PanAfrican Medical Journal

Research

A comparative assessment of the animal and human disease surveillance systems in the East-Central Africa infectious disease hot-spot, 2013: a case study of Uganda

Michael Muleme[1], Richard Mafigiri[1], Joyce Nguna[1], Doreen Birungi[1], John David Kabasa[1], John Baligwamunsi Kaneene[2,&]

[1]College of Veterinary Medicine, Animal Resources and Biosecurity, Makerere University, Kampala, Uganda, [2]Center for Comparative Epidemiology, Michigan State University, 736 Wilson Road, Room A-109, East Lansing, Michigan, United States of America

[&]**Corresponding author:**
John Baligwamunsi Kaneene, Center for Comparative Epidemiology, Michigan State University, 736 Wilson Road, Room A-109, East Lansing, Michigan, United States of America

Cite this: The Pan African Medical Journal. 2017;27 (Supp 4):19.
DOI: 10.11604/pamj.supp.2017.27.4.12192
Received: 08/03/2017 **- Accepted:** 13/05/2017 **- Published:** 27/08/2017
Key words: Disease surveillance, disease hotspots, Africa, shortfalls, strength

Corresponding author: John Baligwamunsi Kaneene, Center for Comparative Epidemiology, Michigan State University, 736 Wilson Road, Room A-109, East Lansing, Michigan, United States of America (kaneenej@cvm.msu.edu)

This article is published as part of the supplement **"Capacity building in Integrated Management of Transboundary Animal Diseases and Zoonoses"** sponsored by **Capacity building in Integrated Management of Transboundary Animal Diseases and Zoonoses (CIMTRADZ)**

Guest editors: Margaret L Khaitsa, John B Kaneene

Available online at: http://www.panafrican-med-journal.com/content/series/27/4/19/full

Abstract

Introduction: timely management of diseases in developing countries is evidently affected by limitations of public health systems, which should be addressed to establish holistic surveillance plans.
Methods: this study aimed to compare the status of the veterinary to the human surveillance system in Uganda, as well as to assess the suitability of the two systems in dealing with emerging infectious diseases relative to the Integrated Disease Surveillance and Response core targets.
Results: the human health sector had health units of all levels involved in disease surveillance and laboratory disease detection, as well as an efficient mobile-based data transfer system for priority diseases which was used by 74 of the 75 health units (99%; 95% Confidence Interval (CI): 93, 100) involved in the study. Conversely, the veterinary sector lacked a real-time data management program and had limited functionality with few laboratory infrastructures at units (1 out of 11) below the District Veterinary Office. More veterinary units (64%; 95% CI: 35, 85), however, targeted zoonotic diseases compared to human health units (12%; 95% CI: 6, 21) which underscores the need to integrate zoonotic disease surveillance in both human and animal health services. Passive surveillance, data management personnel and communication between the veterinary and human health units were below the Integrated Disease Surveillance and Response core targets in both human and veterinary units.
Conclusion: data management, communication between veterinary and human units, animal disease laboratory units and veterinary personnel at sub-counties were inadequate and should be improved to establish holistic surveillance systems.

