Using Infection Prevention Resources Wisely – Examples From Ebola
Prof Shaheen Mehtar, Chair ICAN, UIPC, SUN, Cape Town S Africa
Broadcast live from IPAC Canada 2015 conference

Impact of poorly used resources
- Increase in mortality can be up to 15 times higher due to
- Lack of infrastructure- water, electricity
- Lack of administrative controls- no policies
- Lack of knowledge- surrounded by myth and superstition- no evidence
- Impact of HCW fear on patient care during EVD outbreak
  - Same gloves between patients
  - No drips put up on EVD cases
  - Deliveries not assisted - 100% mortality for mother and child
- Lack of preparedness!

Health profile of EVD affected countries

<table>
<thead>
<tr>
<th></th>
<th>2012</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Guinea</td>
<td>Liberia</td>
<td>Nigeria</td>
<td>Sierra Leone</td>
</tr>
<tr>
<td>Total population (millions)</td>
<td>11.45</td>
<td>4.19</td>
<td>169</td>
<td>6</td>
</tr>
<tr>
<td>&lt; 5y mort / 1 000 live births</td>
<td>101</td>
<td>75</td>
<td>124</td>
<td>182</td>
</tr>
<tr>
<td>Mort 15 &amp; 60 yr m/f ( / 1000 pop)</td>
<td>306/277</td>
<td>282/246</td>
<td>371/346</td>
<td>444/426</td>
</tr>
<tr>
<td>Total expenditure on health per capita ($) % of GDP</td>
<td>67 (6.3)</td>
<td>102 (15.5)</td>
<td>161 (6.1)</td>
<td>205 (15.1)</td>
</tr>
<tr>
<td>Doctors /10 000 pop (regional average 4.6)</td>
<td>0.03</td>
<td>0.1</td>
<td>4.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Nurses- /10 000 pop (regional average 12.6)</td>
<td>0.04</td>
<td>2.7</td>
<td>16.1</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Ebola outbreak- 2013
- Medical teams, epidemiologists, veterinary teams work in Africa
- Several NGOs work in Africa
- Most teams work in silos and communication with each other
- Why is it important to communicate with each other?

WHO- epidemic curve

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What happened in 2013?

- In 2012 and 2013 there was an outbreak of Ebola amongst the great apes in the DRC and surrounding areas which largely went unnoticed by the medical fraternity (over 5000 apes died)
- That was the epicentre of the current outbreak

The EVD spread to humans

- On 13 Dec 2013, a 2 year old child was diagnosed with Ebola in Guinea - the first human case in the current outbreak.
- Why a toddler?
- Not investigated further
- From Guinea, it spread to Liberia and Sierra Leone

Bats and humans

- Bats found to be carriers of Ebola
- The eat high hanging fruit in the forest
- Children and non human primates eat these fruit (foraging in the forest)
- Young adults hunt bats, small animals and non human primates for food
- "Bush meat" also consists of carcasses of dead animals.

### Ebola subspecies in humans and Non human primate outbreaks

<table>
<thead>
<tr>
<th>Year</th>
<th>Country</th>
<th>Ebola subspecies</th>
<th>Case fatality</th>
<th>Case fatality</th>
<th>Non primates</th>
<th>Subspecies</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>DRC</td>
<td>Zaire</td>
<td>32</td>
<td>14</td>
<td>44%</td>
<td>No published report</td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>DRC</td>
<td>Zaire</td>
<td>254</td>
<td>167</td>
<td>71%</td>
<td>No published report</td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>DRC</td>
<td>Zaire</td>
<td>19</td>
<td>53</td>
<td>63%</td>
<td>Gorillas</td>
<td>Zaire, Congo</td>
</tr>
<tr>
<td>2005</td>
<td>DRC</td>
<td>Zaire</td>
<td>12</td>
<td>13</td>
<td>46%</td>
<td>Gorillas</td>
<td>Zaire, Congo</td>
</tr>
<tr>
<td>2001-2002</td>
<td>Gabon</td>
<td>Zaire</td>
<td>62</td>
<td>53</td>
<td>82%</td>
<td>Gorillas</td>
<td>Zaire, Gabon</td>
</tr>
<tr>
<td>1996 (Jan-Apr)</td>
<td>Gabon</td>
<td>Zaire</td>
<td>31</td>
<td>21</td>
<td>68%</td>
<td>Chimpanzees</td>
<td>Zaire, Gabon</td>
</tr>
<tr>
<td>1996 (Dec)</td>
<td>Gabon</td>
<td>Zaire</td>
<td>315</td>
<td>254</td>
<td>81%</td>
<td>No published report</td>
<td></td>
</tr>
<tr>
<td>1994</td>
<td>Gabon</td>
<td>Zaire</td>
<td>1</td>
<td>1</td>
<td>100%</td>
<td>No published report</td>
<td></td>
</tr>
<tr>
<td>1997</td>
<td>DRC</td>
<td>Zaire</td>
<td>318</td>
<td>280</td>
<td>88%</td>
<td>No published report</td>
<td></td>
</tr>
</tbody>
</table>

