From Ebola to other emerging infectious diseases: the case for strong risk assessment, mitigation and prevention

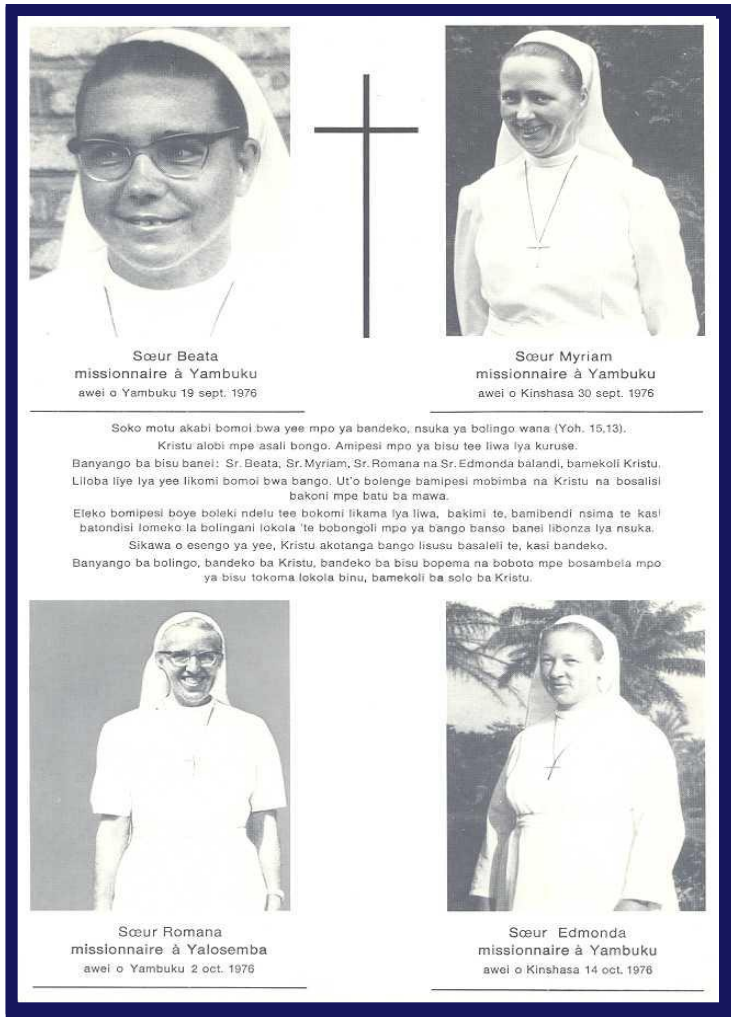
Yambuku Mission Hospital, DRC (Zaire), 1976

Yambuku Mission, DRC, 1976

Nurses, Yambuku Mission Hospital

Maternity, Yambuku Mission Hospital

Deceased health workers, Yambuku Mission Hospital, DRC, 1976



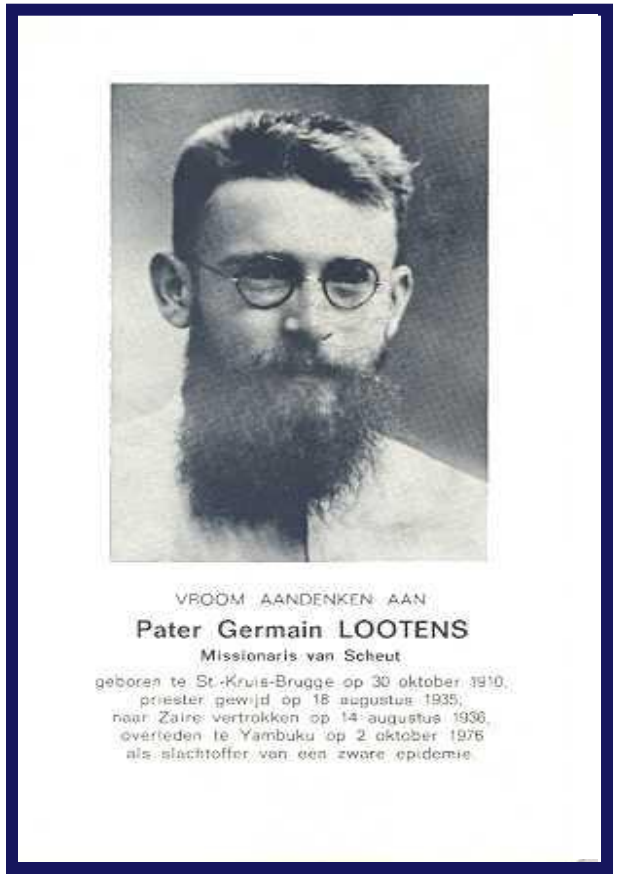
Sœur Beata
missionnaire à Yambuku
awei o Yambuku 19 sept. 1976

Sœur Myriam
missionnaire à Yambuku
awei o Kinshasa 30 sept. 1976

Soko motu akabi bomoi bwa yee mpo ya bandeko, nsuka ya bolingo wana (Yoh. 15,13).
Kristu alobi mpe asali bongo. Amipesi mpo ya bisu tee liwa lya kuruse.
Banyango ba bisu banei: Sr. Beata, Sr. Myriam, Sr. Romana na Sr. Edmonda balandi, bamekoli Kristu.
Liloba liye lya yee likomi bomoi bwa bango. Ut'o bolenge bamipesi mobimba na Kristu na bosalisi bakoni mpe batu ba mawa.
Eleko bomipesi boye boleki ndelu tee bokomi likama lya liwa, bakimi te, bamibendi nsima te kasi batondisi lomeko la bolingani lokola 'te bobongoli mpo ya bango banso banei libonza lya nsuka.
Sikawa o esengo ya yee, Kristu akotanga bango lisusu basaleli te, kasi bandeko.
Banyango ba bolingo, bandeko ba Kristu, bandeko ba bisu bopema na boboto mpe bosambela mpo ya bisu tokoma lokola binu, bamekoli ba solo ba Kristu.

Sœur Romana
missionnaire à Yalosemba
awei o Yambuku 2 oct. 1976

Sœur Edmonda
missionnaire à Yambuku
awei o Kinshasa 14 oct. 1976



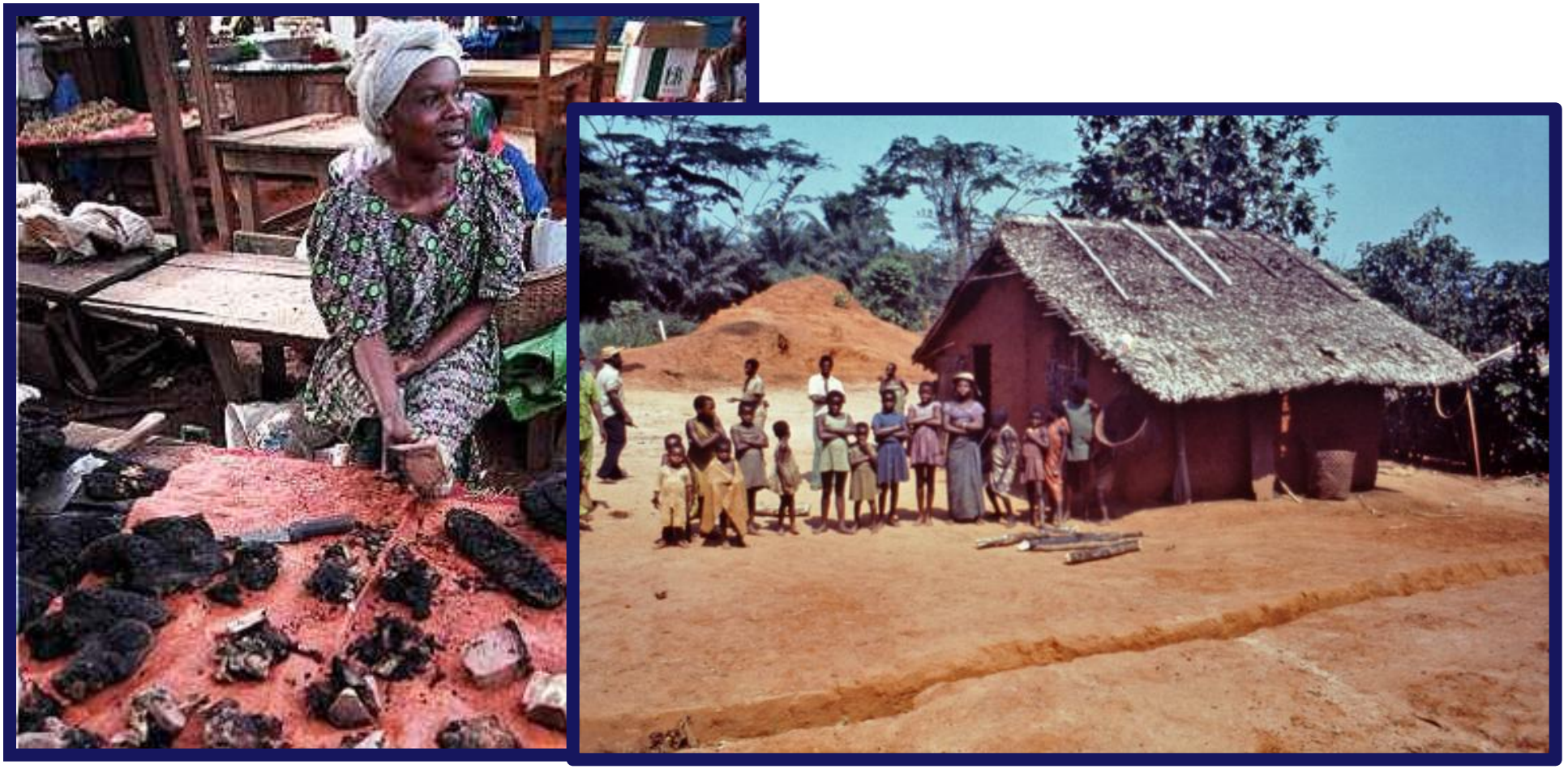
VROOM AANDENKEN AAN
Pater Germain LOOTENS
Missionaris van Scheut
geboren te St.-Kruis-Brugge op 30 oktober 1910,
priester gewijd op 18 augustus 1935,
naar Zaire vertrokken op 14 augustus 1936,
overleden te Yambuku op 2 oktober 1976
als slachtoffer van een zware epidemie