Introduction

Emerging infectious diseases cause the second highest proportion of deaths globally [1]. The highest death rate due to infectious causes, estimated at about 500 deaths per 100,000 people, is reported be occur in Sub-Saharan Africa [2]. The occurrence of most of these emerging infectious diseases in Sub-Saharan Africa is driven by socio-economic and ecological changes, as well as under-developed public health systems [3, 4]. In a bid to improve surveillance in Africa, the World Health Organization (WHO) rolled out a framework for improving epidemiologic surveillance which covered surveillance core functions of disease detection, reporting, analysis, communication and preparedness, among others [5, 6]. The framework (if adopted) can be an easy way for public health managers to effectively address health challenges. However, its implementation could be affected by the absence of basic surveillance infrastructure, like laboratories for disease detection. It's now common knowledge to all stakeholders in animal, human and environmental health that the best defense towards emerging and re-emerging infectious diseases is having functional surveillance systems [7]. However, early response and management of communicable diseases is evidently affected by barriers, like inadequate laboratories and under-developed public health systems [8, 9]. The challenges of improving surveillance systems are further complicated by the increasingly important move to holistically use the One-Health approach in dealing with public health emergencies, especially in countries where human health has always been the epitome of public health policy [10-12]. There are currently many organizations, like the World Health Organizations' Global Outbreak Alert and Response Network, set-up to improve public health systems through the holistic One-Health approach [12, 13]. However, there has been limited reviews on operational routine surveillance for animal and human health in Sub-Saharan Africa, and the suitability of these systems, in their current state, to implement a holistic integrated human and animal surveillance plan [14]. This study's aim is to compare the current status of the veterinary surveillance system to that of the human surveillance system, as well as to assess the ability of the two systems in dealing with emerging infectious diseases. The specific objectives of this study were to: 1) carry out a comparative assessment of the status of current veterinary surveillance system and the human surveillance systems with specific emphasis on the types of surveillance systems and target diseases for surveillance; 2) to evaluate the status of surveillance support structures available for communication, laboratory diagnosis and data management; and 3) to appraise the current status of human and animal disease surveillance in reference to core targets set by WHO [15]. Any existing integration between animal and human disease surveillance, especially in regard to zoonotic disease surveillance, disease management, inter-disciplinary communication, and data dissemination, was also highlighted and described.

Methods

Study area

The study was carried out in Uganda due to the repeated occurrence of many zoonotic infections and communicable disease outbreaks, and because it's located within the East-Central Africa infectious disease hot-spot. The human and animal systems in Uganda are run under a semi-decentralized system with central ministries of health and agriculture, animal industry and fisheries providing a general oversight, especially with regards to core functions of disease surveillance and data management. However, all planning, budgeting and service delivery is managed by the district administration under a Chief Administrative Officer (CAO). The District Veterinary Officer (DVO) and District Health Officer (DHO) all report issues of service delivery to the CAO.

Study design

The study was carried out in a total of 13 out of the 111 districts from all the four regions (Northern (nUg), Eastern (eUg), Western (wUg) and Central (cUg)) of Uganda [16]. These included: Gulu, Lira and Arua in nUg; Lyantonde, Mbarara, Hoima and Bushenyi in wUg; Kampala, Wakiso and Nakasongala in cUg; and Jinja, Iganga and Mbale in eUg. Kampala, Mbale, Mbarara and Arua were purposely selected because they had regional referral hospitals. The other two districts in each region were randomly selected. A third district was selected from the wUg because it's bigger than the rest of the regions. We aimed to administer questionnaires and carry out guided tours at all levels of human [16] service delivery (Regional hospital, District hospital, Health Centre II, III, and IV) and animal health administration (sub-county and district veterinary offices) in all the districts selected for this study. The aim of the study was explained to all respondents, and informed consents were obtained from each of them before being recruited in to the study. A structured questionnaire to obtain surveillance information and to comparatively assess the status of disease surveillance support infrastructure. Guided tours of premises were carried out to obtain further details the functioning and status of the laboratory facilities. This study was done under ethical approval of the Ethics Committee at Makerere University, College of Health Sciences.

Statistical analysis

All scribed data were entered into Microsoft Excel and categorized. The proportion of human and veterinary health units engaged in all aspects of disease surveillance, as well as Wilson score confidence limits for these proportions, were computed in OpenEpi. The Wilson Score confidence limits are corrected for total number of units in the study areas [17]. Population reference of 134 veterinary units (the total number of sub-counties in the districts sampled with 1 count added per district to cater for the DVO) [16] and 896 human health units (the total number of human health units in the selected districts) [18] for computing Wilson score confidence intervals for all reported proportions [17]. Comparison of the proportions of human and veterinary health units engaged in the different aspects of disease surveillance was done using the "comparison of two proportions" function in MedCalc, which was adapted from previously published work [19, 20]. The MedCalc "comparison of two proportions" function computes the difference between proportions and adjusts the confidence interval using the sample size of the two proportions [19, 20]. Graphical description of the data was done using Rstudio 3.1.0 statistical software [21]. Furthermore, a one-sample test for binomial proportions was done in OpenEpi [22] to compare proportions of either human or veterinary health units involved in different aspects of disease surveillance to the integrated disease surveillance and response (IDSR) core targets set by the WHO, which included passive surveillance coverage, weekly and monthly reporting, presence of data management personnel, electronic data transfer, communication with other health units and laboratory coverage in 100%, 80%, 80%, 80%, 80% and 90%, respectively, of all health units [15].