### Geographic distribution of Zaire virus disease outbreaks in humans and animals

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Why was the spread amplified?

- Deforestation in Liberia and parts of Guinea
- The non human and human primate populations moved closer together
- Foraging for food in the same area
- Humans encroaching on ape territory and their resources.
- Climate change increased bat migration and roosting to residential areas (DRC & Guinea)

In Africa from Dec 2013

- Ebola outbreak
- Affected areas
- No longer active cases
- DRC separate outbreak

30 Sept, first case outside Africa!

And funding started coming!

- NOW IS A POLITICAL ISSUE
- American lives are at stake!
  - Money coming in!
  - Deployment of troops
  - Healthcare workers
  - Mobile laboratories
  - Mobilizing global resources
- Contain Ebola in West Africa to stop it spreading to USA & Europe!!

International Support since April 2014

- Not very clearly documented
  - Chinese CDC = 7500 HCW- laboratories, IPC
  - Cuba = 600 approximately
  - African HCW= 8000 sent by AU
  - UK = 750 HCW, laboratory staff, plus research team
  - USA via CDC= 1000 trainers, mentors, and researchers
  - NGOs= 2000

Use what ever is available!

- Healthcare workers in the field since May 2014
- Support arrived after late August when the first US citizen contracted Ebola!
- Working with limited resources

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Ebola Preparedness
Survey conducted between October to Dec 2014
Number of replies ............ 192
Number of countries .......... 45

Participating countries
Geographic Distribution of Respondents

Participating healthcare professionals
Medical Profession of Respondents

General Administration

<table>
<thead>
<tr>
<th>Administration</th>
<th>EVD receiving</th>
<th>Non EVD receiving</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPC represented on Hosp Team EVD</td>
<td>57</td>
<td>46</td>
</tr>
<tr>
<td>Alert system in place</td>
<td>61</td>
<td>51</td>
</tr>
<tr>
<td>Frontline staff aware of surveillance</td>
<td>56</td>
<td>43</td>
</tr>
<tr>
<td>IPC policy in place</td>
<td>57</td>
<td>48</td>
</tr>
<tr>
<td>Monitoring of clusters of infection</td>
<td>27</td>
<td>19</td>
</tr>
</tbody>
</table>

Alert systems in place but monitoring for clusters of infection inadequate

Communication

<table>
<thead>
<tr>
<th>Communication</th>
<th>EVD receiving</th>
<th>Non EVD receiving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information disseminated</td>
<td>45</td>
<td>33</td>
</tr>
<tr>
<td>Teaching material available</td>
<td>29</td>
<td>28</td>
</tr>
<tr>
<td>Public messaging systems in place</td>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td>Draft press release ready</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>Internal communication in place</td>
<td>42</td>
<td>37</td>
</tr>
</tbody>
</table>

Information available but poorly disseminated and inadequate teaching material circulated

Supplies

<table>
<thead>
<tr>
<th>Supplies and monitoring</th>
<th>EVD receiving</th>
<th>Non EVD receiving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adequate amount of PPE available</td>
<td>55</td>
<td>42</td>
</tr>
<tr>
<td>Adequate stocks of essential drugs &amp; PPE</td>
<td>36</td>
<td>22</td>
</tr>
<tr>
<td>Checking systems for supplies in place</td>
<td>37</td>
<td>33</td>
</tr>
</tbody>
</table>

Reasonable supplies but monitoring stores and supply chain needed improvement- responsibility for ordering!!