Ngaliema Hospital, Kinshasa, DRC

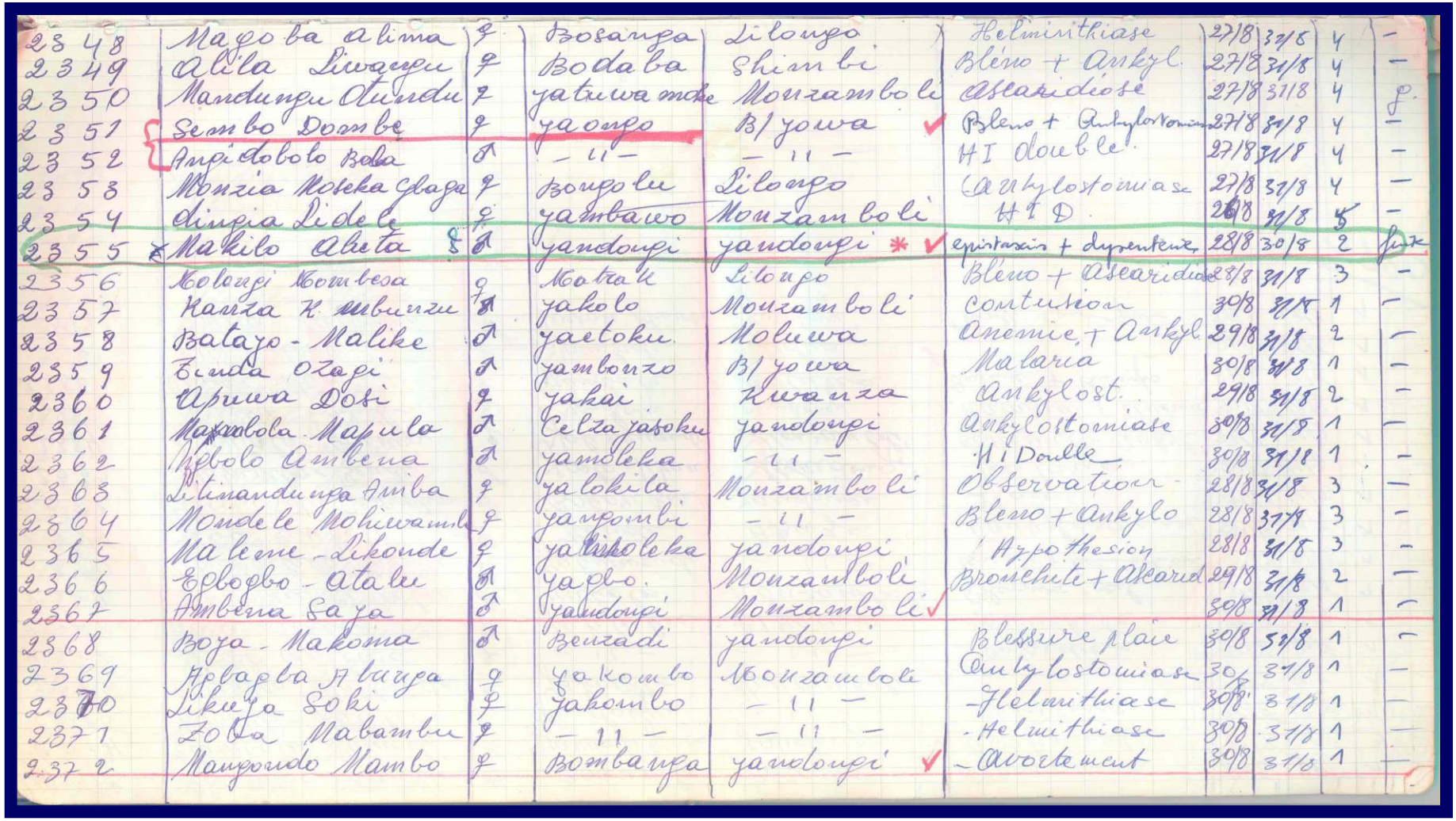
Filoform virus, first identified 1976, CDC (Atlanta) and Porton (UK)

Source: CDC

Animal market, near Yambuku, DRC



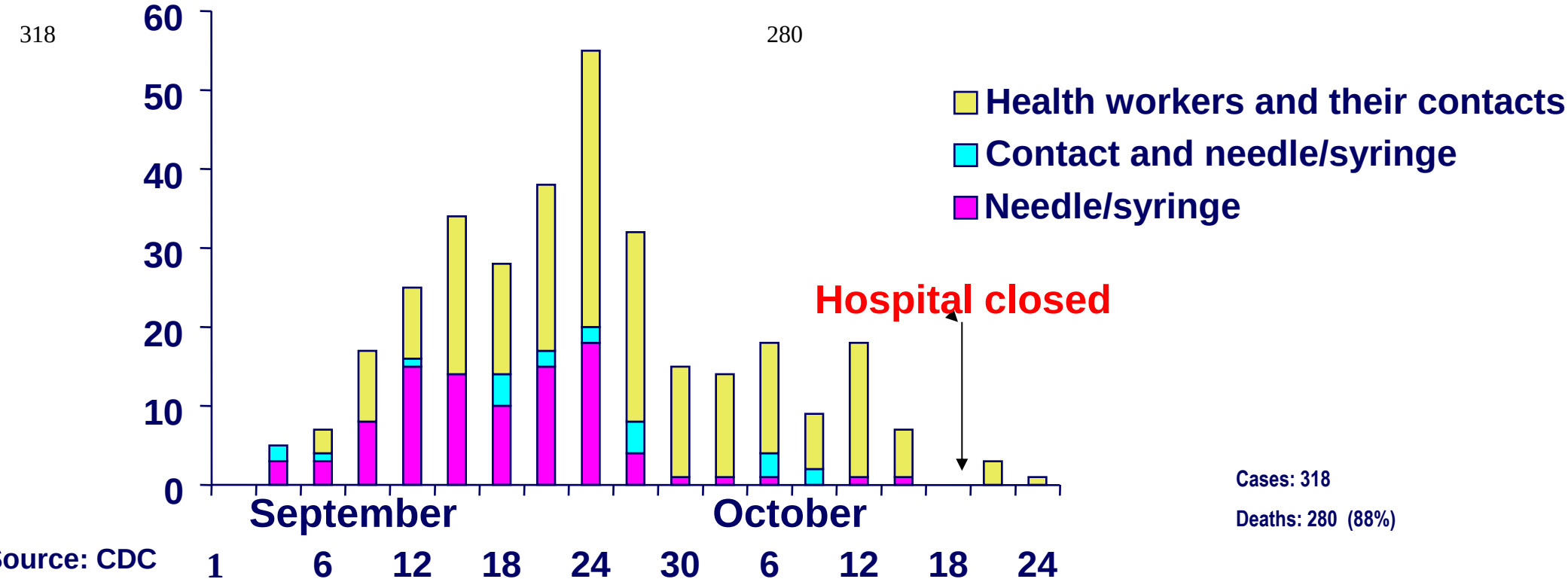
Patient record, outpatient department, Yambuku Hospital, DRC, August 1976



