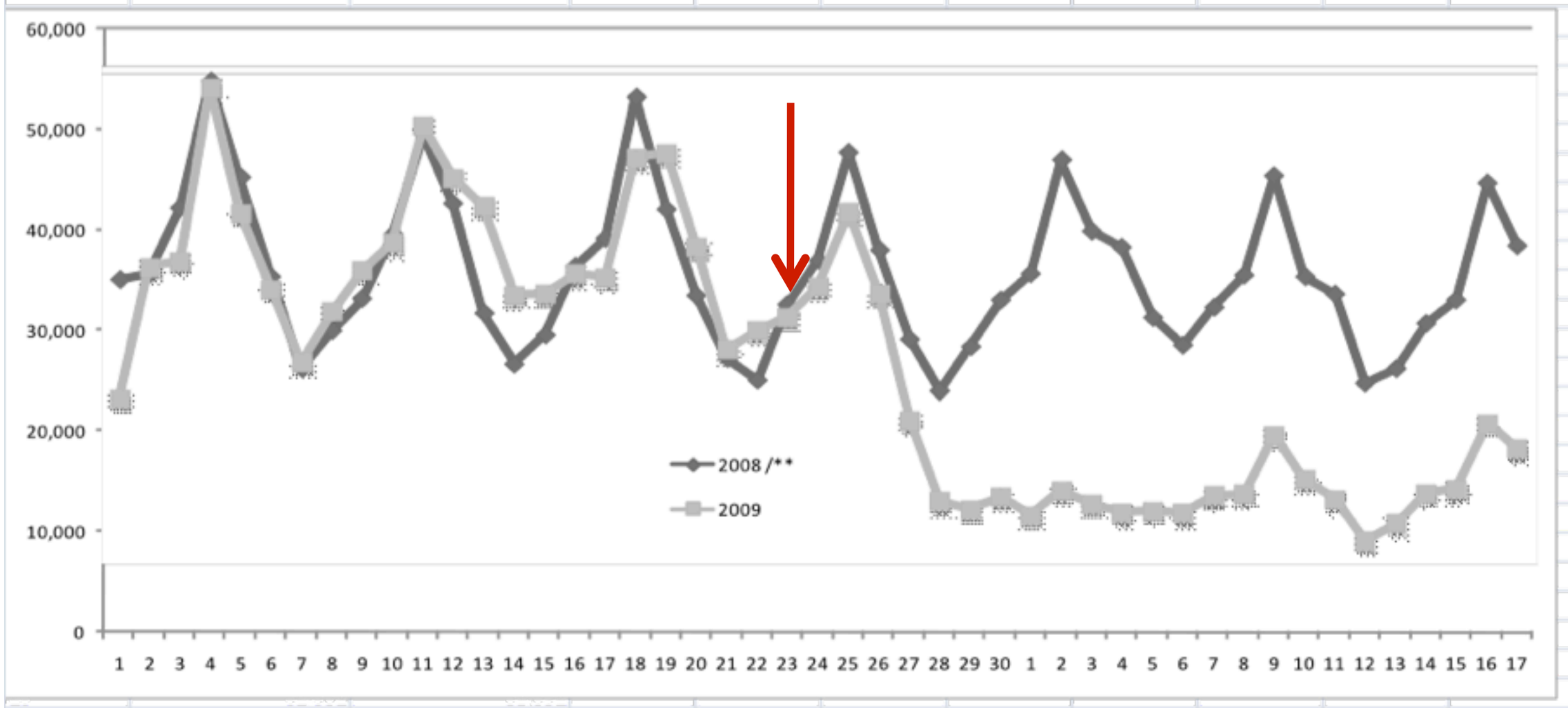
Flujo de entradas aéreas a México, según día de ingreso
del 1º de abril al 17 de mayo de 2008 y de 2009 (cifras preliminares) /*



Fuente: Elaboración Centro de Estudios Migratorios del INM, con cifras obtenidas del Sistema Integral de Operación Migratoria (SIOM).
/* Entradas de pasajeros internacionales registradas en SIOM en los aeropuertos de San José del Cabo, Guadalajara, Puerto Vallarta, Ciudad de México, Cancún, Monterrey, Cozumel, Mazatlán, Silao, Hermosillo, Mérida, Acapulco, Zihuatanejo, Huatulco, Tijuana, Morelia, Zacatecas y Toluca. La cobertura del SIOM es de alrededor del 90 por ciento del total de entradas.
/ Los datos de 2008 se rezagaron un día para que las fechas coincidieran con los días de la semana, o sea viernes contra viernes, etc.**

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Aerial flows to México according to origin of the traveller

Acumulado del 25 de abril al 17 de mayo de 2008 / 2009 (cifras preliminares) /*

Nacionalidad	2008 /**	2009	Variación 2009/2008 Absoluta	Relativa
Total	**800,671**	**371,977**	**-428,694**	**-53.5**
Estados Unidos de América	372,881	164,383	-208,498	-55.9
México	225,272	147,499	-77,773	-34.5
Canadá	49,215	17,329	-31,886	-64.8
España	17,212	4,101	-13,111	-76.2
Gran Bretaña	21,169	3,534	-17,635	-83.3
Alemania	9,770	3,445	-6,325	-64.7
Francia	13,610	3,441	-10,169	-74.7
Argentina	8,435	2,329	-6,106	-72.4
Países Bajos (Holanda)	5,860	2,216	-3,644	-62.2
Otras	77,247	23,700	-53,547	-69.3

Fuente: Elaboración Centro de Estudios Migratorios del INM, con cifras obtenidas del Sistema Integral de Operación Migratoria (SIOM).

/* Entradas de pasajeros internacionales registradas en SIOM en los aeropuertos de San José del Cabo, Guadalajara, Puerto Vallarta, Ciudad de México, Cancún, Monterrey, Cozumel, Mazatlán, Silao, Hermosillo, Mérida, Acapulco, Zihuatanejo, Huatulco, Tijuana, Morelia, Zacatecas y Toluca. La cobertura del SIOM es de alrededor del 90 por ciento del total de entradas.

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Influenza H1H1: profiling and anti-scientific measures

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- In late April 2009, China retained 138 Mexican citizens in involuntary quarantine for two weeks
- A dozen of European, African and Latin American countries initially blocked Mexican flights

Influenza H1N1: uneven vaccine procurement

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Country	Doses of monovalent anti-H1N1 vaccines (million)
USA	251
Japan	100
France	94
UK	90
Italy	50.4
Canada	50.4
Germany	50
México	30

Challenges in vaccine acquisition

- No information on comparative cost - effectiveness
- No reference pricing
- Concealed country-specific negotiation with industry
- Unequal access to the market
- Limited participation of international organizations to balance the market

Source: Global Health Security Action Group - Pandemic Influenza Working Group

Influenza H1N1: four lessons for health security

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- **Lesson 1**: Preparedness and response
  - Key challenges: coordination & risk communication
- **Lesson 2**: Epidemiological surveillance
  - Flexible, analytical approaches a crucial: epidemic intelligence
- **Lesson 3**: Externalities
  - Transparency leads to economic losses, but pays - off
  - Access to resources is uneven and worst in panic
- **Lesson 4**: Risk communication
  - Hold to clarity, transparency & timeliness

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Thank you!

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The 2009 H1N1 Influenza Pandemic at the Epicenter: Lessons for Global Health Security

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University of Southern Denmark, 26 June 2013