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![Image](https://via.placeholder.com/150)

**Education**

<table>
<thead>
<tr>
<th>Item</th>
<th>EVD receiving</th>
<th>EVD receiving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evidence of training in SP &amp; TBP</td>
<td>52</td>
<td>37</td>
</tr>
<tr>
<td>Training teams to train others</td>
<td>46</td>
<td>35</td>
</tr>
<tr>
<td>Audit of training teams independently</td>
<td>24</td>
<td>16</td>
</tr>
</tbody>
</table>

Training given but audit of the competency of the training teams not audited

**Facilities to deal with EVD**

<table>
<thead>
<tr>
<th>Item</th>
<th>EVD receiving</th>
<th>EVD receiving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designated team for high risk clinical care</td>
<td>27</td>
<td>11</td>
</tr>
<tr>
<td>Completed fit testing for N95 respirator</td>
<td>21</td>
<td>11</td>
</tr>
<tr>
<td>Ventilation – negative pressure</td>
<td>38</td>
<td>20</td>
</tr>
<tr>
<td>Surgical masks are available and used</td>
<td>53</td>
<td>67</td>
</tr>
<tr>
<td>N95 respirators</td>
<td>37</td>
<td>24</td>
</tr>
<tr>
<td>PAPR</td>
<td>25</td>
<td>9</td>
</tr>
</tbody>
</table>

Contributing to mixed messages-indicating airborne rather than droplet transmission based precautions

**IPC practices in place- good!**

<table>
<thead>
<tr>
<th>Item</th>
<th>EVD receiving</th>
<th>EVD receiving</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPC to produce evidence based GL</td>
<td>43</td>
<td>40</td>
</tr>
<tr>
<td>Isolation area for clinical evaluation</td>
<td>46</td>
<td>40</td>
</tr>
<tr>
<td>Safe movement of patients</td>
<td>47</td>
<td>32</td>
</tr>
<tr>
<td>Isolation facilities for patients</td>
<td>50</td>
<td>34</td>
</tr>
<tr>
<td>Environmental cleaning &amp; disinfection</td>
<td>33</td>
<td>17</td>
</tr>
<tr>
<td>HCW management satisfactory</td>
<td>51</td>
<td>37</td>
</tr>
<tr>
<td>Trained cleaning staff</td>
<td>33</td>
<td>24</td>
</tr>
<tr>
<td>Safe disposal of human waste</td>
<td>44</td>
<td>27</td>
</tr>
</tbody>
</table>

**Community involvement**

- **TALK TO THE TRADITIONAL LEADERS FIRST!**
  - Pivotal for containing outbreaks
  - There is
    - Fear
    - Stigma
    - Concern around witchcraft
    - Insecurity and suspicion
  - If the traditional heads of tribes or communities are aware of the risks, they can become great allies!
  - It enhances their power and presence in the community

**Transmission- household**

- EVD cases become more infectious as they move from the “dry” to the “wet” stage of the disease.
- Direct contact within families
  - Only those who were looking after a confirmed case of EVD actually developed EVD
  - Possibly due to lack of hand hygiene and contact with body fluids and excrement

Houses are quarantined for 21 days but some escaped

**Transmission within social circles**

- Transmission has occurred when EVD survivors returned home and, despite warning, had unprotected sex- protection required for 3 months- 5 households; 14 cases
- Transmission also occurred from female EVD survivors- 1 household, 4 cases
- One child infected from a wet nurse (anecdotal)
- Infections from several infected traditional healer- 137 cases in SL alone! Still continues today!

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WHO Weekly Rep, 10th June ‘15
http://apps.who.int/iris/bitstream/10665/174709/1/roadmapsitrep
Figure 1: Confirmed, probable, and suspected EVD cases worldwide [data up to 7 June 2015]

Guinea- 10th June ‘15

Current-Sierra Leone 10th June ‘15

Current -Liberia 29th April ‘15

Transmission: Clinical areas
- Not in Ebola Treatment Centres but in general clinical areas- not aware of EVD
- Poor IPC
  – Lack of equipment and PPE
  – Lack of segregation
  – Poor healthcare waste management
- Most HCW working in Ebola Treatment Centres so routine HCF closed down.
- Few untrained staff left behind to look after non EVD emergencies

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**HCW contact with EVD**

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
<th>%age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attack rate</td>
<td>37/429</td>
<td>9%</td>
</tr>
<tr>
<td>Physicians</td>
<td>4/13</td>
<td>31%</td>
</tr>
<tr>
<td>Nurses</td>
<td>22/212</td>
<td>10%</td>
</tr>
<tr>
<td>Technicians</td>
<td>7/62</td>
<td>11%</td>
</tr>
<tr>
<td>Others</td>
<td>4/111</td>
<td>4%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of contact</th>
<th>Number</th>
<th>%age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct</td>
<td>204</td>
<td>73%</td>
</tr>
<tr>
<td>Indirect</td>
<td>3</td>
<td>33%</td>
</tr>
<tr>
<td>Unlikely</td>
<td>63</td>
<td>64%</td>
</tr>
<tr>
<td>Unknown</td>
<td>9</td>
<td>56%</td>
</tr>
</tbody>
</table>

