Abstract
Background: Five outbreaks of Ebola occurred in Uganda between 2000-2012. The outbreaks were quickly contained in rural areas. However, the Gulu outbreak in 2000 was the largest and complex due to insurgency. It invaded Gulu municipality and the slum-like camps of internally displaced persons (IDPs). The Bundibugyo district outbreak followed but was detected late as a new virus. The subsequent outbreaks in the districts of Luwero (2011-2012) and Kibaale (2012) were limited to rural areas.

Methods: Detailed records of the outbreak presentation, cases, and outcomes were reviewed and analyzed. Each outbreak was described and the outcomes examined for the different scenarios.

Results: Early detection and action provided the best outcomes and results. The ideal scenario occurred in the Luwero outbreak during which only a single case was observed. Rural outbreaks were easier to contain. The community imposed quarantine prevented the spread of Ebola following introduction into Masindi district. The outbreak was confined to the extended family of the index case and only one case developed in the general population. However, the outbreak invasion of the town slum areas escalated the spread of infection in Gulu municipality. Community mobilization and leadership was vital in supporting early case detection and isolations well as contact tracing and public education.

Conclusion: Palliative care improved survival. Focusing on treatment and not just quarantine should be emphasized as it also enhanced public trust and health seeking behavior.

Keywords: Ebola, Uganda

Introduction
Ebola virus disease (EVD) is a highly fatal emerging infection. It is an acute infectious febrile illness with no known cure. In 1976, the first outbreak occurred near a river called Ebola, in the Democratic Republic of Congo. Eight major epidemics occurred in DR Congo and Gabon and about 2000 cases were reported in the 25 outbreaks. Until 2013, the Uganda outbreak was the biggest and most complex. Some 425 cases and 224 deaths occurred including 31 health care workers. Five distinct species of Ebola have been identified but only 3 have caused disease outbreaks in humans. The virus is spread by direct contact with body fluids of cases (dead or alive). Contact with killed bats or non-human primates is also linked to transmission. The liver, spleen, thymus, and lymph nodes and macrophage rich lymphoid tissue, are targets for the Filoviruses. Liver damage leads to decreased production of clotting factors and impairment of coagulation. The adrenal gland maintains blood pressure homeostasis. Its damage leads to reduced production of steroids, sodium loss and hypovolaemia. In this paper we report our experience with the Uganda ebola epidemics and discuss them in the context of the current ebola outbreak in West Africa.

Methods:
During the Ebola outbreaks in Uganda we kept detailed records of the cases, presentation outcome. Laboratory confirmation was in South Africa, USA and Uganda. The cause of the Gulu epidemic of 2000 was confirmed by the South Africa Institute of Virology.

Fig 1 Map of Uganda showing ebola affected districts, 2000-2012

The camps were organised around trading centres or schools. Each camp had between 1000 and 10,000 inhabitants living in temporary huts with minimal sanitation and overcrowded. The camps were low grade towns and slums (Fig 2). Infrastructure had collapsed including schools and roads. The health care delivery system had deteriorated severely. There was an acute shortage of staff due to lack of motivation to go to insurgency areas. Traditional beliefs explained the deaths within the context of witchcraft. The clustering of deaths by
family lent support to this idea and fomented rumours, which the local media often capitalised on.

The epidemic started in a rural village around August 2000. A husband and wife died followed by members of the immediate households. It is after community members started dying that medical assistance was sought. Six weeks later the first cases were admitted to Lacor hospital. Three student nurses died that week to be followed a few days later by more nurses and patients. On the 14th October, the Sudan Ebola virus was confirmed by the South Africa Institute of Virology as the cause of the epidemic. Health workers panicked and fled leaving patients, most of who died in the first weeks of the outbreak. Some IDP camp dwellers commuted to Gulu town at night to avoid abduction by the rebels (Fig 3). They also feared ebola in rural areas. Unfortunately they brought ebola with them to the slum areas of Gulu Municipality. The urban invasion of ebola led to even more panic and scare. Cases escalated in the municipality.