2348	Nagoba alima	♀	Bosanga	Lilongo	Helminthiase	27/8	31/8	4	–
2349	Alila Liwangu	♀	Bodaba	Shimbi	Bleno + Ankyl.	27/8	31/8	4	–
2350	Mandungu Ouandu	♂	yatuwamoke	Monzamboli	Ascaridiose	27/8	31/8	4	–
2351	Sembo Dombe	♀	yaompo	B/jowa ✓	Bleno + Ankylostomiase	27/8	31/8	4	–
2352	Ampidobolo Boba	♂	– 11 –	– 11 –	HI double	27/8	31/8	4	–
2353	Monzia Moleka Yaya	♀	Bongolu	Lilongo	Ankylostomiase	27/8	31/8	4	–
2354	Dinga Lidele	♀	yambawo	Monzamboli	H I D	28/8	31/8	3	–
2355	Makilo Abeta	♀♂	yandongi	yandongi * ✓	epistaxis + dysenterie	28/8	30/8	2	–
2356	Kolongi Tombesa	♀	Matoka	Lilongo	Bleno + Ascaridiase	28/8	31/8	3	–
2357	Kanza K. Mburu	♂	yakolo	Monzamboli	contusion	30/8	31/8	1	–
2358	Batayo - Malike	♂	yaetoku	Moluwa	Anemie + Ankyl.	29/8	31/8	2	–
2359	Enda Ozapi	♂	yambonzo	B/jowa	Malaria	30/8	31/8	1	–
2360	Apuwa Dosi	♀	yakai	Kwanza	Ankylost.	29/8	31/8	2	–
2361	Mambola Mapula	♂	Celza jasoku	yandongi	Ankylostomiase	30/8	31/8	1	–
2362	Ngbolo Ambena	♂	yamoleka	– 11 –	HI Double	30/8	31/8	1	–
2363	Litinandungu Amba	♀	yalokila	Monzamboli	Observation	28/8	31/8	3	–
2364	Mondele Mokiwamba	♀	yampombi	– 11 –	Bleno + Ankylo	28/8	31/8	3	–
2365	Malemo - Likonde	♀	yalikoleka	yandongi	Hypothesion	28/8	31/8	3	–
2366	Eboqbo - Atalu	♂	yapbo	Monzamboli	Bronchite + Ascaride	29/8	31/8	2	–
2367	Ambena Saya	♂	yakudongi	Monzamboli ✓		30/8	31/8	1	–
2368	Boya - Makoma	♂	Benzadi	yandongi	Blessure plaie	30/8	31/8	1	–
2369	Ngbagba Nbanga	♀	yakombo	Monzamboli	Ankylostomiase	30/8	31/8	1	–
2370	Likuya Soki	♀	Jakombo	– 11 –	Helminthiase	30/8	31/8	1	–
2371	Zoba Mabambu	♀	– 11 –	– 11 –	Helmithiase	30/8	31/8	1	–
2372	Mangondo Mambo	♀	Bombanga	yandongi ✓	Avortement	30/8	31/8	1	–

Hospital Implements, Yambuku, 1976

Ebola Haemorrhagic Fever by mode of transmission, Yambuku DRC,1976



Source: CDC

Risk assessment, Ebola haemorrhagic fever, 1976

- Two highly lethal outbreaks simultaneously
  - Zaire (Yambuku) 280/318
  - Sudan (Maridi) 151/284
- Nosocomial transmission drove outbreaks into health workers and through them to community
- Animal reservoir suspected
- Unknown potential to reappear – one time emergence vs. periodic re-emergence

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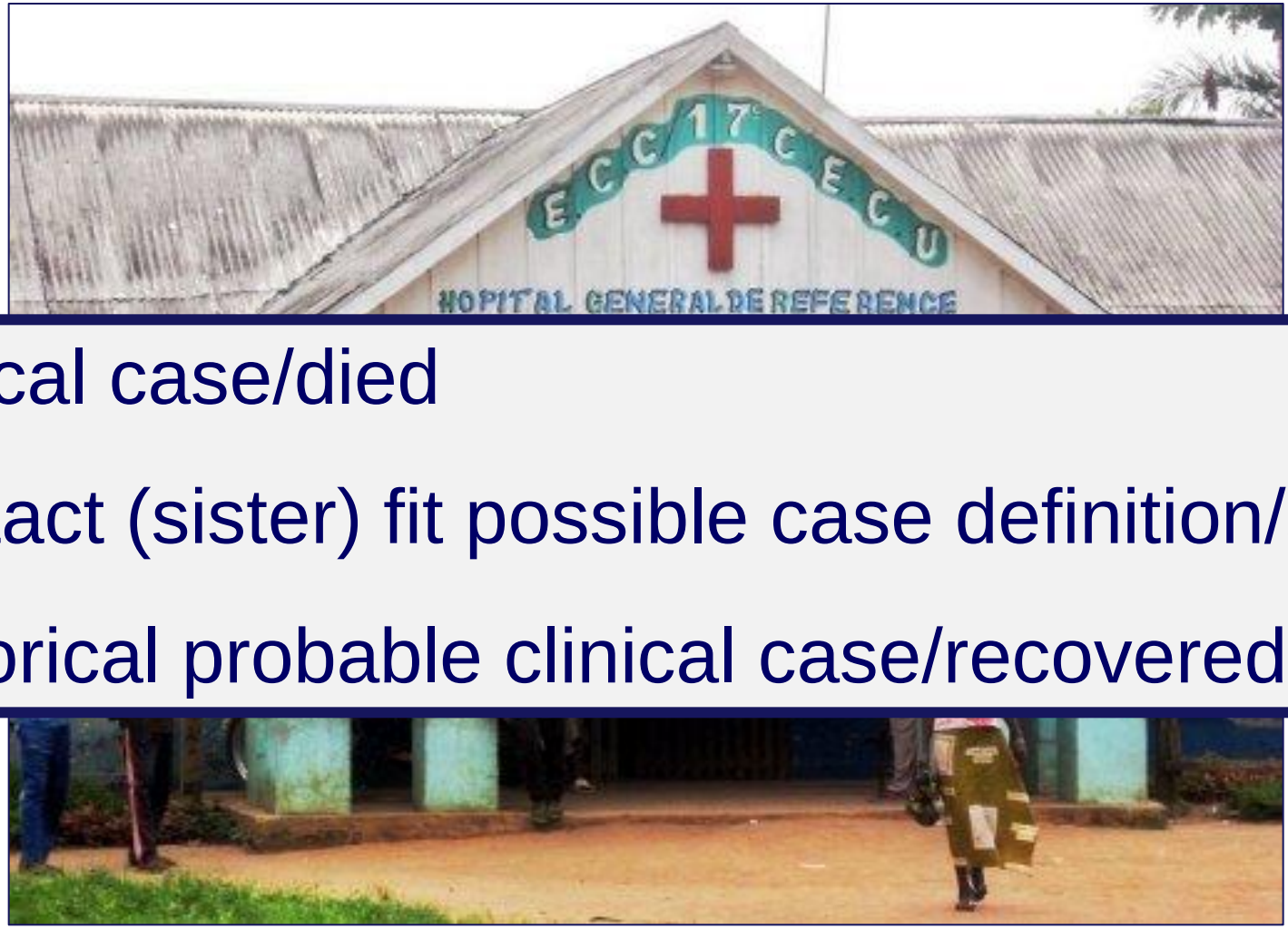
Mission Hosptial, Tandala Zaire (DRC), 1977