**Poorly managed HC Waste**

- Pit burning, dumping and too much PPE to handle!!
- 30/kg/bed/day is generated by an EVD case

**Difference in isolation facilities - 2014**

Rudimentary: Plastic buckets for disinfectant or even possibly vomit from patients stand in front of simple partitions put up to make cubicles for the ever-increasing number of patients

Isolator used to treat VHF at the RFH

**Differences in PPE – both effective?**

First, protect yourself.

**Dressing up for Ebola**

- “First-on-last off” principle?
- Do the outer gloves come off first? (CDC)
- Does the apron come off first? (WHO)
- Evidence for exposure occurs while removing PPE?

**Confusion about taking off PPE**

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Has the training been effective?

- Now extensive training, mentorship programmes and support in the field has been provided
- **173 healthcare workers trained in IPC**
- Fewer cases of transmission amongst the national HCW
- Only cases occurred in international groups
- NGO mentors found to be less knowledgeable than the nationals
- Many African HCW have been dealing with VHF in Africa for years- and have survived

### WHO report on HCW infection

<table>
<thead>
<tr>
<th>Country</th>
<th>Cases</th>
<th>Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guinea</td>
<td>167</td>
<td>16</td>
</tr>
<tr>
<td>Liberia</td>
<td>373*</td>
<td>10**</td>
</tr>
<tr>
<td>Sierra Leone</td>
<td>683</td>
<td>104</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1,123</td>
<td>124</td>
</tr>
</tbody>
</table>

*Data are confirmed cases and deaths only; apart from deaths in Sierra Leone, which include confirmed, probable, and suspected deaths. Dates ending for 26th April. **Data as of 19th February 26th April, ‘15

### Structures SL- UIPC at national level

- A national IPC coordinator appointed
- An IPC training coordinator appointed
- National offices being set up
- Massive IPC training programmes funded by the WHO & CDC and delivered by ICAN
- Getting there– slowly!

### Hand washing stations everywhere!

- Hand hygiene stations with 0.05% chlorine where everyone has to rub ones hands and allow to air dry
- Many HCW have had skin reactions

### Fears and Healthcare

- Many people will not go to ordinary HCF because of fear of exposure to EVD but mainly to chlorine.
- Several people died because of a lack of healthcare
- Not much staff available outside ETUs

- No protection for the person being sprayed

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Community triage

When a case is identified in the community
• A team of investigators and sprayers are dispatched
• The household is interrogated and the suspected case or cases are taken to the nearest ETU

About chlorine

• Highly toxic and dangerous!
• Usually accidental exposure
  – Train derailment
  – Wrong dilutions of concentrated chlorine powder or liquid
• WHO proposes ambient level of chlorine is
  – 0.034 ppm (0.1 mg/m$^3$) to protect the general population from sensory irritation and significant reduction in ventilatory capacity.
• Fatality - 400 ppm in 30 min and 1000 ppm in few minutes.
• Spraying has been in higher concentrations than the recommended dose

Workplace exposure

Workplace exposure limits include
• Short-term exposure of up to 15 min not to exceed 1 ppm (2.9 mg/m$^3$)
• Long-term exposure not to exceed 0.5 ppm (1.5 mg/m$^3$)

Injury to the respiratory tract

Converts from chlorine to hydrochloric acid and other toxic substances which destroy the lining of the respiratory tract and cause wheezing!

Chlorine effect on Eyes

• 10 volunteers’ eyes were irrigated with
  – 250 mL (50 seconds) of physiological salt solution (PSS), pH 6.4
  – distilled water (DW), pH 6.8
  – tap water, pH 6.8
  – or PSS with chlorine (0.5 mg/L) pH 6.4.
• Vital staining, fluorophotometric assessment, and confocal microscopy were performed before and after irrigation with each fluid
• Chlorine showed corneal irritation, ulceration and increase uptake of fluorescein

Chlorine study- SL preliminary data

S Mehtar, A Bulabula- SUN
H Nyandemoh, S Jambawai- SL

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Methodology

- Data on chlorine exposure collected retrospectively between March – May 2015
- HCW and Ebola survivors were interviewed using a questionnaire
- The number of exposure to chlorine spraying
- Adverse effects of chlorine recorded
  - Eyes
  - Respiratory
  - Skin

