Mandated Actions, Legitimate Role-Bearers and Expected Actor Networks in the Management of Infectious Disease Epidemics: The Case of Marburg Virus Disease in Uganda.

Steven Ssendagire (✉ sssendagire@musph.ac.ug)

Doreen Tuhebwe

Makerere University School of Public Health <https://orcid.org/0000-0002-9464-2340>

Susan Babirye

Makerere University School of Public Health

Rebecca Nuwematsiko

Makerere University School of Public Health

Andrew K. Tusubira

Makerere University School of Public Health

Joshua Kayiwa

Public Health Emergency Operations Center, Uganda Ministry of Health

Aloysius Ssenyonjo

Makerere University School of Public Health, Supporting Policy Engagement for Evidence-Based Decisions (SPEED) Project

Issa Makumbi

Public Health Emergency Operations Center, Uganda Ministry of Health

Freddie Ssengooba

Makerere University School of Public Health, Supporting Policy Engagement for Evidence-Based Decisions (SPEED) Project

Research article

Keywords: Epidemic Management, Coordination, Actor-networks, Mandated-actions, Role-bearers, Uganda

Posted Date: April 23rd, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-22886/v1>

License: This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Mandated Actions, Legitimate Role-Bearers and Expected Actor Networks in the Management of Infectious Disease Epidemics: The Case of Marburg Virus Disease in Uganda.

Authors

Ssendagire Steven¹, Tuhebwe Doreen¹, Babirye Susan¹, Nuwematsiko Rebecca¹, Tusubira K. Andrew¹, Kayiwa Joshua³, Ssenyonjo Aloysius^{1, 2} Makumbi Issa³ and Ssenkooba Freddie^{1, 2}

Corresponding Author

Ssendagire Steven, sssendagire@musph.ac.ug, +256(0)700373285

Affiliation

¹Makerere University School of Public Health

²Supporting Policy Engagement for Evidence-Based Decisions (*SPEED*) Project

³Public Health Emergency Operations Center (PHEOC), Uganda Ministry of Health

Abstract

Background

In many Sub-Saharan Africa (SSA) countries, epidemic management is characterized with inaction, confusion and friction among a multitude of participating organizations. This is partially attributable to the inability to customize international epidemic management actions and guidelines to local institutional architecture, agencies and relational contexts. This results into poor coordination and suboptimal epidemic management outcomes.

Using the case of Marburg Virus Disease (MVD) in Uganda, we explored how to clarify responsibility and collaboration across a multitude of inter-dependent actions and actors during epidemic management.

Methods

In July 2018, we reviewed MVD management literature and documents to identify key expected actions and actors/agencies. Data was summarized by phase and action area of MVD management. In March 2019, a 2-round Delphi survey was then undertaken to;

1) validate the identified actions and 2) assign legitimate role-bearers to each of the validated actions in accordance to the agency mandates in Uganda. Finally, we used *NetDraw* in *UCInet* to elaborate the expected network structure among legitimate role-bearers across all the phases and four selected action areas of MVD management.

Results

We validated 304 mandated actions and 79 legitimate role-bearers in MVD management in Uganda. Across the four phases and selected action areas of MVD management, there is a high variation in the identity and number of mandated role bearers. Overall, Ministry of Health headquarters (MoH-HQs), National Task Force (NTF), District task Force (DTF) and National Rapid Response Team (NRRT) are expected to be the most central agencies during MVD management. Across the four phases and the selected action areas, actors are expected to be networked using a core-periphery network structure.

Conclusions

There is a multitude of agencies required to work inter-dependently to accomplish the mandated actions for MVD management in Uganda. MoH-HQs, NTF and DTF are most central to assume coordination of MVD management in the Ugandan context. It is imperative to build/maintain the information processing, decision making and command and control capacity of these central agencies. The study findings can be used as the basis for exploring compliance and deviation in mandated actions in future MVD epidemics. The methodological approach could be replicated to other infectious disease epidemics in Uganda and beyond.

Key words: Epidemic Management, Coordination, Actor-networks, Mandated-actions, Role-bearers, Uganda

Background

The burden of infectious disease epidemics

Infectious disease epidemics are on the rise in Sub Saharan Africa (Fenollar & Mediannikov, 2018). In 2018 alone, over 95 new outbreaks were reported to World Health Organization (WHO) by member states of the WHO African region. In this same year, Uganda reported the highest number of new epidemics to WHO. These included Cholera, Rift Valley Fever (RVF), Crimean-Congo Hemorrhagic Fever (CCHF), Avian Influenza (HPAI), Marburg Virus Disease (MVD), Meningitis and Anthrax (Mboussou et al., 2019). Frequently, these epidemics are recurrent, in more or less the same location with similar or even greater magnitude. For example, since the year 2000, Uganda has experienced six Ebola Virus Disease (EVD) and five MVD epidemics (CDC, 2020). The last outbreak of MVD in Uganda was in September 2017. More than 40 organizations were drawn to participate in the response. Among others, these included WHO, United States Centers for Disease Control (US-CDC), Médecins Sans Frontières (MSF), Uganda Virus research institute (UVRI), United Nations Children's Fund (UNICEF), United States Agency for International Development (USAID), European Union (EU), Uganda Red Cross Society (URCS), World Vision Uganda (WV), Infectious Diseases Institute (IDI), African Field Epidemiology Network (AFENET), Family Health International (FHI360), Joint Mobile Emerging Disease Clinical Capability

(JMEDICC) and Makerere University School of Public Health (MakSPH) (Ario et al., 2020; MoH, 2017; Nyakarahuka et al., 2019).