1 clinical case/died

1 contact (sister) fit possible case definition/survived

1 historical probable clinical case/recovered,1972

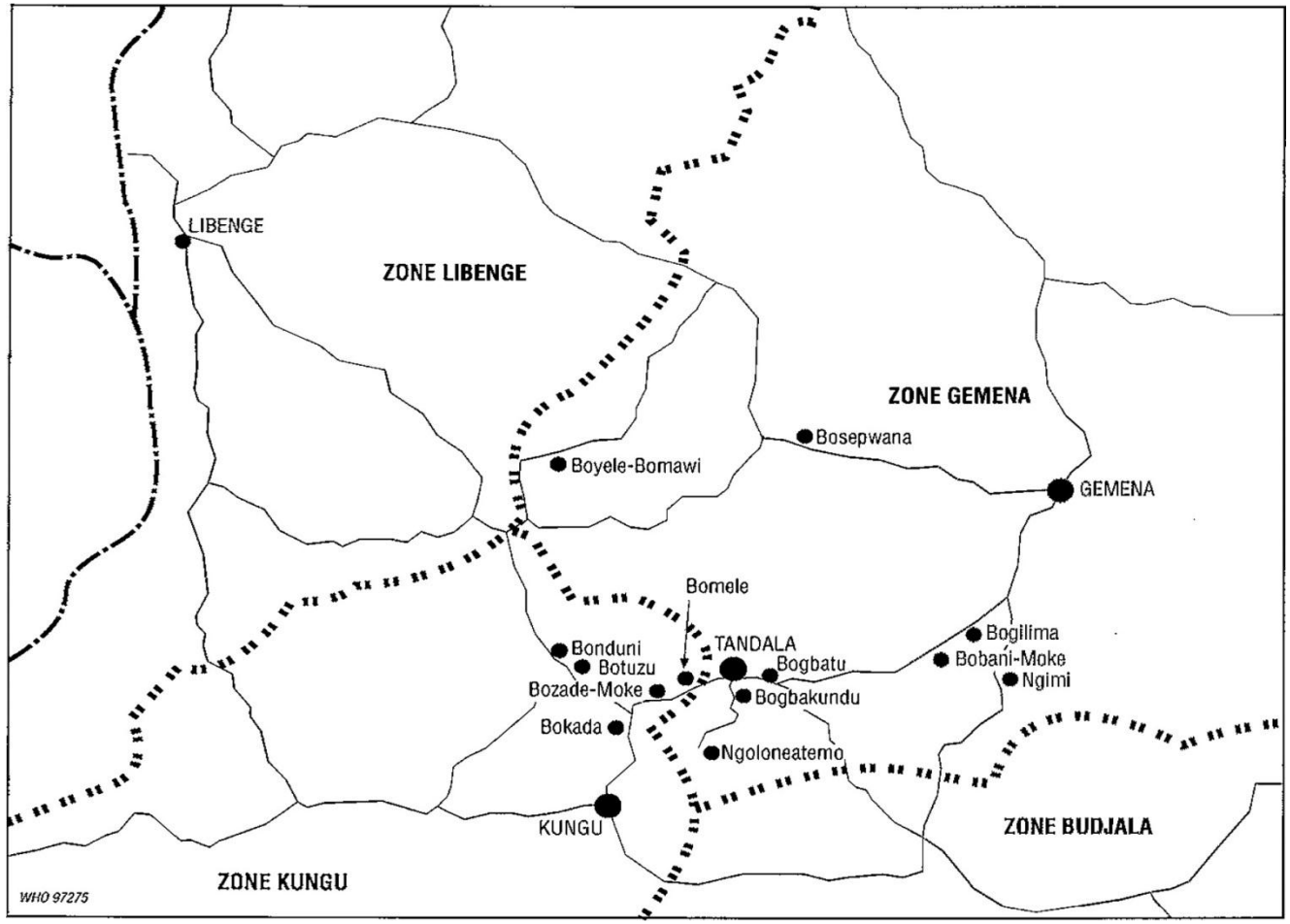
Ebola haemorrhagic fever surveillance, Zaire, 1981–1985: antibody in reported possible, probable and clinical cases

Case definition	1981 ($n = 0$)	1982 ($n = 4$)	1983 ($n = 36$)	1984 ($n = 27$)	1985 ($n = 31$)	1981–1985 ($n = 98$)
Possible	0	0	0	1	2	3
Clinical	0	1	4	2	4	11
Probable	0	2	5	0	0	7
Total	0	3	9	3	6	21

NOTE. n = no. of surveillance reports investigated.

Source: WHO

Ebola haemorrhagic fever surveillance, Zaire, 1981–1985: villages reporting probable, possible and clinical cases



Risk assessment, Ebola haemorrhagic fever, 1977

- Two highly lethal outbreaks simultaneously
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- Nosocomial transmission can be prevented
- Animal reservoir suspected
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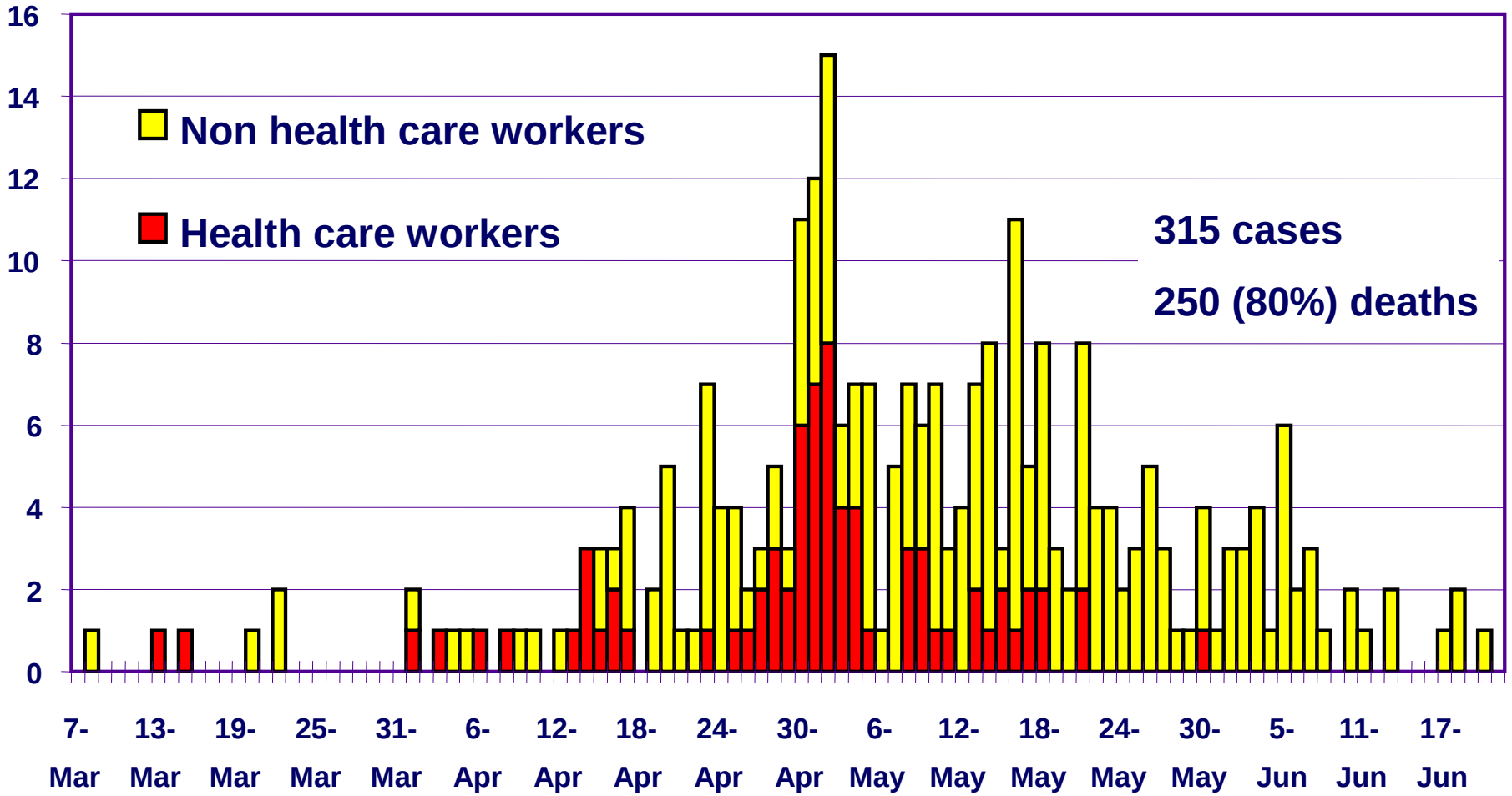
Kikwit General Hospital, Zaire, 1995

Nursing sisters, Kikwit General Hospital, Zaire, 1995

Ebola Haemorrhagic Fever by mode of transmission, Kikwit Zaire, 1995



Source: WHO/CDC

Ebola Haemorrhagic Fever, Mayibout Gabon,1996

- 19 index cases: found and butchered freshly dead chimpanzee
- 18 family members infected
- No nosocomial transmission
- 21/37 (70%) fatal