Four more ebola outbreaks in the districts of Bundibugyo [2] (2007), Luwero (2011), Kibaale (2012) and Luwero in 2012 (Figure 1) have occurred. These outbreaks were basically rural and were ably contained.

The national response

The national response was comprehensive and multi-sectoral. His Excellency, the President mobilised the country for a national response. He directed all sectors to participate in the response. A national task force was appointed to coordinate the implementation of the national strategy. Similar coordinating mechanisms were set up at the district, county, subcounty, parish and village levels. Within weeks cascade training amplified by training of trainers had covered the country. Each village appointed leadership (Chairman and scout) to coordinate activities. The scout was the backbone of community based case search and isolation and public education. He was constantly on phone with the village team members and the district coordinating and surveillance. The entire response was coordinated by the district task force and surveillance centre (Figure 4).

A special mobilisation team was required for the IDP camps, most of who were at great risk in view of the overcrowding and insanitary slum like environment. Camp leaders of blocks of 100 families were recruited, trained to undertake active case search of suspected cases. A village scout (secretary) supported the team with record keeping and liaison with the district task force and surveillance office. They were actually hired for the period the outbreak lasted. Incentives were paid to those for each ebola case reported and revalidated. A truce was negotiated between the community and the rebel leaders to allow free access to their area of operation. All the stakeholders including the rebels, security personnel and task force members were part of the 160 committed individuals that patrolled the camps and organised containment activities including burials and the ambulance service. Soft power and negotiation and understanding were tools used with community in-
Single updated and jointly owned situation report was in liaison with the other levels and stakeholders. A patched immediately on request. The scout worked. A mobile team or a trained burial team would be despatched towards the end of the outbreak (Fig 5).

Case fatality improved to less than half towards the end of the outbreak (Fig 5). Some 393 cases in Gulu district alone occurred. The most affected areas were in the municipality (Table 1). The attack rates for the municipality from slum areas was the highest (15 fold) compared with other rural counties (Table 2). It took 6 months to contain the outbreak which had invaded the municipality through slums.

**Examples of successful mobilisation: the critical role of the community**

Community mobilisation was a central strategy of the national response. The community undertook early detection and swift reporting of suspected cases, enforced isolation at household level and maintained working relationship with the rebels. The community included the rebels and other stakeholders including opinion leaders and traditional healers.

The vital role of the community was demonstrated when a case escaped from Gulu hospital to her ancestral home in Masindi district. She belonged to an extended family of 73 members in the district. The local community imposed quarantine of these members and communicated quickly to the community. The outbreak to a single case occurred. This was the third outbreak which was isolated 6 months after onset. The isolation was carried out at the CDC, Atlanta. However, once the diagnosis was confirmed it took just 3 weeks to contain the outbreak. Community mobilisation and involvement contained the outbreak. Altogether 116 cases and 39 deaths were confirmed, including 14 health care workers. Unlike in the Gulu outbreak, the health care workers contracted infection before the isolation units were established.

Early detection was vital in limiting the Luwero 2011 outbreak to a single case. This was the third outbreak since 2000. On the 5th of May, a 13 year old girl was admitted to Bombo hospital with a 5 day history of fever, diarrhoea and vomiting. She was isolated and a blood sample taken. She developed vaginal bleeding and deteriorated and died the following day. The laboratory results from the Uganda Virus Research Institute, Entebbe confirmed the Sudan Ebola subtype. The results were communicated quickly to the community and containment was achieved.

The second ebola outbreak in Uganda occurred in Bundibugyo district in 2007. Although we were prepared this was another different experience. This was a new virus which was isolated 6 months after onset. The isolation was carried out at the CDC, Atlanta. However, the diagnosis was confirmed it took just 3 weeks to contain the outbreak. Community mobilisation and involvement contained the outbreak. Altogether 116 cases and 39 deaths were confirmed, including 14 health care workers. Unlike in the Gulu outbreak, the health care workers contracted infection before the isolation units were established.