During the response, the following observations were made; 1) some actors had conflicting roles, 2) some actions were being supported by more than one actor, yet, 3) other actions were left unsupported. At some point during the response, unnecessary friction was also observed; to the extent that some actors were temporarily recalled from the response frontline. This is not unique to the 2017 MVD response in Uganda. Such inaction, confusion and friction have been observed in disease epidemic responses elsewhere in SSA and other Low and Middle Income Country (LMIC) settings (Olu et al., 2016; Ross, Welch, & Angelides, 2017).

The inherent challenges with management of infectious disease epidemics in LMICs

Broadly, epidemic management in LMICs faces a coordination problem as a result of following related challenges; a) narrow focus on surveillance and response and b) limited clarity on mandate, roles and actors. First, the Integrated Disease Surveillance and Response (IDSR) framework; the strategy through which the majority of LMICs aspire to achieve their epidemic management goals is suboptimal. The framework is premised on a medical model of disease management (Ssendagire, Tuhebwe, Kayongo, & Ssengooba, 2018). The framework emphasizes epidemic detection and response actions with little attention to the equally important mitigation, preparedness and recovery interventions. After response to an epidemic, little or no attention and resources are dedicated to recovery and prevention of future epidemics. Instead, the

1 system waits to detect and respond to the next epidemic, creating a vicious cycle of
2 epidemic detection and response. By design, therefore, the IDSR framework does not
3 build health systems' resilience to infectious disease epidemics, which we define as the
4 capacity of the health system to prevent, prepare for, respond and recover from the
5 effects of infectious disease epidemics (Kruk, Myers, Varpilah, & Dahn, 2015).

6 Secondly, in many LMICs like Uganda, there is no published guideline on how
7 tasks/mandates are allocated during epidemic management. When epidemics occur,
8 the commonly observed practice is either to reactively ask available potential actors to
9 indicate the actions they are willing to support or to randomly allocate actions to those
10 physically available actors. This practice does not perfectly match actor competences to
11 specific response actions. It also does not effectively allocate the available resources to
12 all the critical epidemic response actions. Commonly, the required epidemic
13 management actions are not comprehensively defined. Even where attempts to define
14 these actions have been made, the legitimate role-bearers have not been explicitly
15 assigned (MoH, 2012). This creates the inaction, confusion and friction observed during
16 epidemic management. This culminates into poor coordination and suboptimal
17 epidemic management in LMICs, preventable escalation of epidemics, diversion of
18 resources from other critically important health priorities, more suffering, death, social
19 disruption and loss of revenue due to trade and travel related aversion behaviors
20 associated with escalated epidemics (Frieden & Damon, 2015; Gostin & Friedman,
21 2015).

22 **Theoretical Framework**

We identify three (3) theories as appropriate for the exploration of the challenges of sub-optimal epidemic management in LMIC settings. These are; 1) Coordination Theory, 2) Network Theory and 3) Comprehensive Emergency Management Theory.

Coordination Theory

Coordination theory can be applied to predict, understand and influence the process and outcomes of managing dependences between multiple actors. When multiple dependences in form of actions and in form of role-bearers are required to deliver on a single outcome, efficiency of the outcome will likely be constrained. To reduce the likelihood of such constraints, certain structures and processes must be in place before and or during the execution of interdependent actions by multiple role-bearers. These structures and processes are generally referred to as coordination mechanisms. Broadly, there are three coordination mechanisms. These are; 1) Hierarchy (which includes Standardization of required inputs and processes, authority, command and control), 2) Speeding-up information flow (for example through formal and informal networking) and 3) Increasing the capacity for information processing (for example centralization of information processing). To maximize the performance of inter-dependent relationships, the positive contributions from these three broad categories of coordination mechanisms needs to be maximized (Crowston, 1997; Malone & Crowston, 1994; Melin & Axelsson, 2005).

Network Theory

A network is a collection of multiple actors and the relationships that bind them together, and broadly a coordination mechanism also. There are a set of principles that can be

1 applied to predict, control and explain the functionality of networks. Provan and Kenis
2 describe three (3) major types of network forms; Shared governance, Lead Organization
3 and Network Administrative Organization (NAO) (Provan & Kenis, 2008). These network
4 forms correspond to four (4) major network structures; Centralization, Closure,
5 Brokerage and Core/Periphery as described by Nowell and colleagues and as shown in
6 figure 1 (Nowell, Steelman, Velez, & Yang, 2018).

8 Provan and Kenis also contend that different types of network structures are likely to be
9 more effective than others depending on certain contingencies. Such contingencies
10 include the level of trust among actors in the network, the number of actors in the
11 network, the level of goal consensus among the actors in the network and the capacity
12 of these actors to operate in a network (Provan & Kenis, 2008).

13 Comprehensive Emergency Management Theory

14 Comprehensive Emergency Management Theory is premised on the coordination
15 mechanism of standardization (Whittaker, 1979). Standardization as a coordination
16 mechanism requires prior identification of all the required emergency management

actions, allocation of these actions to specified role-bearers and developing the capacity of these role-bearers to deliver on their mandated actions. This is the theoretical underpinning of the Emergency Management Cycle (EMC) Model (Waugh, 1999; Whittaker, 1979), which has been found effective in the management of natural disasters like floods and earthquakes (Banipal, 2006; FEMA, 2001).

The EMC model specifies four phases of modern emergency/disaster management. These are; 1) Mitigation (actions that prevent a disaster and reduce the chance of it happening, or lessen its damaging effects); 2) Preparedness (actions taken before impact, including development of response plans), 3) Response (actions taken during the initial impact of a disaster, including those to save lives and to prevent further damage to property) and Recovery (actions taken after the initial impact, including those aimed at achieving a return to normality). When the required/mandated actions and the legitimate role-bearers for each of the EMC phases are agreed upon a priori, coordination of emergencies/disasters tends to be more effective compared to when this is not done in advance. Prior assignment of roles creates collaboration, preparedness and clarity; which are all critical to effective emergency management.