Tai Forest, Cote d'Ivoire,1992

Chimpanzee die off, Tai Forest sociology research project area, 1992 - 1994

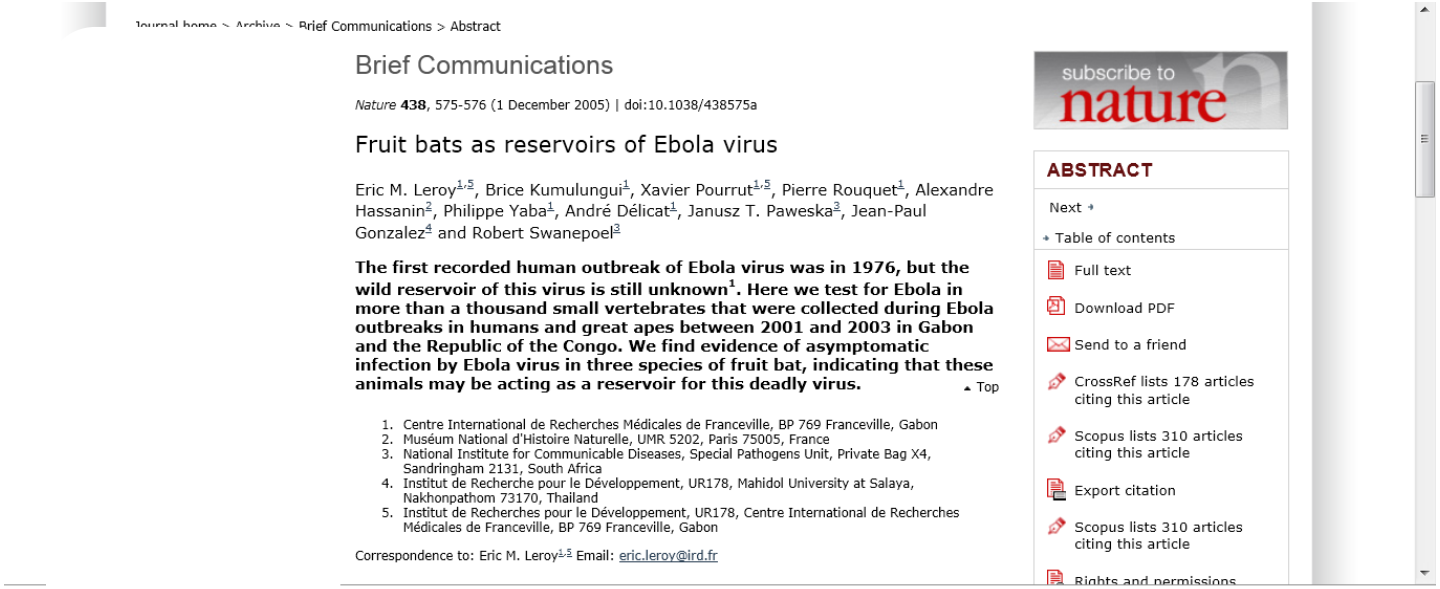
Risk assessment, Ebola haemorrhagic fever, 1994

- Periodic re-emergence occurs
- Highly lethal outbreaks occur periodically when health workers become infected
- Nosocomial transmission can be prevented
- Animal link to transmission confirmed
  - DRC (Yambuku and Tandala)
  - Cameroun

The search for a reservoir in nature, Ebola Haemorrhagic Fever, 1996

Source:: Emerging Infectious Diseases

The search for a reservoir in nature, Ebola Haemorrhagic Fever, 2001 - 2003



Journal home > Archive > Brief Communications > Abstract

Brief Communications

Nature **438**, 575-576 (1 December 2005) | doi:10.1038/438575a

Fruit bats as reservoirs of Ebola virus

Eric M. Leroy[1,5], Brice Kumulungui[1], Xavier Pourrut[1,5], Pierre Rouquet[1], Alexandre Hassanin[2], Philippe Yaba[1], André Délicat[1], Janusz T. Paweska[3], Jean-Paul Gonzalez[4] and Robert Swanepoel[3]

The first recorded human outbreak of Ebola virus was in 1976, but the wild reservoir of this virus is still unknown[1]. Here we test for Ebola in more than a thousand small vertebrates that were collected during Ebola outbreaks in humans and great apes between 2001 and 2003 in Gabon and the Republic of the Congo. We find evidence of asymptomatic infection by Ebola virus in three species of fruit bat, indicating that these animals may be acting as a reservoir for this deadly virus. ▲ Top

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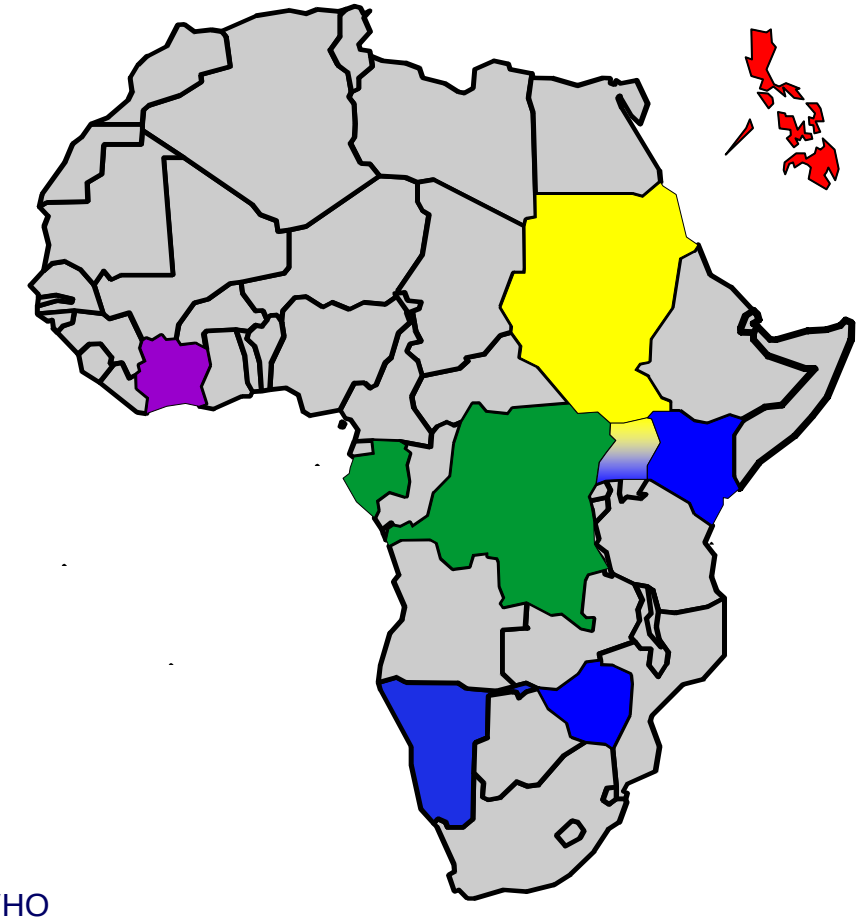
3. National Institute for Communicable Diseases, Special Pathogens Unit, Private Bag X4, Sandringham 2131, South Africa
4. Institut de Recherche pour le Développement, UR178, Mahidol University at Salaya, Nakhonpathom 73170, Thailand
5. Institut de Recherches pour le Développement, UR178, Centre International de Recherches Médicales de Franceville, BP 769 Franceville, Gabon