Early detection was vital in limiting the Luwero 2011 outbreak to a single case. This was the third outbreak since 2000. On the 5th of May, a 13 year old girl was admitted to Bombo hospital with a 5 day history of fever, diarrhoea and vomiting. She was isolated and a blood sample taken. She developed vaginal bleeding and deteriorated and died the following day. The laboratory results from the Uganda Virus Research Institute, Entebbe confirmed the Sudan Ebola subtype. The results were communicated quickly to the community and containment was achieved. The outbreak was promptly contained with just a single fatality. Twenty four contacts were followed up with community support. This should be the ideal scenario for Ebola containment. This was a typically a rural ebola outbreak.

The fourth Ebola outbreak occurred in the district of Kibale. On the 12th July 2012, a 16 year old female from Kikaara village 55 km west of Kagadi. She was opening up forest land with her husband when she fell sick. She was admitted to Hapyo Health Centre III with complaints of fever, diarrhoea and vomiting, and a

---

**Table 1: Cumulative ebola cases by most affected parish, Gulu municipality, Uganda, 2000**

<table>
<thead>
<tr>
<th>Parish</th>
<th>Sub county</th>
<th>County</th>
<th>No. of cases*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kasubi</td>
<td>Bardege</td>
<td>Gulu Municipality</td>
<td>40</td>
</tr>
<tr>
<td>Krombe</td>
<td>Layibi</td>
<td>Gulu Municipality</td>
<td>36</td>
</tr>
<tr>
<td>Atibaar</td>
<td>Bungatira</td>
<td>Aswa</td>
<td>31</td>
</tr>
<tr>
<td>Bardege</td>
<td>Bardege</td>
<td>Municipality</td>
<td>19</td>
</tr>
<tr>
<td>Kanyonga</td>
<td>Bardege</td>
<td>Municipality</td>
<td>18</td>
</tr>
<tr>
<td>Techo</td>
<td>Layibi</td>
<td>Municipality</td>
<td>17</td>
</tr>
<tr>
<td>Ariaga</td>
<td>Laroo</td>
<td>Municipality</td>
<td>17</td>
</tr>
<tr>
<td>Pageya</td>
<td>Koro</td>
<td>Omoro</td>
<td>16</td>
</tr>
<tr>
<td>Patudat</td>
<td>Layibi</td>
<td>Municipality</td>
<td>15</td>
</tr>
<tr>
<td>Vanguara</td>
<td>Tece</td>
<td>Municipality</td>
<td>13</td>
</tr>
<tr>
<td>Pabbo Kal</td>
<td>Pabbo</td>
<td>Kilak</td>
<td>13</td>
</tr>
</tbody>
</table>

*Population data at sub county unknown to compute attack rates

---

**Table 2: Ebola Attack rates per 10,000 population by county, Gulu district, Uganda, 2000**

<table>
<thead>
<tr>
<th>County</th>
<th>Population, 2000</th>
<th>Confirmed cases</th>
<th>Attack rates</th>
<th>Relative risk*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Omoro*</td>
<td>111,886</td>
<td>19</td>
<td>1.6</td>
<td>1.0</td>
</tr>
<tr>
<td>Aswa</td>
<td>88,450</td>
<td>9</td>
<td>1.0</td>
<td>0.6</td>
</tr>
<tr>
<td>Mwoya</td>
<td>45,350</td>
<td>10</td>
<td>2.2</td>
<td>1.4</td>
</tr>
<tr>
<td>Gulu Municipality</td>
<td>45,768</td>
<td>109</td>
<td>23.8</td>
<td>14.9</td>
</tr>
<tr>
<td>Kilak</td>
<td>105,995</td>
<td>32</td>
<td>3.0</td>
<td>1.9</td>
</tr>
</tbody>
</table>

* Reference county
In this paper we describe our experience with several Ebola outbreaks in Uganda. Lessons to learn from these scenarios are that it was easier to stop the rural based epidemics. However in the case of Gulu the outbreak had become urbanised in the camps and also in town slums. As a result, attack rates increased steeply in town suburbs of Gulu (Table 1). These outcomes depend on the greater mobil- ity of the people and the differences between rural and urban. While the rural people have a communal spirit, social networks, are self-reliant and are easy to mobi- lise, the urban slum dwellers are individualistic, lack so- cial support, and are money dependant and difficult to mobilise in their overcrowded neighbourhoods. For instance community mobilisation was quick in Masindi in response to an Ebola patient who had escaped to the district from Gulu. The community imposed isolation of all 73 members of the index extended family. Of the 27 infections in the district 25 were from the extended family. Only one case came from the general population.