The study makes a contribution to improved coordination of multiple actions and actors during epidemics management in LMICs. The study addressed three questions. 1) What are the mandated actions in the comprehensive management of MVD in Uganda? 2) Who are the legitimate role-bearers for these mandated actions? 3) How should the legitimate role-bearers be networked?

Methodology

The three methodological approaches used were; 1) Review of MVD management related literature and Documents (July-August 2018), 2) A Delphi survey (March 2019) and Social Network Analysis (SNA).

Review of MVD management related literature and Documents

To identify the documented mandated actions and legitimate role-bearers in the comprehensive management of MVD in Uganda, we conducted a search and review of MVD management literature and documents.

Search strategy

We searched online databases using multiple online search strings constructed by combining the terms Marburg, Virus, Disease, Mitigation, Prevention, Preparedness, Response, Recovery, Stakeholders, Actors, Actions, Uganda, WHO, CDC, Outbreak, Epidemic and Resilience. The databases searched included Google, Google Scholar, Pub-Med and Medline. The official websites for WHO, CDC, UNICEF, MSF and MoH-Uganda were also searched for official MVD management related documents. The Uganda Public Health Emergency Operations Centre (PHEOC) also provided documents that were collected during the 2017 Joint External Evaluation (JEE) of International Health Regulation (IHR) core capacities for Uganda.

Screening of retrieved Literature and Documents

The process and outcomes of screening of the retrieved literature and documents is summarized in Figure 2. First, all the retrieved documents we put into one folder, removed duplicates and screened for relevance of each document by reading their abstracts/executive summaries only. Sixty (60) documents were maintained for full

reading. The 60 documents were each reviewed separately by two independent researchers (NR and TKA) who abstracted MVD management actions and any role-bearers indicated in these documents.

Any data discrepancies between the two reviewers were resolved by conducting a joint review of the source documents in question. The abstracted data was summarized in excel into a single action-actor matrix with descriptors of phase (Mitigation, Preparedness, Response and Recovery) and action area (as reflected in column 2 of table 3) of MVD management.

The Delphi survey

We then conducted a 2 round Delphi survey (Giannarou & Zervas, 2014; Habibi, Sarafrazi, & Izadyar, 2014) with 30 purposively sampled local experts in MVD

management drawn from multiple fields to validate and customize the action-actor matrix developed from literature and documentary review. The details of the 30 member Delphi panel are summarized in table 2.

Table 2: Characteristics of experts consulted to validate and customize MVD actions and actors identified from reviewed literature and documents

Variable	Values	n	%
<i>Practice Domain</i>	Academia	5	17
	Policy development	15	50
	Implementation	10	33
<i>Parent Ministry</i>	Health	9	30
	Prime Minister	3	10
	Agriculture	12	40
	Wildlife	3	10
<i>Years in current Position</i>	Education	3	10
	≥10	8	27
	≥5	14	46
	<5	8	27
<i>Gender</i>	Males	18	60
	Female	12	40
<i>Highest Level of Training</i>	PhD	3	10
	Masters	24	80
	Graduate	3	10
<i>Experience in MVD management (years)</i>	≥5	25	83
	<5	5	17

First Delphi Survey round

Round one of the surveys was a face to face half-day workshop. During this survey, the action-actor matrix generated from reviewed literature and documents was divided into sub-matrices corresponding to the 4 phases (Mitigation, Preparedness, Response and Recovery) of comprehensive MVD management and pinned on the wall to create four respective stations. The workshop participants moved across the 4 stations; adding relevant or deleting irrelevant actions and actors, and indicating the lead and other actors for each of the actions. This was later followed by plenary discussion facilitated

1 by a research team member experienced in facilitating stakeholder deliberations (SF).
2 The workshop outputs were summarized into draft “customized” action-actor matrices
3 for each of the 4 phases of MVD management in Uganda.

4 Second Delphi Survey Round

5 In the second round of the survey, the draft customized matrices were shared by
6 electronic mail to each of the 30 panel members who were asked to send any feedback
7 /adjustments within 2 weeks. All the panel members responded within the stipulated
8 time and their feedback was used to produce the final customized action-actor matrices
9 for comprehensive management of MVD in Uganda. No additional survey rounds were
10 conducted because of the high levels of consensus among panel members after the
11 second round of the survey.

12 Social Network Analysis

13 To explore how the multiple legitimate role-bearers should be networked/aligned to
14 each other during MVD management in Uganda, Social Network Analysis was
15 employed (SNA) (Butts, 2008; Hanneman & Riddle, 2005). The validated matrices acted
16 as input data. SNA approaches using (*NetDraw* in) *UCINET* software were used to
17 visualize the expected interdependencies between the legitimate role-bearers for all the
18 phases of MVD management combined, each of the four phases of MVD management
19 separately and 4 out of the 26 MVD management action areas. The structures of
20 visualized networks were compared to those described by Nowell and colleagues (Nowell
21 et al., 2018). The ego-centric quality of the visualized networks was determined using

1 degree centralization and density. This enabled comparison of the network attributes
2 across the 4 phases and selected action areas.

3 Ethical approval for this study was provided by the Institutional Review Board (IRB) of
4 MakSPH (HDREC Protocol number 580) and granted permission from Ministry of
5 Health Headquarters was also granted (Ref Number ADM.105/309/16). We determined
6 the judicious use of agency names in the findings using the overriding principle of do no
7 harm, practical application of the study and the need for relationship management with
8 known agencies that play key roles in MVD management in Uganda. Participation as a
9 Delphi panel member was voluntary. Informed consent was also sought and
10 documented. We shared the study findings at a national level stakeholder dissemination
11 workshop.