Results

A total of 75 human health units from all the 13 districts were available to participate in this study, while animal health personnel from 11 out of the 13 districts were available for this study. Additionally, DVO's were available and mandated to carryout routine disease surveillance in 10 out of the 11 districts that participated in this study, however no sub-county veterinary offices were available. There was a sub-county veterinary office in 1 of the 11 districts, but it was momentarily run by the DVO.

Comparison of the current status of the veterinary surveillance systems to the human surveillance system in Uganda

Types of surveillance systems

All the four different types of disease surveillance are carried out at human and veterinary health units. The proportion of human health units, as well as that of veterinary health units involved in different forms of disease surveillance, is shown in Table 1. There was no statistically significant difference in the proportion of human and veterinary health units involved in the various types of disease surveillance.

Table 1: comparison of the proportion of human and animal health units carrying out the different types of disease surveillance in Uganda, May to October 2013

Types of disease surveillance	Proportion of human health units involved, N=75		Proportion of animal health units involved, N=11		Percentage Difference in proportions (95% CI)	χ^2	P value
	n	% [95% CI])	n	% [95% CI]			
Disease specific	69	92 [84, 96]	11	100 [74, 100]	8 (-21, 17)	0.9	0.334
Syndromic	56	75 [64, 83]	8	73 [43, 90]	2 (-22, 37)	0.0	0.887
Passive	68	91 [82, 95]	9	82 [52, 94]	9 (-9, 43)	0.8	0.359
Active	62	83 [73, 90]	10	91 [62, 98]	8 (-25, 22)	0.5	0.501

N is the total number of health units sampled. χ^2 is chi-square

Target diseases

The proportion of human health units targeting zoonotic diseases other than tuberculosis under disease-specific (12%; 95%CI: 6, 21), passive (4%; 95%CI: 1, 11) and active surveillance (5%; 95%CI: 2, 13) types was lower than that of veterinary health units (disease-specific (54%; 95%CI: 35, 85); passive (54%; 95%CI: 35, 85); active (36%; 95%CI: 35, 85)). The major zoonotic diseases targeted by both human and animal surveillance systems were rabies, avian influenza and brucellosis. Only human surveillance systems targeted viral hemorrhagic fevers (VHF), whereas trypanosomiasis and anthrax were part of only veterinary surveillance. Tuberculosis was part of both immunizable target diseases and HIV related syndrome surveillance. It was targeted at all human health units visited.

Status of support structures available for surveillance

Laboratory facilities

All field human health units except the DHO and the Epidemiology and Surveillance Division had functional laboratory diagnosis (89% (95% CI: 80, 94)). Similarly, 9 of the 11 (82% (95% CI: 52, 97) veterinary units visited during this study had veterinary laboratories. During our guided tour of the premises, we observed that the laboratories in 7 out of the 9 facilities were basic and carried out only light microscopy and fecal floatation for detection of parasite eggs. They also had no laboratory staff, and diagnosis was performed by the DVO. Only 2 of the veterinary facilities visited (NADDEC laboratory and another district laboratory serving as a regional diagnostic laboratory) carried out a variety of laboratory tests and had laboratory staff. Only 1 of the 11 districts visited during this study had a functional laboratory at sub-county level. The distribution of human and veterinary laboratories at different levels of health service included in this study is shown in Figure 1. All human health units visited referred laboratory diagnosis to a higher level of health service delivery, i.e. HC II to HC III and HC IV, hospitals and specialized laboratories like the Central Public Health Laboratory, Infectious Disease Institute and Uganda Virus Research Institute. All DVO visited, referral laboratory diagnosis in veterinary health units was made to the National Animal Disease Diagnostics and Epidemiology Centre and to regional laboratories. The regional laboratories mentioned by respondents in this study included Kiboga regional laboratory (wUg), Masaka regional laboratory (cUg), Mbale regional laboratory (eUg), Mbarara regional laboratory (wUG) and the Central Diagnostic Laboratory in Makerere University (cUg). The regional laboratories were set up at formerly district veterinary laboratories, and are managed under a project run by Japan International Cooperation Agency (JICA) as revealed during guided tour of the laboratories.