### Challenges in early diagnosis and detection

Besides the slum environment there were some techni- cal challenges which affected timely detection and iso- lation of cases. Some of these challenges are associated with some weaknesses in the application of the clinical syndromic based diagnosis. The clustering of deaths and bleeding manifestations and the death of health care workers is suspicious. However, there are many condi- tions that mimic Ebola in Uganda and include illnesses like malaria and other enteric and parasitic fevers. Some atypical cases presented without fever or bleeding. Fe- ver was absent in 15% of cases while bleeding tenden- cies were observed only in 30-53% of admissions in Gulu5. Bleeding manifestation was also rare in the West Africa outbreak19. About half of the suspected cases identified by the community surveillance were re- validated as true cases. Only half of the suspected and probable Ebola cases tested yielded positive laboratory results20 (Table 3). This low positive predictive value for the case definition and the laboratory tests is a major weakness affecting early diagnosis critical in initiating the national response. This is frustrating to the patients and the community. Laboratory tests and results helped in the confirmation of cases and the management of admission to isolation units and also the management of discharges. The sensitivity and the specificity of the tests are not known and need local revalidation.

### Role of early detection and action

Delays in early detection prolonged the spread of in- fection and late action in the districts of Gulu district (6 weeks); Bundibugyo (6 months); Kibaale (6 weeks). Most (75%) of the delays were at community level. Once the diagnosis was made, it took on average 5-17 days to contain the outbreak, except for the Gulu out- break. It took 66 days post confirmation to register the last case in Gulu. The Luwero outbreak of 2011 was contained during the first week. The critical role of early diagnosis and action was vital in containment.

### Discussion

In this paper we describe our experience with several Ebola outbreaks in Uganda. Lessons to learn from these scenarios are that it was easier to stop the rural based epidemics. However in the case of Gulu the outbreak had become urbanised in the camps and also in town slums. As a result, attack rates increased steeply in town suburbs of Gulu (Ta- ble 1). These outcomes depend on the greater mobil- ity of the people and the differences between rural and urban. While the rural people have a communal spirit, social networks, are self-reliant and are easy to mobi- lise, the urban slum dwellers are individualistic, lack so- cial support, and are money dependant and difficult to mobilise in their overcrowded neighbourhoods. For instance community mobilisation was quick in Masindi in response to an Ebola patient who had escaped to the district from Gulu. The community imposed isolation of all 73 members of the index extended family. Of the 27 infections in the district 25 were from the extended family. Only one case came from the general population.

### Table 3: Propotion of screened suspected cases revalidated as true cases by the supervisors, Uganda

<table>
<thead>
<tr>
<th>District</th>
<th>Identified by mobile teams</th>
<th>Revalidated by supervisors as cases</th>
<th>Regarded by supervisors as non-cases</th>
<th>Positive predictive value %</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gulu</td>
<td>1069</td>
<td>536</td>
<td>533*</td>
<td>50.1%</td>
<td>47.1 – 53.2</td>
</tr>
<tr>
<td>Bundibugyo</td>
<td>192</td>
<td>116</td>
<td>76</td>
<td>60.4%</td>
<td>53.1 – 67.3</td>
</tr>
<tr>
<td>Luwero</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>20.0%</td>
<td>–</td>
</tr>
</tbody>
</table>

*Those with all data and information available.
*** numbers few.