Results

Introduction

Overall, we identified, validated and customized a total of 304 unique mandated actions and 79 unique legitimate Role-Bearers during MVD management in Uganda. Below, we stratify the actions and legitimate Role-Bearers by phase and selected action areas of MVD management

Mandated Actions and Legitimate Role-Bearers per phase of MVD management in Uganda

We identified, validated and customized 21, 166, 96 and 21 mandated actions under the Mitigation, Preparedness, Response and Recovery Phases of MVD management in Uganda respectively. These are summarized in table 3. These actions were assigned to 36, 51, 55 and 28 legitimate Role-Bearers in the Mitigation, Preparedness, Response and Recovery Phases of MVD management respectively. These are summarized in table 4.

Mandated Actions and Legitimate Role-Bearers for selected action areas of MVD management in Uganda

Further, the 304 mandated actions were categorized under 26 action areas of MVD management. These action areas are reflected in table 3. We report on the results of 4 out of all the 26 action areas. The 4 selected action areas are Coordination, Surveillance, Resource Mapping and Risk Communication. We identified, validated and customized 86, 16, 3 and 10 mandated actions under Coordination, Surveillance, Resource Mapping and Risk Communication respectively, as summarized in table 4.

1 Table 3: Summary of MVD management mandated actions and their lead legitimate
2 role-bearers

Phase	Action Area	Actions	Main Actors (No of actions)
Mitigation	<i>Capacity Building</i>	1	Line Ministries(1)
	<i>Guideline Development</i>	4	Line Ministries(4)
	<i>Guideline Implementation</i>	6	DTF(4), HWs(3)
	<i>Risk Assessment</i>	8	OPM(4), Line Ministries(3)
	<i>Social Mobilization</i>	2	DTF(1),Line Ministries(1)
Preparedness	<i>Advocacy</i>	6	DTF(5)
	<i>Capacity Assessment</i>	6	DTF(3), DHT(3),
	<i>Capacity Building</i>	16	DHT (13), DTF(2)
	<i>Capacity Monitoring</i>	2	ESD(2)
	<i>Coordination</i>	33	NTF(12), MoH-HQ(19), DTF(7), DRRT(9)
	<i>Guidelines Update</i>	37	Line Ministries(4)
	<i>Guideline Dissemination</i>	4	MoH-HQ(4)
	<i>Laboratory Strengthening</i>	9	NTF(7), MoH-HQ(6)
	<i>Partner Mapping</i>	2	NTF(2)
	<i>Policy Implementation</i>	2	Line Ministries(8)
	<i>Resource Mapping</i>	3	NTF(3)
	<i>Resource Mobilization</i>	16	NTF(17)
	<i>Risk Assessment</i>	4	OPM(4), Line Ministries(3)
	<i>Risk Communication</i>	9	UNPHLS(4), PHEOC(6)
	<i>Simulation Exercises</i>	1	PHEOC(1), DTF(1)
	<i>Surveillance Strengthening</i>	16	ESD(10),EOC(9), UVRI(5)
Response	<i>Case management</i>	14	DTF(4), DRRT(4), NTF(2)
	<i>Coordination</i>	53	NTF(12), MoH-HQ(19), DTF(7), DRRT(9)
	<i>Laboratory</i>	7	NTF(7), MoH-HQ(6)
	<i>Resource Mobilization</i>	1	NTF(17)
	<i>Social Mobilization</i>	5	NTF(4), DTF(1)
	<i>Surveillance</i>	16	WHO(11), ZDCO(5), PHEOC(3), UVRI(3),RRT(5)
Recovery	<i>Reactivation of routine services</i>	1	DHT(1)
	<i>Rehabilitation</i>	1	DHT(1)
	<i>Response Evaluation</i>	5	DTF(2), MoH-HQ(2)
	<i>Risk Communication</i>	1	UNPHLS(4), PHEOC(6)
	<i>Routine Surveillance</i>	4	DHT(3)
	<i>Systems Strengthening</i>	9	MoH-HQ(4), DTF(2), DHT(1)

3

Networks of legitimate Role-Bearers during MVD management in Uganda

Multiple actor networks were determined. These include an overall actor network, a network for each of the 4 phases of MVD management and a network for a selection of 4 (Coordination, Surveillance, Resource Mapping and Risk Communication) of the 26 action areas of MVD management in Uganda. These are shown in figure 3, figure 4 and figure 5 respectively. The quality of these actor networks in terms of degree centralization and density is summarized in table 4.

Table 4: Selected quality metrics of expected actor networks in the different phases and selected action areas of MVD management in Uganda

	Most Connected Actors	Unique Actors	Total Connections	Degree Centralization	Density
Mitigation	1. MoH-HQs 2. DTF 3. NOHP	36	51	0.35	0.04
Preparedness	1. MoH-HQs 2. DHT 3. NTF	51	179	0.64	0.07
Response	1. NTF 2. DRRT 3. NRRT	55	132	0.5	0.04
Recovery	1. MoH-HQs 2. DTF 3. NOHP	28	35	0.63	0.05
Coordination	1. MoH-HQs 2. DTF 3. DDRT	50	106	0.44	0.04
Surveillance	1. WHO-CO 2. UVRI 3. NNRT	38	96	0.38	0.07
Resource Mapping	1. NTF 2. DTF	18	19	0.99	0.06
Risk Communication	1. UNPHLS 2. EOC 3. NTF	26	45	0.49	0.07

Figure 3: Network of expected actors during MVD management in Uganda; all phases and action areas combined