In process

Figure 1
number of human and veterinary health units that had laboratory facilities or services, and the number of units visitedes Studies

Communication

The telephone was the most used means of communication amongst both human and veterinary health units involved in this study. The other methods of communication and the proportion of human and veterinary health units is shown in Table 2. A total of 10 out of the 75 (13% (95% CI: 7, 22)) health units communicated with veterinary health units, while 6 out of the 11 (55% (95% CI: 28, 79)) veterinary health units communicated with human health units. Table 2 gives a detailed description of the methods used between human and veterinary health units.

Table 2: methods of communication used by human and veterinary health units for disease surveillance in Uganda, May to October 2013

Variable	Methods	Proportion of human health units, N=75 (%)		Proportion of animal health units, N=11 (%)		Difference in proportion % (95% CI)	χ^2	P value
		n	%(95% CI)	n	%(95% CI)			
Communication between primary and secondary units	Tel.	74	99 (93, 100)	10	91 (62, 98)	8 (-2, 40)	3.1	0.008
	Email	28	37 (27, 49)	6	55 (28, 79)	18 (-15, 49)	1.3	0.267
	Fax	0	0 (0, 5)	1	9 (2, 38)	9 (-1, 41)	6.7	0.009
	Regular meetings	41	55 (43, 65)	5	45 (21, 72)	10 (-23, 41)	0.4	0.537
	Meetings if needed	11	15 (8, 24)	6	55 (28, 79)	40 (7, 69)	9.4	0.002
	Hardcopy letters, circulars	27	36 (26, 47)	6	55 (28, 79)	19 (-14, 50)	1.4	0.229
Communication between human and veterinary health units	Tel.	4	5 (2, 13)	5	45 (21, 72)	40 (10, 71)	16.7	<0.001
	Email	1	1 (0, 7)	3	27 (10, 57)	26 (4, 60)	15.5	<0.001
	Fax	0	0 (0, 5)	0	0 (0, 26)	0	-	
	Regular meetings	0	0 (0, 5))	0	0 (0, 26)	0	–	
	Meetings if needed	4	5 (2, 13)	3	27 (10, 57)	27 (5, 61)	20.7	<0.001
	Hardcopy letters, circulars	2	3 (1, 9)	0	0 (0, 26)	3 (-26, 10)	0.3	0.564

N is the total number of health units sampled. χ2 is chi-square, Tel. is telephone

Data collection, transfer and storage

Surveillance data collection, storage and transfer was mainly done on hand written/hard copies in the majority of the human and veterinary health units included in this study, as shown in Table 3. The proportion of veterinary health units using computer based electronic storage and transmission of surveillance data was higher than that of human health units. However, 74 of the 75 (99% (95% CI: 93, 100)) human health units used a phone based data transmission software (MTRAC) to report surveillance data about priority diseases.