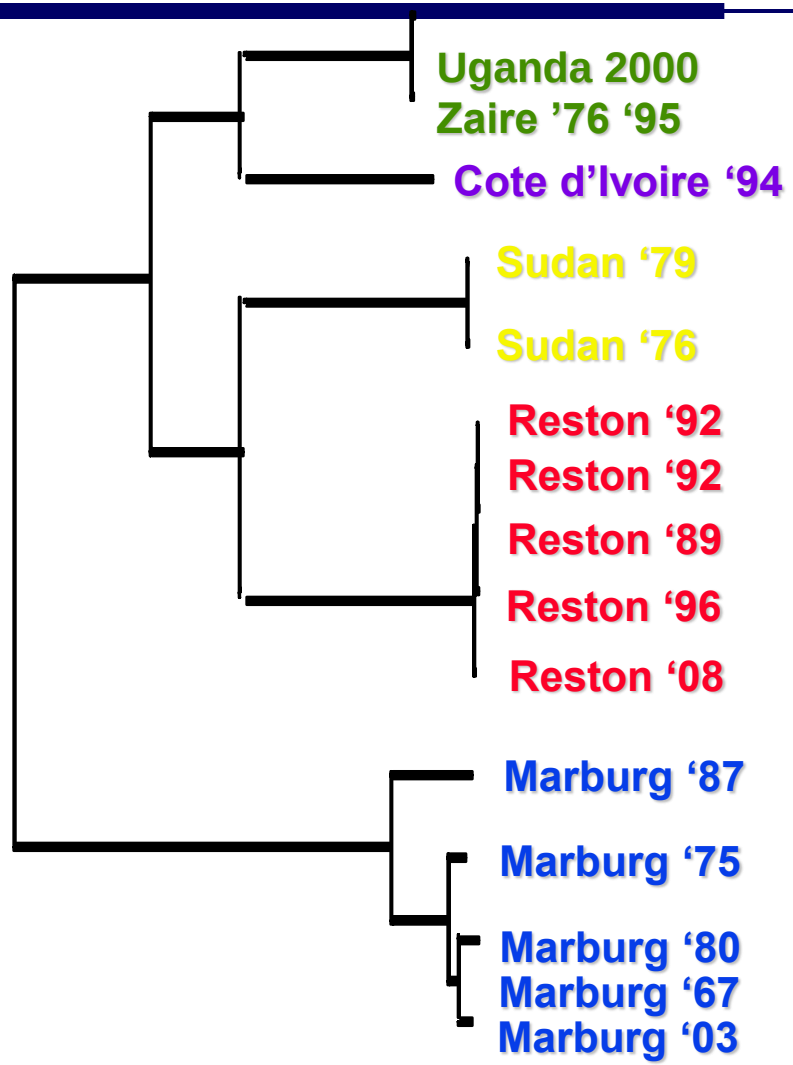
Correspondence to: Eric M. Leroy[1,5] Email: eric.leroy@ird.fr

Risk assessment, Ebola haemorrhagic fever, 2002

- Periodic re-emergence occurs
- Highly lethal outbreaks occur periodically when health workers become infected
- Nosocomial transmission can be prevented
- Animal link to transmission confirmed
- Bat probable reservoir in nature

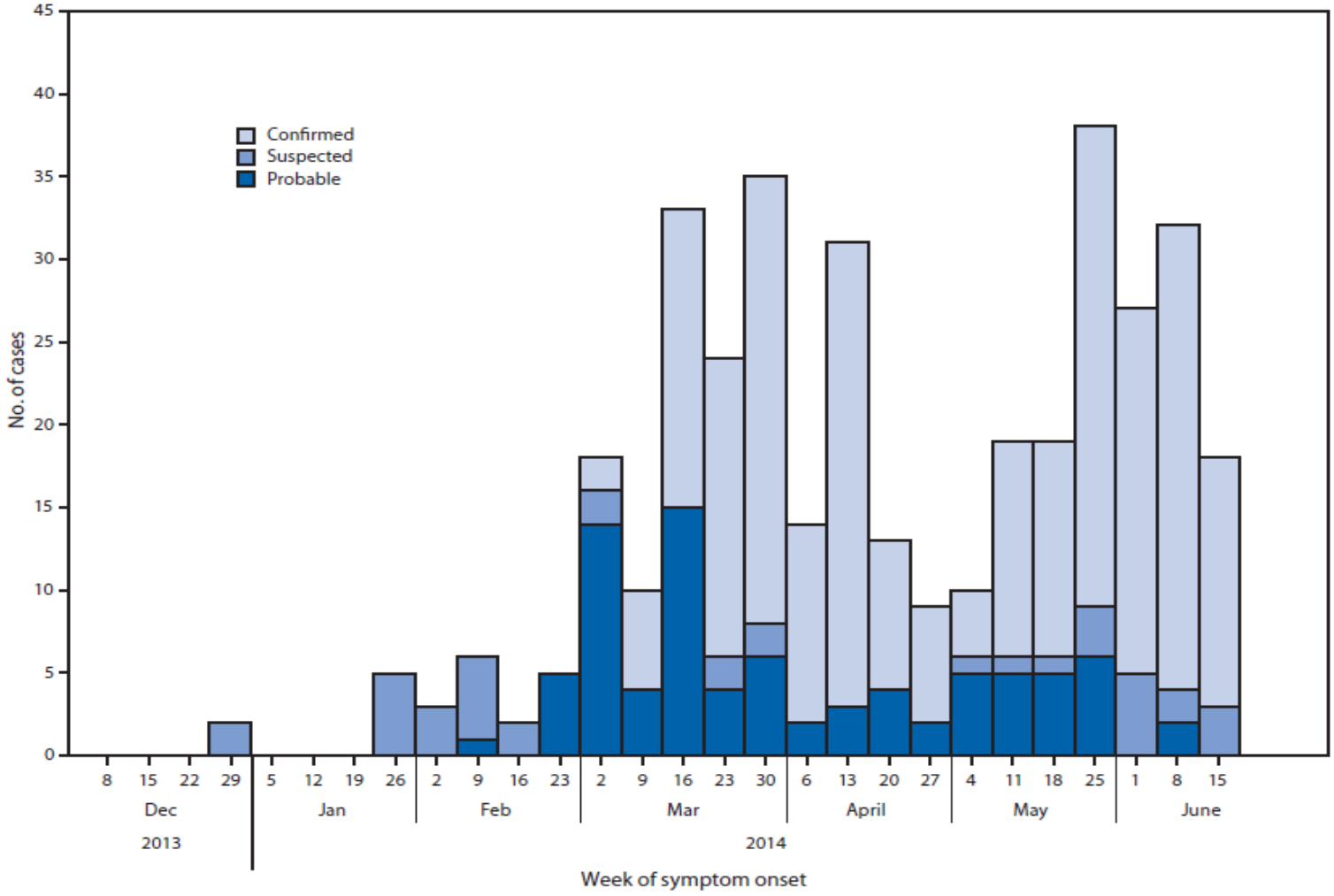
Selected Ebola outbreaks, 1976 - 2002





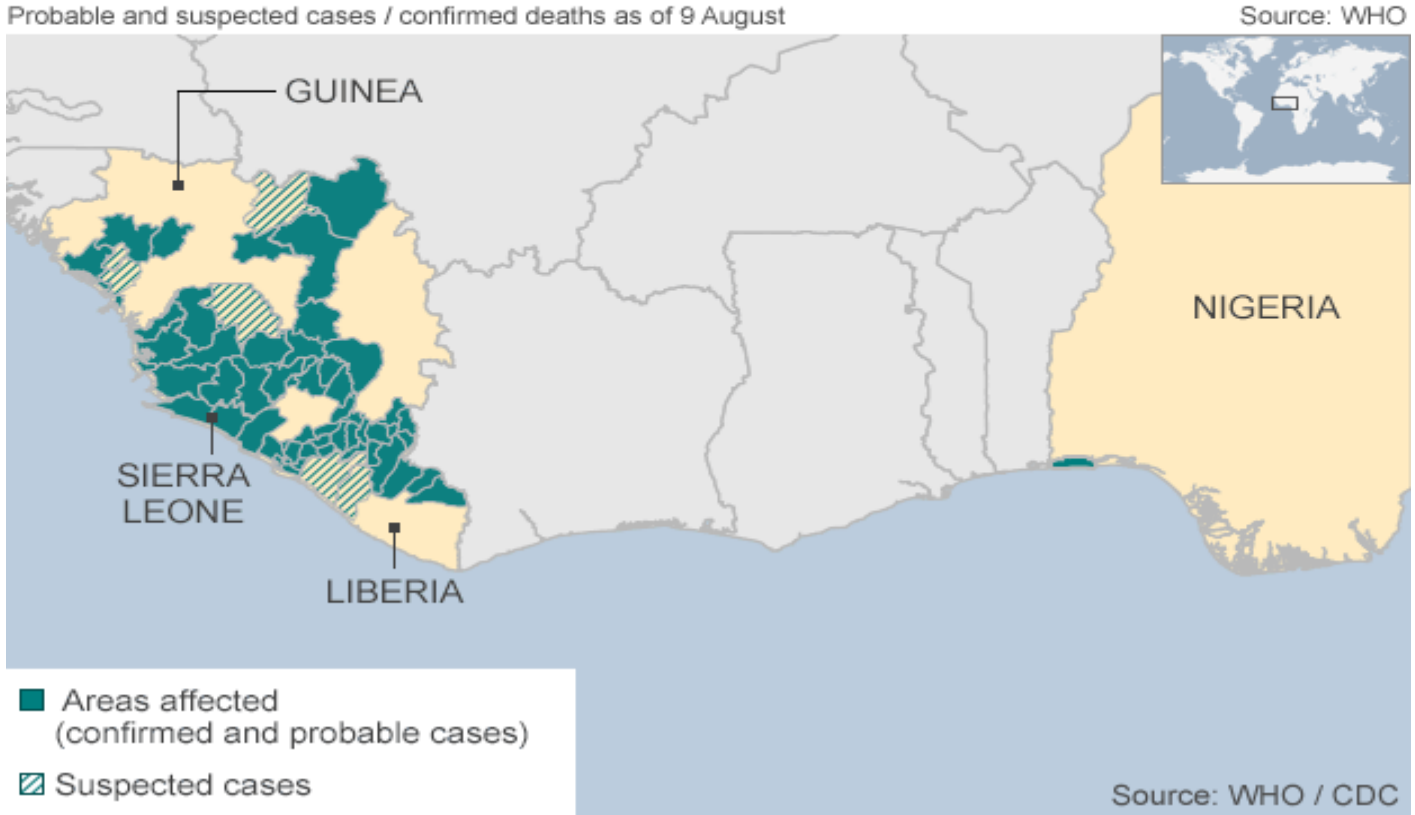
Source: WHO

Ebola outbreak, Guinea, December 2013 - present



Ebola outbreaks, West Africa 2014

Guinea	Sierra Leone	Liberia	Nigeria
506 cases	730 cases	599 cases	13 cases
373 deaths	315 deaths	323 deaths	2 deaths