Figure 4: Expected actor networks per phase (mitigation, preparedness, response and recovery) of MVD management

Figure 5: Expected actor network for selected action areas (MVD Coordination, Surveillance, Resource-Mapping and Risk-Communication)

Discussion

Introduction

In Uganda, just like it is in many LMICs, management of epidemics should be collaborative endeavor. This is because no single Ministry, Department or Agency (MDA) has the required jurisdictional authority, legitimacy, resources and technical capability to effectively assume command and control of epidemic management alone. By extension, government entities require collaboration with non-state actors such as development partners, private sector and civil society organizations. The requirement to operate interdependently however comes with the inherent challenge that interdependence often reduces the efficiency of outcomes – partly due to increase in inter-agency transaction costs (Williamson, 1981). To reduce the likelihood of outcome inefficiency, the mandated actions, their legitimate role-bearers and the mechanisms for coordinating the multitude of legitimate role-bearers ought to be clear ex ante (Crowston, 1997; Malone & Crowston, 1994; Melin & Axelsson, 2005; Nowell et al., 2018). Using the case of Marburg Virus Disease (MVD), we identified, validated and customized the mandated actions, their legitimate role-bearers and expected actor networks in the management of MVD epidemics in Uganda.

Mandated actions and legitimate role-bearers during MVD management in Uganda

We identified, validated and customized a total of 304 actions expected to be implemented across the four phases of MVD management in Uganda. All the synthesized actions (304) were assigned to specific legitimate lead and led (other) role bearers. We were not able to find any published literature against which to compare

whether the determined number of MVD actors (and actions) was small, medium or large. Also, we were not able to find any evidence from Uganda or other LMIC setting on comprehensiveness of allocation of the multiple actors to all the required actions for management of MVD or any other epidemic. Elsewhere, previous studies have however indicated that prior identification of actors and clarification about their mandated roles increases cross-institutional preparedness and response to complex health emergencies including but not limited to MVD and other infectious disease epidemics (De Vries et al., 2019; Isken et al., 2008; Joustra, Meurs, & Fresco, 2012).

Expected networks of legitimate Role-Bearers during MVD management in Uganda

We elaborated and visualized the expected actor networks by the four (4) phases (Mitigation, Preparedness, Response and Recovery) of MVD management in Uganda. This elaboration was also applied to four action areas (Coordination, Surveillance, Risk Communication and Resource Mapping) selected out of the 26 pragmatic action areas (as reflected in table 3). We indicated the actors who are expected to be central (and peripheral) for each of the four (4) phases and each of the 26 action areas of MVD management in Uganda. Previous studies have underscored for need for prior clarity on the relationship between multiple actors involved in the management of complex situations, especially on the structures and channels of decision making and communication respectively. This facilitates a more coordinated management of complex crises (Moynihan, 2009; Wimelius & Engberg, 2015).

Available literature on global social networks identifies four main types of structural configurations for aligning the actions of multiple stakeholders involved in the same

1 problem space (Nowell et al 2018). These are; 1) centralized, 2) closed, 3)
2 brokered/decentralized and 4) core/periphery. Centralized networks are networks in
3 which actors are linked together through a single central actor. Closed networks refer to
4 a network in which there is a high level of connectivity across all actors in the network.
5 Brokered or decentralized network are the ones characterized by sub-networks of
6 actors that are connected together through a series of brokers. A core-periphery
7 network is one characterized by dense connections among a central subgroup of actors
8 at the core of the network surrounded by a peripheral set of actors with more sparse
9 connections (Nowell et al., 2018).

10 Our findings indicate that all the actor networks across the four phases and the 4 of the
11 26 action areas of MVD management in Uganda conform to the Core-Periphery
12 structure than any other global social network structure. From our findings, the actors at
13 the core of MVD management in Uganda are NTF, DTF, MoH-HQs, DDRT, NRRT,
14 EOC, WHO-CO and UNPHLN. The actors making up the periphery are highly variable.
15 The Core-Periphery structure of network governance has several advantages (including
16 better coordination) over all other structures. By inference, the coordination of MVD
17 management in Uganda could be considered more effective, because of the core-
18 periphery structure for aligning the actions of multiple actors during MVD management
19 (Johnson, Boster, & Palinkas, 2003; Provan & Lemaire, 2012). We however do not have
20 any evidence yet as to whether this expected core-periphery structure of network
21 governance is observed during actual MVD management in Uganda.

Provan and colleagues argue that there are certain critical contingencies that can be used to predict which type of network governance structure would be more effective. These are; 1) The total number of actors involved, 2) The level of trust among the actors involved, 3) The level of goal consensus among the actors involved and 4) the competency of the actors involved (Provan & Kenis, 2008). On the number of actors involved, Provan and colleagues argue that if the number of actors involved is moderate to many, then the core-periphery structure is expected to be the most effective structure to deploy. Apart from resource Mobilization, our findings reveal that the number of expected actors in each of the 4 phases of MVD management and in each of the other 26 action areas of MVD management is greater than 25. To the extent that is interpreted as a moderate to large number of expected actors, and if MVD management in Uganda is relatively more effective (Mbonye et al., 2014; Okware, 2016), then our findings conform to the propositions stated by Provan and colleagues that if the number of actors is moderate to large, the core-periphery structure of network governance is expected to result into more effective coordination of multiple actors working in the same problem space (Provan & Kenis, 2008).

The expected quality of actor networks during MVD management in Uganda

The ego-centric quality of expected networks in the comprehensive management of MVD in Uganda was determined. In ego-centric Social Network Analysis (SNA), there are multiple metrics that can be used to report on the quality of a social network. We opted for centralization and density; some of the commonly used metrics in ego-centric SNA. Density is perhaps the most well-known network metric and represents the degree

1 to which all actors are connected to all other actors in the network, the notion of network
2 closure. centralization focuses on the degree the network is organized around a single
3 actor or set of actors (Hawe, Webster, & Shiell, 2004).