Table 3: surveillance data collection, storage and transfer in Uganda, May to October 2013

Data management	Methods	Proportion of human health units N=75		Proportion of animal health units N=11		Difference in proportion % (95% CI)	χ^2	P value
		n	%(95% CI)	n	%(95% CI)			
Data collection	Hand-written	75	100 (95, 100)	8	73 (43, 90)	19 (5, 61)	20.7	<0.001
	Questionnaire	29	39 (28, 50)	4	36 (15, 65)	3 (-4, 31)	0.0	0.850
	Computer	5	7 (3, 15)	1	9 (2, 38)	2 (-10, 34)	0.1	0.812
	Audio and video	2	3 (1, 9)	1	9 (2, 38)	6 (-5, 38)	0.9	0.332
Data storage	Hardcopy	75	100 (95, 100)	11	100 (74, 100)	0	-	-
	Computer	14	19 (11, 29)	9	82 (52, 95)	63 (28, 81)	19.1	<0.001
	Audio and video	1	1 (0, 7)	1	9 (2, 38)	8 (-2, 40)	3.1	0.080
Data transfer	Hardcopy	75	100 (95, 100)	11	100 (74, 100)	0	–	–
	Computer	25	33 (24, 45)	7	64 (35, 85)	31 (-4, 58)	3.9	0.048
	Audio and video	1	1 (0, 7)	0	0 (0, 26)	1 (-28, 7)	0.1	0.741

N is the total number of health units sampled. χ2 is chi-square

Data reporting and stakeholders

Data management in 10 out of the 11 veterinary units visited was done by the DVO inferring limited (9% (95% CI: 2, 38)) skilled data personnel in this sector. Only the National Disease Diagnostics and Epidemiology center had a surveillance data manager who receives data from all the districts. Similarly, only 29% (95% CI: 20, 40) of human health units had specialized surveillance data managers. All veterinary and human health units visited reported surveillance information. There was no weekly reporting of surveillance data among veterinary health units, while weekly reporting was done in 83% (95% CI: 73, 90) of the human health units visited. A total of 82% (95% CI: 52, 95) of the veterinary health units made monthly reports and 45% (95% CI: 21, 72) made quarterly reports, while 85% (95% CI: 76, 92) of the human health units made monthly reports and 61% made quarterly reports. Reports on special programs, disease outbreak reports and annual summaries were made by 82% (95% CI: 52, 95), 64% (95% CI: 35, 85) and 55% (95% CI: 28, 79) of the veterinary health units. On the other hand, 45%

(95% CI: 35, 57), 56% (95% CI: 45, 67) and 67% (95% CI: 55, 76) of human health units made special program reports, disease outbreak reports and annual summaries, respectively. The report formats were mainly hard copy reports in both the veterinary (100% (95% CI: 74, 100)) and human health units (97% (95% CI: 91, 99)). Only 64% (95% CI: 35, 85) of the veterinary health units and 48% (95% CI: 37, 59) of the human health units generated electronic reports. In all the human and veterinary health units visited, the stakeholders mentioned included communities, local governments, their respective ministries, politicians and non-government organizations. However, none of the human health units mentioned veterinary health units as stakeholders and vice versa. Among both human and veterinary health units, passive surveillance, data management personnel and communication between animal and human health units were below the IDSR targets. Weekly reporting was also below the IDSR target among animal health units, while computerized data transfer was below IDSR target for human health units. Monthly data reporting, laboratory coverage and communication between primary and secondary units met the IDSR target in both human and veterinary health units.