Initial Ebola economic impact, 2014

Sierra Leone, Liberia and Guinea had all been shaking off recent instable histories until Ebola decimated mining production, halted economic recovery and sent it back into reverse. **PAULINE BAX, SILAS GBANDIA** *and* **ELISE ZOKER** *report from Freetown*

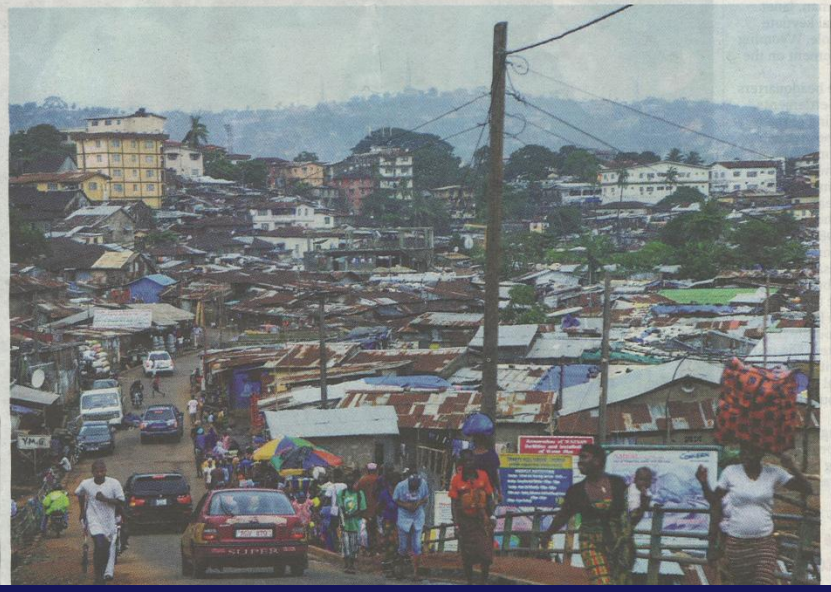
Along came a virus and hauled three nations out of recovery

Sandi Sesay's boss promised him three months' pay when he told the driver to stop coming to work. The goal was to prevent any possible spread of the Ebola virus at the Sierra Leone mine that employs him.

Two weeks later, Mr Sesay, 29, has yet to see any money from Dawnus Construction, a contractor at London Mining's Marampa iron-ore deposit. "I take care of my mother, my sisters and my wife and three children," he said. "How am I going to cope?"

The prospects for both Mr Sesay and Sierra Leone were bright before the outbreak. The economy was set to grow 14 per cent, almost three times faster than the average in sub-Saharan Africa. In Liberia and Guinea, investment in iron ore was luring billions of dollars and fuelling growth.

Then the first case of Ebola appeared in December. Initially tagged as a short-term phenomenon, the disease now threatens to cripple three economies with a combined gross domestic product of about $13bn (£8bn) – less than that of Afghanistan.



tion of the three countries in the coming months.

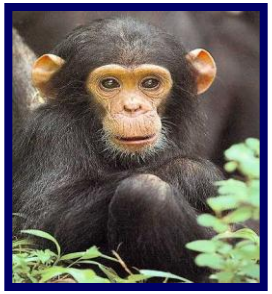
The past few months mark the first time that the disease, identified in 1976 near the Ebola River in what is now the Democratic Republic of Congo, has killed anyone in West Africa. The virus lives naturally in fruit bats and other wild animals. Humans get it from the animal's secretions and pass it on to other humans through bodily fluids.

The outbreak is isolating the countries. Nigeria's Arik Air suspended flights to Liberia and Sierra Leone after a Liberian man travelled by plane to Lagos and infected at least eight others with the disease after he collapsed at the airport.

British Airways and Kenya Airways also halted routes to Liberia and Sierra Leone, while Gulf carrier Emirates scrapped flights to Guinea.

"It's not just that international flights are cancelled and movement of people is restricted because of the quarantine measures," said the political analyst Lansana Gberie. "There's also a disabling psychological atmos-

Breaches in species barrier since 1976



Infection	Animal linked	Year 1st reported
Ebola virus	Bats	1976
HIV-1	Primates	1981
E. coli O157:H7	Cattle	`1982
Borrelia burgdorferi	Rodents	1982
HIV-2	Primates	1986
Hendra virus	Bats	1994
BSE/vCJD	Cattle	1996
Australian lyssavirus	Bats	1996
Influenza A(H5N1)	Chickens	1997
Nipah virus	Bats	1999
SARS coronavirus	Palm civets	2003
Influenza A(H1N1)	Swine	2009
MERS coronavirus	? Camel	2012
Influenza A(H7N9)	Chickens	2013

Nipah virus infection, Malaysia, 1998-1999

- Source: Chua KB, Journal of Clinical Virology, April 2003

Nipah virus outbreaks, humans, 1998 - 2008

Dates	Location	No. cases	No. deaths	CFR(%)
1998-1999	Malaysia;	265	105	40
1999	Singapore	11	1	9
2001	W. Bengal, India	66	45	68
2001	Bangladesh	13	9	69
2003	Bangladesh	12	8	67
2004	Bangladesh	29	22	76
	Bangladesh	36	27	75
2005	Bangladesh	12	11	92
2007	W. Bengal, India	5	5	100
2007	Bangladesh	15	8	54
2008	Bangladesh	11	6	54

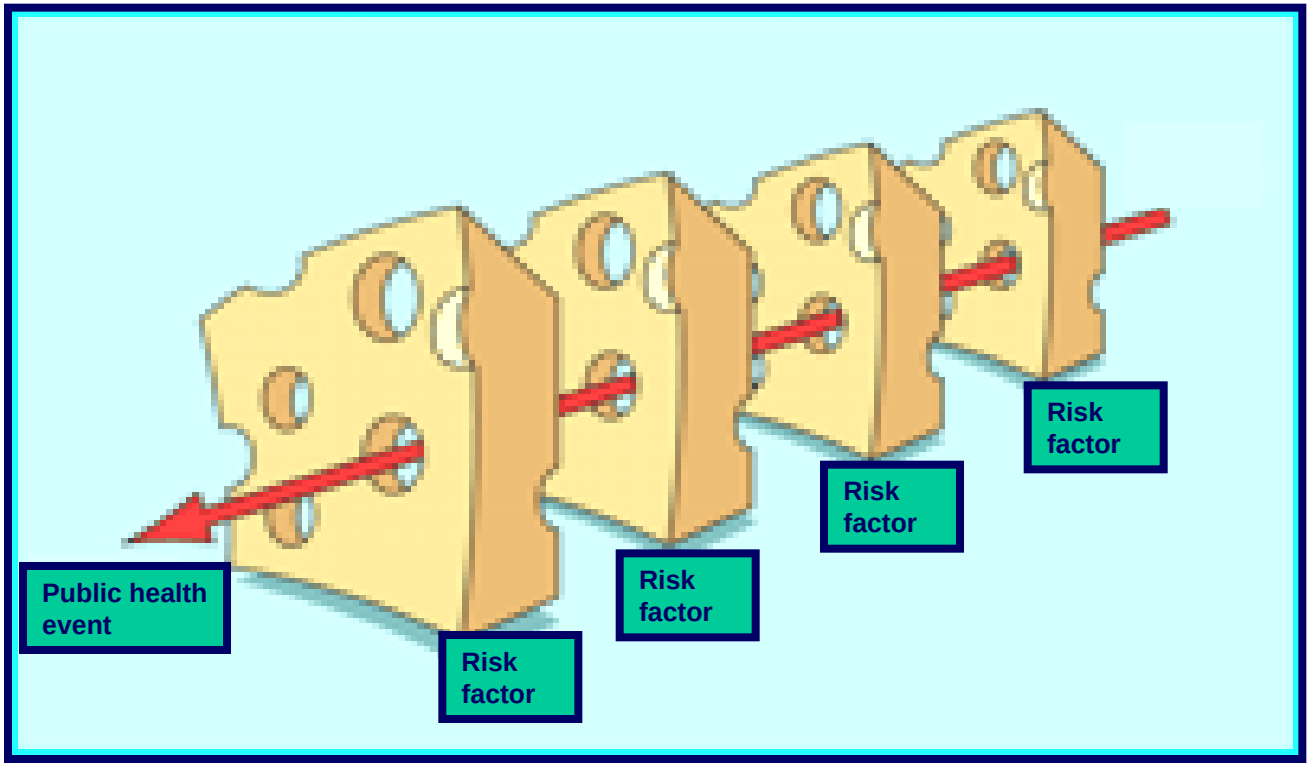
Changing Nipah virus epidemiology: Bangladesh and India