4 The expected core actors across all the visualized MVD management related networks
5 are NTF, DTF, MoH-HQs, DDRT, NRRT, EOC, WHO-CO and UNPHLN. Core actors
6 were connected to the largest number of actors and therefore expected to be the most
7 critical actors in the MVD management networks in Uganda. If resources and mandate
8 to coordinate MVD outbreaks is built among these core agencies, inefficiencies in the
9 functionality of the whole network of actors can be improved. By practice and
10 observation, these actors have always been at the core of MVD management in
11 Uganda. The overall density and centralization of the MVD networks ranged from 0.04-
12 0.07 and 0.35-0.99 respectively. The density was low because the networks are
13 predominantly core-periphery with few core actors and many peripheral actors (Provan
14 & Lemaire, 2012). For the same reason, centralization of the expected MVD
15 management actor networks is high.

16 Development of basis for exploring stakeholder deviations from mandated actions 17 during MVD management

18 We recognize that the actions elaborated in this paper will likely be more constant than
19 the elaborated actors. We also recognize that the elaborated actor interlinkages during
20 the four phases and 4 of the 26 action areas of MVD management need not to be rigid.
21 In fact, in the face of a rapidly changing complex emergency, ad hoc structures of actor
22 management are sometimes more efficient, resulting into a more effective crisis

response (Huizer, Kraaij-Dirkzwager, Timen, Schuitmaker, & van Steenbergen, 2015; Weick, 2005). The findings from this study provide a basis for exploring compliance and deviations from expected action and actor inter-linkages during the management of future MVD outbreaks in Uganda

Conclusion

Mandated actions and legitimate role-bearers during MVD management in Uganda are multiple and highly inter-dependent. The inter-dependencies are mostly mediated by MoH-HQs, NTF and DTF as the most central and legitimate agencies across all the phases and action areas of MVD management in Uganda. These are therefore expected to play a leadership role in information processing, information sharing, decision making and command and control during MVD management in Uganda.

Recommendations

The study findings can be used as the basis for exploring compliance and deviation in mandated actions and legitimate role-bearers during the actual management of future MVD epidemics in Uganda.

To improve the effectiveness of MVD management, it is important to build the capacity of the agencies at the center of MVD management in the core mechanisms of coordination.

The methodological approach employed in this study could be replicated to other infectious disease epidemics in Uganda and beyond to aid the management and resilience of health systems in the face of future epidemics.

List of Abbreviations

AFENET:	African Field Epidemiology Network
AMREF:	African Medical and Research Foundation
CAA:	Civil Aviation Authority
CAHWs:	Community Animal Health Workers
CBOs:	Community Based Organizations
CCHF:	Crimean Congo Hemorrhagic Fever
CDC:	Centers for Disease Control and Prevention
CHWs:	Community Health Workers
CoVAB:	Collage of Veterinary and Agricultural Business
DGHS:	Director General of Health Services
DHT:	District Health Team
DRRT:	District Rapid Response Team
DSFP:	District Surveillance Focal Person
DTF:	District Task Force
DVO:	District Veterinary Officer
EMC:	Emergency Management Cycle
ESD:	Epidemiology and Surveillance Division
EU:	European Union
GOARN:	Global Outbreak Alert and Response Network
HDPs:	Health Development Partners
HFs:	Heath Facilities
HDREC:	Higher Degrees Research and Ethics Committee
HPAI:	Highly Pathogenic Avian Influenza
HWs:	Health Workers
IDI:	Infectious Disease Institute
IDSR:	Integrated Disease Surveillance and Response
IHR:	International Health Regulations
IMF:	International Monetary Fund
IMT:	Incident Management Team
IRB:	Institutional Review Board
JEE:	Joint Enteral Evaluation
JMEDICC:	Joint Mobile Emerging Disease Intervention Clinical Capacity
LMICs:	Low and Middle Income Countries
MAAIF:	Ministry of Agriculture Animal Industry and Fisheries
MakSPH:	Makerere University School of Public Health

1	MoD:	Ministry of Defense
2	MOFP&ED:	Ministry of Finance, Planning and Economic Development
3	MoH-HQs:	Ministry of Health Headquarters
4	MSF:	Médecins San Frontieres
5	MUWRP:	Makerere University Walter Reed Project
6	MVD:	Marburg Virus Disease
7	NADDEC:	National Animal Disease Diagnostics and Epidemiology Center
8	NAO:	Network Administrative Organization
9	NAPS:	National Action-Plan for Health Security
10	NGOs:	Non-Governmental Organizations
11	NMS:	National Medical Stores
12	NRRT:	National Rapid Response Team
13	NTF:	National Task Force
14	OHCEA:	One Health Central and East Africa
15	OPM:	Office of the Prime Minister
16	P&R:	Predict and Respond
17	PHEOC:	Public Health Emergency Operations Center
18	RRT:	Rapid Response Team
19	RVF:	Rift Valley Fever
20	SNA:	Social Network Analysis
21	SSA:	Sub Saharan Africa
22	UCRS:	Uganda Catholic Relief Services
23	UNCST:	Uganda National Council of Science and Technology
24	UNICEF:	United Nations Children Education Fund
25	UNMEER:	United Nations Mission for Ebola Emergency Response
26	UNPHLS:	Uganda National Public Health Laboratory Services
27	URC:	Uganda Red Cross
28	USAID:	United States Agency for International Development
29	UVRI:	Uganda Virus Research Institute
30	UWA:	Uganda Wildlife Authority
31	WB:	World Bank
32	WHO:	World Health Organization
33	WHO-CO:	World Health Organization Country Office
34	WHO-RO:	World Health Organization Regional Office
35	ZDCO:	Zoonotic Disease Coordination Office
36		