Discussion

The strengths and shortcomings of the animal health and human health disease surveillance systems in Uganda discussed in this study highlight important aspects that could be utilized or improved in the implementation of a "One Health" IDSR program. For instance, shared strengths of widespread laboratory coverage, monthly reporting and constant communication between primary and secondary health units could be important foundations to utilize in implementing a one health IDSR program. On the other hand, the limited data management personnel and communication between veterinary and human health units as well as the limited focus on zoonotic disease surveillance in human health units, and the absence of structured surveillance programs at sub-county level in the veterinary sector would have to be addressed if an efficient one-health IDSR program was to be implemented. The involvement of all levels of human health units in disease surveillance compared to animal disease surveillance, which was mainly done at district, regional and central level with the majority (10 out of 11) of the districts involved in this study having no veterinary personnel engaged in disease surveillance at sub-county level, could be due to the introduction of the National Agricultural Advisory Services (NAADS), where most veterinary/para-veterinary staff get recruited as service providers. The NAADS program is mandated to increase farmers' access to information and knowledge to improve agricultural production and profitability and does not carry out any disease surveillance roles [23]. This leaves the efficiency of the current animal health service system, which is made up of district veterinarians questionable [24]. The animal health system could therefore be suffering late recognition of disease occurrence, as well as delayed response to outbreaks. This underscores the need for re-establishing sub-county or county veterinary service delivery in majority of the districts. The poor grass root coverage of veterinary disease surveillance in Uganda has previously been published in a study that specifically looked at the piggery value chain [24]. This study noted that most of the veterinary personnel serving communities were engaged in private business as drug stockists, while the rest were para-veterinarians with limited skills in disease surveillance [24]. These village-based veterinarians and para-veterinarians had limited engagement in disease surveillance, and were not obliged to report the field disease conditions they encountered to the DVO. Perhaps a mechanism of increasing the involvement of private veterinarians and para-veterinarians in disease surveillance needs to be forged. The presence of the different forms of surveillance in equally similar proportions at both the animal and human health systems is an indication that disease monitoring and control is still among the core functions of the two systems. The proportion of animal health units involved in zoonotic disease surveillance was greater than that of the human health units. This could be due to the presence of a department of livestock health and entomology within the Ministry of Agriculture, Animal Industries and Fisheries (MAAIF), as well as, an agency for controlling Trypanasomiasis [25]. However, to synchronize zoonotic disease surveillance in the human and animal ministries, there is need to set up a joint zoonotic disease unit.

The wide laboratory coverage in the human health system could be due to distribution of human health units at village, sub-county, county and district level, and the well streamlined delivery of services made at each level of health unit, which are based on the resources and skills of staff that run those facilities. The human laboratory surveillance has a number of projects that have provided support services for sample collection, sample transportation and training of health workers [26]. This could be the reason behind the systematic laboratory referral system which is essential for efficient detection and diagnosis of diseases. The limited functionality of the veterinary diagnostic laboratories at district level is a result of limited laboratory support. The more advanced laboratory testing being carried out at regional veterinary laboratories and NADDEC is due to support in both human resource and infrastructural improvement through development partners, especially JICA, which provided the grant for setting up regional diagnostic laboratories and a central diagnostic facilities at NADDEC and Makerere University [27]. However, both human and veterinary diagnostic laboratories seemed to refer cases to the CPHL, which could be an indication of possible integration of public health laboratory diagnosis. None the less, there is need to integrate animal morbidity and mortality data in public health surveillance if early diagnosis of zoonotic diseases is to be achieved [28]. Communication between primary and secondary facilities in both the human and veterinary system by telephone was reasonably high, possibly due to the cheap and widespread telephone coverage in Uganda, which is estimated to be over 70% of the entire country [29]. Communication through email and internet was scarce, which could be due to costly and uneven internet coverage in Uganda [30]. The limited communication between human and veterinary unit's points to a lack of regular integration of the two systems with the teams from the two sectors only working together when outbreaks occur. This concurs with the current arrangement of having veterinarians as part of the National Rapid Response Teams formed to control disease outbreaks [31]. There is, however, need for regular integration of surveillance activities and communication of surveillance information between the human and animal disease surveillance systems. The low proportion of human health facilities using computer based data-collection, storage and transfer compared to the veterinary facilities could be due to the lack of absence of veterinary staff at units below the district, whereas the human health data included lower levels of health units where computer and internet facilities are most likely non-existent. On the other hand, the majority of human health units (74 out of 75) included in this study used a real time mobile phone based method to transfer weekly surveillance data on priority diseases. There was no such a system for animal disease surveillance. Mobile phone animal disease surveillance has previously been implemented in Sri Lanka, a low income country with conditions similar to those in Uganda [32] where the method was found to increase reporting and interactions between animal and human health personnel, as well as other stakeholders [32]. Mobile phone disease surveillance was also found to be acceptable and feasible under low-income setting [32]. Overall, both human and animal health surveillance systems had inadequate number of personnel to handle surveillance data with health workers, especially at lower level health facilities left to handle both health service delivery and health data which could ultimately affect the quality of data generated. The majority (>80%) of health facilities involved in this study reported surveillance data every month, which could indicate constant generation of surveillance data that could be essential in early detection and response to disease outbreaks. However, there seems to be less integration of data generated between the human and animal disease surveillance systems because the two systems did not share their routinely generated reports with each other. Additionally, the units generated mainly hard copy reports which may possibly not be easy to share compared to electronic reports.