- ✓ **Human-to-human transmission first suspected 2001, hospitalized patients, India**
- ✓ **Human to human transmission suspected again in 2003, 2005, and 2007, Bangladesh**
  - **cases could not be linked to domestic animal exposure, including pigs**
  - **index cases not identified: one potential exposure to bat guano in palm wine**

Precautionary measures: community agreement to cover the collection containers

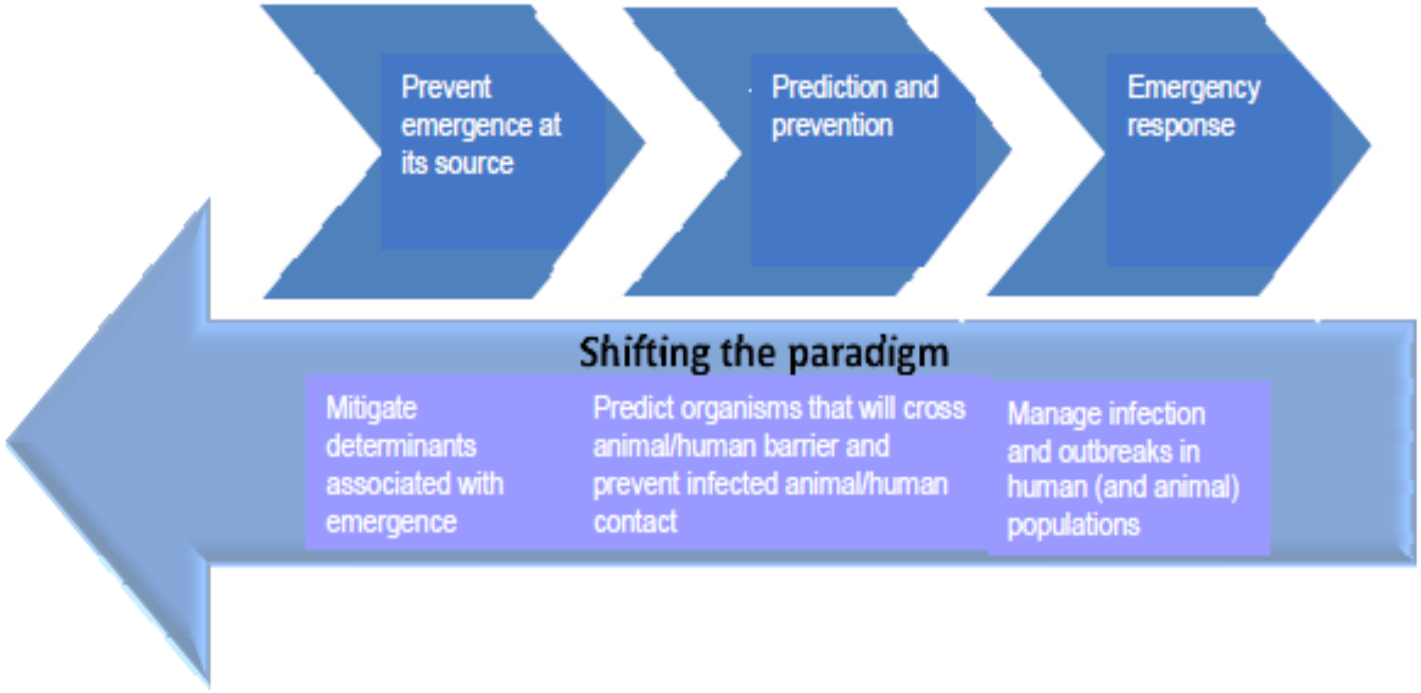
Community agriculture meeting

Swiss cheese events in epidemiology and public health



- *James Reason: BMJ* 2000;320:768-770

Shifting the paradigm from emergency response to prevention



Knowledge, attitude and practices study, 4 mining companies, DRC

Recognition of Impact of disease outbreak on mining companies:

ArcelorMittal, London Mining and African Minerals - postponed expansion plans and evacuated workers during current Ebola outbreak

Shares immediately fell in London trading

Clear recognition that a healthy community is a productive workforce

Community malaria control programmes reduce malaria-related work days lost by 94%; malaria-related spending at clinic by 76%;

Clear understanding of corporate social responsibility - "it is the right thing"

Must respond to NGO and other social pressures

KAP study, 4 mining companies, DRC

Clear understanding of potential barriers to improving current risk assessment/ mitigation/prevention

Costs because of demand for more services and replacement of government investment in public health

Corruption and lack of enforcement of regulations.

Clear understanding of facilitators to adopt risk assessment/mitigation and prevention strategies

Good practices in place in mining sites/camp to prevent, detect and control diseases.

Unambiguous company policies and enforcement (e.g. no bushmeat consumption in camp, provision of sufficient sources of protein in diet).

Ex Kulinda Afya – 11 Aug 2014

- One day desk top exercise: Katanga province DRC
- Objective: to raise awareness about emerging infections, their risk assessment, mitigation and prevention among senior field staff of mining companies and local government health officials.

Participants, Ex Kulinda Afya, 2014

- 25 participants: mining companies, provincial health authorities, animal health authorities, school of public health University of Lubumbashi

- Four groups with mining company, health and animal health representatives in each

Format of Ex Kulinda Afya exercise

Outbreak scenario (VHF) at mining site and town in a fictional African Country

Participants discussed and considered:

- Their initial response to outbreak of unknown disease
- Resources available to deal with an outbreak in community and in mining facilities
- Communication with and education of mine employees and surrounding areas
- How plans might be developed to mitigate the risk of future outbreaks

Conclusions of discussions during Ex Kulinda Afya

Internal risk mitigation procedures are effective in maintaining healthy workforce

External risk mitigation and preparedness procedures for outbreak alert and response are *ad hoc* and could be improved by:

- Regional level: increased cross working and coordination of public health activities between health representatives, the mining industries, and provincial representatives of non-governmental organisations.
- Local level: increased engagement and health education between the mining industries and the communities around the mining sites, with particular emphasis on risk assessment, mitigation, prevention and alert for zoonotic infections.
- Sharing of financial, technical and logistical resources between mining industries and the provincial health authorities:
  - equipment to assist in the isolation and quarantining of patients, and
  - access to laboratory testing

Potential role of mining companies in mitigation and prevention

Assessing risks from endemic and emerging infectious diseases in the communities and mining camps

Using available risk assessment resources, such as USAID toolkit, to optimise internal risk mitigation processes

Regular desktop scenarios/exercises to ensure external preparedness

Engaging (either individually or collectively) national and local governments as partners in infectious disease risk mitigation and prevention

Surveillance and alert networks in partnership with local communities

Health promotion/education/safe water/sanitation

Building trust

USAID Toolkit for assessment of internal risk management/mitigation processes

- To evaluate potential exposure points for diseases transmitted from animals and mitigate the risk of exposure
- Based on accepted best practice to address public health and environmental issues
- Adopting the practices could secure business continuity by securing the health of the workforce and neighbouring communities

There will always be a risk of emerging infections

There will always be a need to systematically consider emerging infectious diseases in business continuity plans

WHO: DRC Ebola outbr
Africa; cases jum

Filed Under: **Ebola**; **VHF**
Robert Roos | News F

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west
ses and deaths
ed in the past 5 days.

in the DRC has found 53 cases that
Ebola case definition, including 31 deaths,
WHO said in a statement today. That compares
with 24 suspected cases and 13 deaths reported on