HCW exposure to Chlorine

<table>
<thead>
<tr>
<th>Item</th>
<th>N = 400</th>
<th>%</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>213</td>
<td>53</td>
<td>48.2 - 58.2</td>
</tr>
<tr>
<td>19-35 y of age</td>
<td>301</td>
<td>75</td>
<td>70.7 - 79.3</td>
</tr>
<tr>
<td>Working in ETU 4-6 months</td>
<td>278</td>
<td>69.5</td>
<td>64.7 - 73.9</td>
</tr>
<tr>
<td>Hygienist</td>
<td>188</td>
<td>47</td>
<td>42.0 - 52.0</td>
</tr>
<tr>
<td>Nurses</td>
<td>184</td>
<td>46</td>
<td>41.1 - 51.0</td>
</tr>
<tr>
<td>Dr</td>
<td>5</td>
<td>1.3</td>
<td>0.5 - 3.1</td>
</tr>
<tr>
<td>Chlorine Exposure</td>
<td>391</td>
<td>97.8</td>
<td>95.6 - 98.9</td>
</tr>
<tr>
<td>Wearing eye protection</td>
<td>325</td>
<td>81.5</td>
<td>77.2 - 85.1</td>
</tr>
<tr>
<td>Wearing skin protection</td>
<td>358</td>
<td>89.7</td>
<td>86.3 - 92.5</td>
</tr>
</tbody>
</table>

Exposure to chlorine amongst HCW

<table>
<thead>
<tr>
<th>Item</th>
<th>n=400</th>
<th>%</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous eye problems</td>
<td>39</td>
<td>9.8</td>
<td>7.1 - 13.2</td>
</tr>
<tr>
<td>Eye problems after exposure to chlorine</td>
<td>179</td>
<td>44.8</td>
<td>39.8 - 49.8</td>
</tr>
<tr>
<td>Overall eye problems</td>
<td>192</td>
<td>48.0</td>
<td>43 - 53</td>
</tr>
<tr>
<td>Overall respiratory symptoms</td>
<td>253</td>
<td>63.3</td>
<td>58.3 - 67.9</td>
</tr>
<tr>
<td>Skin irritation</td>
<td>152</td>
<td>38.0</td>
<td>33.3 - 41</td>
</tr>
</tbody>
</table>

Multiple chlorine exposure

<table>
<thead>
<tr>
<th>Condition</th>
<th>Multiple Chlorine Exposure</th>
<th>Single Chlorine Exposure</th>
<th>P value</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye</td>
<td>56.8% (109/192)</td>
<td>43.2% (83/192)</td>
<td>&lt;0.001</td>
<td>3.3 (2.18 – 5.02)</td>
</tr>
<tr>
<td>Chest</td>
<td>51.8% (131/253)</td>
<td>48.2% (122/253)</td>
<td>&lt;0.001</td>
<td>3.2 (2.04 – 4.99)</td>
</tr>
<tr>
<td>Skin</td>
<td>55.3% (84/152)</td>
<td>44.7% (68/152)</td>
<td>&lt;0.001</td>
<td>2.4 (1.59 – 3.64)</td>
</tr>
</tbody>
</table>

Comparison between HCW and Ebola Survivors

<table>
<thead>
<tr>
<th>Condition</th>
<th>HCW %</th>
<th>Ebola Survivors %</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye</td>
<td>45.0%</td>
<td>55.0%</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Chest</td>
<td>66.4%</td>
<td>33.6%</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

Chlorine

- There is no published evidence that chlorine spraying will reduce transmission of EVD.
- It is a HCW ritual based on fear of healthcare workers.
- It is messy and drips and spreads the virus!
- It is toxic particularly when burning used PPE soaked in chlorine!
Using Infection Prevention Resources Wisely – Examples From Ebola
Prof Shaheen Mehtar, Chair ICAN, UIPC, SUN, Cape Town S Africa
Broadcast live from IPAC Canada 2015 conference

Summary

- Do not forget the basic IPC principles
- Good IPC is of the essence - safe, and sensible!
- Keep the environment clean and dry!
- Vaccines are coming!

Save The Date
23 – 28 September, 2016

6th Infection Control Africa Network Congress 2016
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Indaba Hotel, Fourways, Johannesburg, South Africa
www.icanetwork.co.za

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