Conclusion

Both the human and veterinary disease surveillance systems were hindered by inadequate data management personnel, limited communication between the veterinary and human health sectors, as well as the absence of real-time surveillance reporting systems for all components of disease surveillance, which may affect the integration of the two systems. These components were also below the IDSR core targets set by WHO. The human surveillance system in Uganda is highly functional with health units of all levels involved in surveillance. They have a widely used mobile-based data transfer system for priority diseases, and functional laboratory facilities at all levels of health service delivery, unlike the veterinary surveillance system which has limited functionality and no laboratory infrastructure at units below the DVO.

This underscores the need to upgrade laboratory facilities and recruit qualified laboratory personnel at the district level, and to set up data management programs at all levels of veterinary service delivery, as well as the recruitment of veterinary personnel at sub-counties in Uganda. Conversely, more veterinary health units targeted zoonotic diseases and compared to the human surveillance systems, which underscores the need to integrate zoonotic disease surveillance in both human and animal health services.

What is known about this topic

- Level of coverage of passive disease surveillance and trend analysis of priority diseases in human health units;
- The proportion of human outbreaks reported on time and proportion of human health units submitting monthly reports on time.

What this study adds

- This study adds a one-health aspect to disease surveillance by comparing the status of human disease surveillance to animal health surveillance thus highlighting the strength and limitations of both systems which may be helpful for implementing a one-health surveillance system in Africa;
- This study further assesses the support systems of the human and animal surveillance ranging from data management, communication, reporting and laboratory capacity which provides details on limitations of disease surveillance;
- The components from this survey are further compared to integrated disease surveillance core targets set by the World Health Organization providing further appraisal of the study results.

Competing interests

The authors declare no competing interest.

Authors' contributions

All authors participated in the design and data collection during the study as well as in writing this manuscript. All authors have read and agreed to the final version of this manuscript and have equally contributed to its content and to the management of the case.

Acknowledgments

The authors would like to acknowledge the help and cooperation of all health workers at the districts, and the USAID-HD for funding.