1 **Declarations**

2 **Ethics approval and consent to participate:** Ethical approval for this study was
3 provided by Makerere University Higher Degree Research and Ethics Committee
4 (HDREC Protocol number 580) and granted permission from Ministry of Health
5 Headquarters was also granted (Ref Number ADM.105/309/16). We determined the
6 judicious use of agency names in the findings using the overriding principle of do no
7 harm, practical application of the study and the need for relationship management with
8 known agencies that play key roles in MVD management in Uganda. Participation as a
9 Delphi panel member was voluntary. Informed consent was also sought and
10 documented. We shared the study findings at a national level stakeholder dissemination
11 workshop.

12 **Consent for publication:** Not applicable.

13 **Availability of data and materials:** The datasets used and/or analyzed during for our
14 study are available from the corresponding author upon reasonable request.

15 **Competing interests:** The authors declare that they have no competing interests

16 **Funding:** This work was funded by the Supporting Policy Engagements for Evidence
17 based Decisions (SPEED) for Universal Health Coverage Project at Makerere
18 University School of Public Health (MakSPH). SPEED is supported by European Union.
19 The contents of this article are however solely the responsibility of the authors and do
20 not necessarily represent the views of the SPEED project or MakSPH.

Authors' contributions: SS, TD, BS, SA and SF conceptualized the study. KJ and MI acquired the documents for the literature review. SS, TD, NR and TKA conducted the data abstraction, analysis and synthesis. SS, TD, NR, TKA AND SF facilitated the Delphi survey. SF facilitated the engagement after the first round of the Delphi survey. KJ and MI mobilized the Delphi panel participants and hosted the Delphi survey at the Public Health Emergency Operations Center. SS prepared the first draft of the manuscript. All the authors revised the various drafts of the manuscript. All authors read and approved the final manuscript.

Acknowledgements: The authors express their gratitude to the SPEED project for funding the study. The authors also acknowledge the support given of the Public Health Emergency Operations Center (PHEOC), Uganda Ministry of Health and members of who participated in the Delphi panel. Special thanks to Annet Joselyn Atuhairwe who also took part in the data abstraction. However, the views expressed in the paper are solely of the authors and do not reflect that of the organizations they are affiliated with.

References

- Ario, A. R., Makumbi, I., Nkonwa, I., Eyu, P., Opio, N., Nakiire, L., . . . Aceng, J. (2020). Investigation of Marburg Virus Disease Outbreak in Kween District, Eastern Uganda, 2017. 4, 2. doi: 10.33140/AIDT.04.01.02
- Banipal, K. (2006). Strategic approach to disaster management: lessons learned from Hurricane Katrina. *Disaster Prevention and Management: An International Journal*, 15(3), 484-494. doi: doi:10.1108/09653560610669945
- Butts, C. T. (2008). Social network analysis: A methodological introduction. *Asian Journal of Social Psychology*, 11(1), 13-41.
- CDC. (2020). National center for Emerging and Zoonotic infectious diseases (NCEZID). *Viral Special Pathogens branch (VSPB)*.
- Crowston, K. (1997). A Coordination Theory approach to Organizatinoal Process Design. *Organizational Science*, 8(2), 157-175. doi: 10.1086/501473
- De Vries, M., Kenis, P., Kraaij-Dirkzwager, M., Ruitenberg, E. J., Raab, J., & Timen, A. (2019). Collaborative emergency preparedness and response to cross-institutional outbreaks of multidrug-resistant organisms: a scenario-based approach in two regions of the Netherlands. *BMC public health*, 19(1), 52.
- FEMA. (2001). Federal Emergency Management Agency (FEMA) Situation Reports. September 11- October 04.
- Fenollar, F., & Mediannikov, O. (2018). Emerging infectious diseases in Africa in the 21st century. *New microbes and new infections*, 26, S10-S18.
- Frieden, T. R., & Damon, I. K. (2015). Ebola in West Africa—CDC's Role in Epidemic Detection, Control, and Prevention. *Emerging Infectious Diseases*, 21(11), 1897-1905. doi: 10.3201/eid2111.150949
- Giannarou, L., & Zervas, E. (2014). Using Delphi technique to build consensus in practice. *International Journal of Business Science & Applied Management (IJBSAM)*, 9(2), 65-82.
- Gostin, L. O., & Friedman, E. A. (2015). A retrospective and prospective analysis of the west African Ebola virus disease epidemic: robust national health systems at the foundation and an empowered WHO at the apex. *The Lancet*, 385(9980), 1902-1909.
- Habibi, A., Sarafrazi, A., & Izadyar, S. (2014). Delphi technique theoretical framework in qualitative research. *The International Journal of Engineering and Science*, 3(4), 8-13.
- Hanneman, R. A., & Riddle, M. (2005). Introduction to social network methods: University of California Riverside.