### Table 4: Laboratory results of suspected ebola cases, Bundibugyo, 2007, Uganda

<table>
<thead>
<tr>
<th>Laboratory status</th>
<th>Number</th>
<th>Proportion %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory positive</td>
<td>42</td>
<td>21.9</td>
</tr>
<tr>
<td>Laboratory negative</td>
<td>76</td>
<td>39.5</td>
</tr>
<tr>
<td>Laboratory negative but probable</td>
<td>74</td>
<td>38.5</td>
</tr>
<tr>
<td>Total tested</td>
<td>192</td>
<td>100</td>
</tr>
<tr>
<td>Total lab positive and probable combined (42+76)/192</td>
<td>116</td>
<td>60.4</td>
</tr>
</tbody>
</table>
Isolation and case management

Isolation and care plays a critical part in outbreak management. We demonstrated in the Gulu outbreak that isolation and care actually reduced mortality18,19. When the health care workers become more confident and motivated performance and patient survival improved. There was reduction in case fatality from 100% at the beginning of the outbreak to less than 50% as quality treatment was instituted over time (Fig 5). Hence care and survival and not just quarantine be emphasized.

Inadequate human resource was a major challenge in the operations of the isolation wards. Isolation wards are labour intensive; they need adequate, motivated and well rewarded workers.

Similarities with the West Africa outbreak

The Ebola outbreak in West Africa is very similar to the outbreak in Gulu. Both occurred in slum conditions in low resource countries. The Gulu outbreak started in a remote rural village near Southern Sudan, and entered the slums of Gulu municipality. It also entered the overcrowded slum like internally displaced persons (IDP) camps. In Gulu confirmation was done 3 weeks after onset. In West Africa the outbreak started at a remote common border of three countries but took months to spread. There was reduction in case fatality from 100% at the beginning of the outbreak to less than 50% as quality treatment was instituted over time (Fig 5). Hence care and survival and not just quarantine be emphasized.

The experiences of Uganda are relevant but should be put in their true perspective.

Africa potentially remains the epicenter of the burden created by Ebolavirus disease (EVD). Practical steps must be taken at country level particularly in critical areas.

First there is a need to strengthen leadership at community level for contact tracing and the early identification and isolation of cases. This was the backbone of the management of infection in the affected areas in the Uganda context. This was applied in the rural and later in the slum settlements in the Gulu municipality. Second, the need to strengthen laboratory capacity for early detection of the infection is critical. Third, focusing on supportive treatment and survival not just quarantine as such intervention reduced case mortality, isolated cases and increased public trust. Fourth, the need to eliminate the gaps in barrier nursing by institutionalizing infection control policy and plans in health facilities for ALL health workers and ALL their working environments. Fifth, the need to develop a human resource policy and plan that attracts rewards and retains workers. In order to support these critical areas there is a need to strengthen health care systems so that they can readily respond to the demands of future outbreaks.

There is need to strengthen international collaboration and partnerships to support the building of comprehensive health systems for surveillance and care. Regional teams and Centers of Excellence will need to be developed to support rapid response and provide timely emergency stocks, expertise and technical support. The experience in West Africa demonstrates that the outbreak if noted early can paralyze socioeconomic activities and impact on development and security. The best hope for low resource countries at least for now is early detection and action.

Acknowledgements

We acknowledge the contributions from all the organizations, institutions, professionals, health care workers, political and civic leaders and local communities and the support from the international agencies and partners. The following were key local contributors: Ministry of Health, Uganda; Office of the Prime Minister, Uganda; District Councils for Gulu, Masindi, Mbarara, Bundibugyo, Luwero, Gulu, Lacor and Mbarara hospitals; Bundibugyo hospital; Mulago hospital.

We also give special thanks to these international organizations. In particular: WHO, CDC, MSF, UNICEF, WFP, UNHCR, USAID, DFID, SIDA, DANIDA, Italian Cooperation, Chinese Red Cross, and AMREF.

References

11. WHO, Ebola outbreak in western Uganda - case counts - Centers... 2014
19. Hemorrhagic... 2015.
23. WHO, Ebola Outbreak in West Africa - Case Counts - Centers... 2014