References

1. Fauci AS, Touchette NA, Folkers GK. Emerging Infectious Diseases: a 10-Year Perspective from the National Institute of Allergy and Infectious Diseases. Emerging Infectious Diseases. 2005; 11(4): 519-25.
2. World Health Organization. Crude death rate by broad cause group, 2000 and 2012 Geneva World Health Organization. 2014 (cited 2015 3/24/2015)
3. Morse SS, Mazet JA, Woolhouse M, Parrish CR, Carroll D, Karesh WB et al. Prediction and prevention of the next pandemic zoonosis. The Lancet. 2012; 380(9857): 1956-65.
4. Bandyopadhyay S, Kanji S, Wang L. The impact of rainfall and temperature variation on diarrheal prevalence in Sub-Saharan Africa. Applied Geography. 2012; 33(1): 63-72.
5. Centers for Disease C. Prevention. Integrated Disease Surveillance and Response. 2010.
6. World Health O, World Health O. Integrated disease surveillance and response. 2008.
7. Heymann DL, Rodier GR. Hot spots in a wired world: WHO surveillance of emerging and re-emerging infectious diseases. The Lancet infectious diseases. 2001; 1(5): 345-53.
8. Petti CA, Polage CR, Quinn TC, Ronald AR, Sande MA. Laboratory medicine in Africa: a barrier to effective health care. Clinical Infectious Diseases. 2006; 42(3): 377-82.
9. Shears P. Emerging and reemerging infections in Africa: the need for improved laboratory services and disease surveillance. Microbes and infection. 2000; 2(5): 489-95.
10. Okello A, Welburn S, Smith J. Crossing institutional boundaries: mapping the policy process for improved control of endemic and neglected zoonoses in sub-Saharan Africa. Health policy and planning. 2014; czu059.
11. Ope M, Sonoiya S, Kariuki J, Mboera LE, Gandham RN, Schneidman M et al. Regional initiatives in support of surveillance in East Africa: The East Africa Integrated Disease Surveillance Network (EAIDSNet) Experience. Emerg Health Threats J. 2013; 6.
12. Coker R, Rushton J, Mounier-Jack S, Karimuribo E, Lutumba P, Kambarage D et al. Towards a conceptual framework to support one-health research for policy on emerging zoonoses. The Lancet infectious diseases. 2011; 11(4): 326-31.
13. Mykhalovskiy E, Weir L. The Global Public Health Intelligence Network and early warning outbreak detection: a Canadian contribution to global public health. Can J Public Health. 2006 Jan-Feb; 97(1): 42-4.
14. Friedman L, Goes J. Why integrated health networks have failed. Front Health Serv Manage. 2001 Summer; 17(4): 3-28.
15. Lukwago L, Nanyunja M, Ndayimirije N, Wamala J, Malimbo M, Mbabazi W et al. The implementation of Integrated Disease Surveillance and Response in Uganda: a review of progress and challenges between 2001 and 2007. Health Policy Plan. 2013 Jan; 28(1): 30-40.
16. Nunnenkamp P, Rank M, Thiele R. Aid fragmentation and donor coordination in Uganda: a district-level analysis. Kiel Working Paper. 2015.
17. Dean Andrew G, Sullivan Kevin M, Soe MM. OpenEpi: Open Source Epidemiologic Statistics for Public Health. 2015 (cited 3 April 2016).
18. Uganda Regional Health Statistics Database. 2012 (cited 3 April 2016).
19. Campbell I. Chi-squared and Fisher–Irwin tests of two-by-two tables with small sample recommendations. Statistics in medicine. 2007; 26(19): 3661-75.
20. Richardson JTE. The analysis of 2×2 contingency tables-Yet again. Statistics in medicine. 2011; 30(8): p890.
21. Team RC. R language definition. Vienna, Austria: R foundation for statistical computing. 2000.
22. Dean AG, Sullivan KM, Soe MM. OpenEpi: Open source epidemiologic statistics for public health, version. 2014; (accessed 2017/01/26).
23. National Agricultural Advisory Services. National Agricultural Advisory Services, Who we are. 2015.
24. Dione M, Ouma E, Lule P, Pezo D. Animal health services delivery systems and disease surveillance in the smallholder pig value chain in Uganda. 2014.
25. Ministry of Agriculture Animal Industries and Fisheries. Policy Planning and Support Services: Ministry of Agriculture Animal Industries and Fisheries. 2015 (cited 2015 4/7/2015).
26. Borchert JN, Tappero JW, Downing R, Shoemaker T, Behumbiize P, Aceng J et al. Rapidly building global health security capacity-Uganda demonstration project, 2013. MMWR Morb Mortal Wkly Rep. 2014 Jan 31; 63(4): 73-6.
27. OIE. On-going JICA activities on animal health. 2013; (cited 2015 4/8/2015).
28. Bisson I-A, Ssebide BJ, Marra PP. Early detection of emerging zoonotic diseases with animal morbidity and mortality monitoring. Ecohealth. 2015 Mar; 12(1): 98-103.
29. Blauw SL, Franses PH. The impact of mobile telephone use on economic development of households in Uganda. 2011.
30. Waiswa R, Okello-Obura C. To what extent have ICTs contributed to e-Governance in Uganda? 2014.
31. Mbonye A, Wamala J, Kaboyo W, Tugumizemo V, Aceng J, Makumbi I. Repeated outbreaks of Viral hemorrhagic fevers in Uganda. African health sciences. 2013; 12(4): 579-89.
32. Robertson C, Sawford K, Daniel SLA, Nelson TA, Stephen C. Mobile Phone–based Infectious Disease Surveillance System, Sri Lanka. Emerging Infectious Diseases. 2010; 16(10): 1524-31.