- 1 Hawe, P., Webster, C., & Shiell, A. (2004). A glossary of terms for navigating the field of
2 social network analysis. *Journal of Epidemiology & Community Health*, 58(12),
3 971-975.
- 4 Huizer, Y. L., Kraaij-Dirkzwager, M. M., Timen, A., Schuitmaker, T. J., & van
5 Steenberg, J. E. (2015). Context analysis for epidemic control in the
6 Netherlands. *Health policy*, 119(1), 66-73.
- 7 Isken, L., Roorda, J., de Kok, L., Kaur, P., van Ouwerkerk, I., & Stenvers, O. (2008).
8 Evaluatie Salmonella Typhimurium ft 560 uitbraak in Twente 2006. *Bilthoven:*
9 *RIVM, GGD Regio Twente, VWA*.
- 10 Johnson, J. C., Boster, J. S., & Palinkas, L. A. (2003). Social roles and the evolution of
11 networks in extreme and isolated environments. *Journal of Mathematical*
12 *Sociology*, 27(2-3), 89-121.
- 13 Joustra, T., Meurs, P., & Fresco, L. (2012). Salmonella in gerookte zalm.
- 14 Kruk, M. E., Myers, M., Varpilah, S. T., & Dahn, B. T. (2015). What is a resilient health
15 system? Lessons from Ebola. *The Lancet*, 385(9980), 1910-1912.
- 16 Malone, T., & Crowston, K. (1994). The interdisciplinary study of coordination. *ACM*
17 *Computer Survey*, 26(1), 87-119.
- 18 Mbonye, A., Wamala, J., Nanyunja, M., Opio, A., Aceng, J., & Makumbi, I. (2014). Ebola
19 viral hemorrhagic disease outbreak in West Africa – lessons from Uganda.
20 *African Health Sciences*.
- 21 Mboussou, F., Ndumbi, P., Ngom, R., Kamassali, Z., Ogundiran, O., Van Beek, J., . . .
22 Impouma, B. (2019). Infectious disease outbreaks in the African region: overview
23 of events reported to the World Health Organization in 2018. *Epidemiology &*
24 *Infection*, 147.
- 25 Melin, U., & Axelsson, K. (2005). *Understanding Organizational Coordination and*
26 *Information Systems-Mintzberg's Coordination Mechanisms Revisited and*
27 *Evaluated*. Paper presented at the 13th European Conference on Information
28 Systems, Regensburg, Germany.
- 29 MoH. (2012). Uganda National Technical Guidelines for Integrated Disease Surveillance
30 and Response (pp. 251-254).
- 31 MoH. (2017). Uganda Declares End of Marburg Virus Disease Outbreak [Press release]
- 32 Moynihan, D. P. (2009). The network governance of crisis response: Case studies of
33 incident command systems. *Journal of public administration research and theory*,
34 19(4), 895-915.

- 1 Nowell, B., Steelman, T., Velez, A.-L. K., & Yang, Z. (2018). The structure of effective
2 governance of disaster response networks: Insights from the field. *The American*
3 *Review of Public Administration*, 48(7), 699-715.
- 4 Nyakarahuka, L., Shoemaker, T. R., Balinandi, S., Chemos, G., Kwesiga, B., Mulei, S., .
5 . . Masiira, B. (2019). Marburg virus disease outbreak in Kween District Uganda,
6 2017: Epidemiological and laboratory findings. *PLoS neglected tropical diseases*,
7 13(3), e0007257.
- 8 Okware, S. I. (2016). *Managing Ebola in Low-resource Settings: Experiences from*
9 *Uganda*. (PhD).
- 10 Olu, O. O., Lamunu, M., Chimbaru, A., Adegboyega, A., Conteh, I., Nsenga, N., . . .
11 Dafee, F. M. (2016). Incident management systems are essential for effective
12 coordination of large disease outbreaks: perspectives from the coordination of
13 the Ebola outbreak response in Sierra Leone. *Frontiers in public health*, 4, 254.
- 14 Provan, K. G., & Kenis, P. (2008). Modes of network governance: Structure,
15 management, and effectiveness. *Journal of public administration research and*
16 *theory*, 18(2), 229-252.
- 17 Provan, K. G., & Lemaire, R. H. (2012). Core concepts and key ideas for understanding
18 public sector organizational networks: Using research to inform scholarship and
19 practice. *Public Administration Review*, 72(5), 638-648.
- 20 Ross, E., Welch, G. H., & Angelides, P. K. (2017). *Sierra Leone's response to the Ebola*
21 *outbreak: Management strategies and key responder experiences*: Chatham
22 House for the Royal Institute of International Affairs.
- 23 Ssendagire, S., Tuhebwe, D., Kayongo, S. B., & Ssengooba, F. (2018).
24 Recommendations to Improve Health System Resilience to Disease Outbreaks in
25 Uganda. *UNIVERSAL HEALTH COVERAGE IN UGANDA*, 350.
- 26 Waugh, W. L. (1999). *Living with hazards, dealing with disasters: An introduction to*
27 *emergency management*: ME Sharpe.
- 28 Weick, K. E. (2005). 5 Managing the unexpected: complexity as distributed
29 sensemaking *Uncertainty and surprise in complex systems* (pp. 51-65): Springer.
- 30 Whittaker, H. (1979). Comprehensive Emergency Management: A Governor's Guide.
31 *Washington DC: National Governors' Association: Center for Policy Research*.
- 32 Williamson, O. E. (1981). The economics of organization: The transaction cost
33 approach. *American journal of sociology*, 87(3), 548-577.
- 34 Wimelius, M. E., & Engberg, J. (2015). Crisis Management through Network
35 Coordination: Experiences of Swedish Civil Defence Directors. *Journal of*
36 *Contingencies and Crisis Management*, 23(3), 129-137.

Figures

Figure 1

Types of Global Network Configuration Structures as described by Nowell and colleagues (Nowell, Steelman, Velez & Yang, 2018).

Figure 2

Flow Diagram for identification of documents reviewed as part of the study methodology

Figure 4

Expected actor networks per phase (mitigation, preparedness, response and recovery) of MVD management

Figure 5

Expected actor network for selected action areas (MVD Coordination, Surveillance, Resource-Mapping and Risk-Communication)