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**Inter-organisational coordination data collection and analyses of H1N1 outbreak: A pilot field study**

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# Inter-organisational coordination data collection and analyses of H1N1 outbreak: A pilot field study

Improving effectiveness in response to H1N1 outbreaks requires us to understand how different organisations within the outbreak coordination network work collectively to share information needed to operate at optimal level. Research for developing reliable framework for the collection of inter-organisational coordinated response data and its impact on decision-making and support system for disease outbreak is lacking to date. We introduce a pilot field study using social networks based approach to capture H1N1 inter-organisational coordination data by introducing qualitative questionnaire and quantitative survey, which resulted in discovering the hidden social networks of coordination. Here, we propose a schema that can be used to classify the quantitative data collection and preparation for further empirical analysis and suggest that lessons learned from this can be applied to explore possible data collection and analysis for other types of natural and man made crises.

Keywords: H1N1 outbreak coordination, Swine flu management, inter-organisational coordination, network analysis methods.

Subject classification codes: include these here if the journal requires them

## Introduction

Sharing reliable information is one of the main challenges in any scenario that requires coordination. This is specifically emphasised in crisis in which timely and accuracy of information is a prerequisite to successful coordination. Pandemics management is a complex domain where many players from different organisational structures and skills need to communicate efficiently and timely. We propose a communication schema that can be used to study the communication patterns during large disease outbreaks. The schema was grounded on qualitative study followed by quantitative survey developed in

cooperation which health officials who were heavily involved in the swine flu H1N1 2009 outbreak. This paper starts by introducing some background information about the nature of the problem and then stating the necessity to deal with complex coordination as social networks structure rather than hierarchal one. Then we discuss the qualitative questionnaire that was developed to collect information about processes and communication that took place in H1N1 2009 outbreak in Hunter New England (HNE) local health district in New South Wales Australia. Findings are presented graphically. Then we use these findings to develop the quantitative survey, along with the schema, which the survey is meant to populate. This paper ends with presenting some conclusions and suggesting future paths for this research.

**Background**

Inter-organisational coordination has been the subject of many research quests rom different perspectives including information collection, sharing and coordination during disasters mainly due to the challenges of such collaboration effort [1].

Coordination is increasingly seen to be important as organisations become more reliant on interdisciplinary teams of specialties and distributed operations for addressing complicated situations demanding a multi organisational response. The Oxford English Dictionary defines coordination as a ‘harmonious combination of agents or functions toward the production of a result’.

Malone & Crowston [2] defined coordination as ‘the act of managing interdependencies between activities performed to achieve a goal’. In its simplest concept, coordination merges the activities of many disciplines and organisations together to achieve desired goals and objectives. It describes both processes and the goals and is particularly challenging where the chains of interaction are complex and long [3]. This definition is consistent with a long history in organisational theory of emphasising the importance of

interdependence [4-7]. The later literature evolved by introducing “interdependency” as a key term to describe coordination. This was accompanied by the advancement of information and communication technologies (ICT) as well as by organisational development from hierarchical structures into more complex ones that could not be handled by a single person’s perspective [8]; deducing that completely centralised control became simply unfeasible [9].

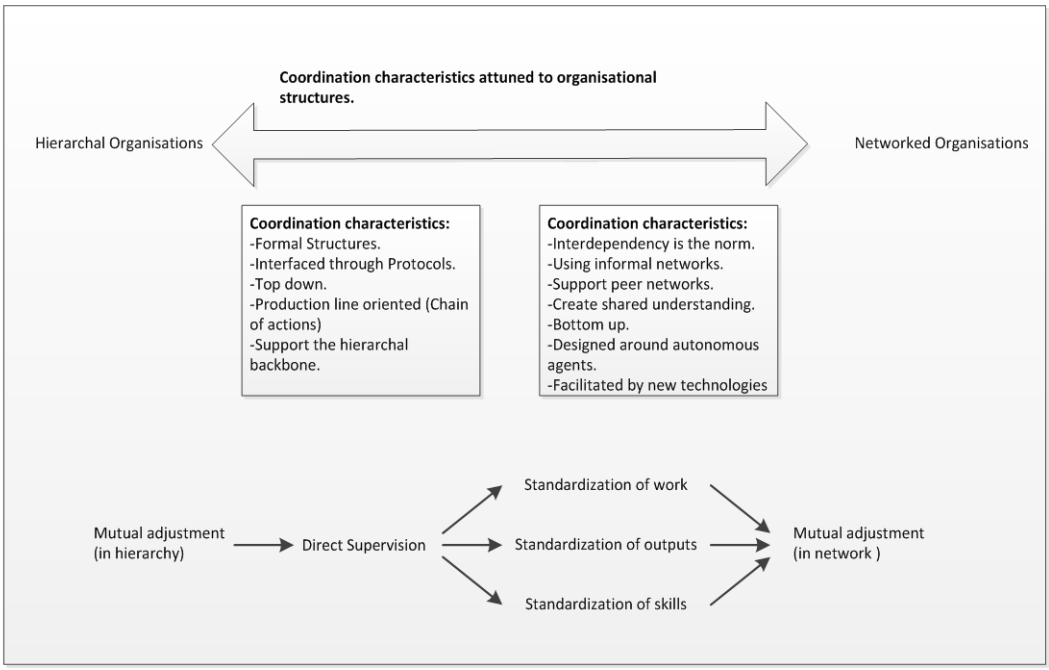


Figure 1: Coordination development with organisations along with the evolution of coordination mechanisms (lower part adopted from Mintzberg [10]

Figure 1 further illustrates the different characteristics of coordination as it phases between hierarchical structures and networked ones, superimposed *of coordination not of control* on Mintzberg’s well-known coordination mechanisms. The new mutual adjustment or horizontal coordination [8] are the most significant contemporary development in organisation design [11].

Research in coordination is therefore an interdisciplinary study that assists in building useful cooperative work tools for supporting activities, actor relations, and their interdependencies for achieving goals collectively.

**Networked Coordination and communication in disasters**

Complexity of coordination in multi-agency dynamic environments during crisis and disasters has been studied by Kapucu [12] and Hossain & Kuti [13] using a framework primarily drawn from both dynamic networks complex adaptive systems theories. Kapucu observed that coordination in extreme events is guided by a group of interconnected actors who necessarily rely on each other to achieve the goals collectively [14].

Being a major facet of coordination, communication has been further studied by Feczak and Hossain [15] within the context of temporal team dynamics for bug fixing behaviour during open source software lifecycle management. A study by Miller & Moser suggests that 'Communication can play a key role in the ability of agents to reach, and maintain, superior coordination' [16]. The two concepts are linked together because communication can be regarded as a necessary precedent to coordination.

Therefore, effective coordination related to timely decision support relies heavily on types, quality and quantity of information flow that passes through different organisational settings. The challenge is to develop a common multijurisdictional coordinated decision support that can detect and support the flow of information required to deal with the crisis. We therefore investigate disease outbreak management and intervention as a coordination effort involving many stakeholders such as public health officials, hospitals, epidemiologists, logistics, etc.

## Disease outbreak coordination

Disease outbreak is a unique form of disasters whereas it can start alone or can accompany other form of disasters (floods, earthquakes) due to dramatic changes in the population welfare and resources. Outbreaks also evolve in a dynamic environment (population movement, travel) in which coordination mechanisms must be also dynamic to adapt to the consequences of disease spread. Therefore, the coordination structure for disease outbreaks cannot be modelled or analysed using current standard and static coordination methods that focus on market theory proposed by Malone & Crowston [17]. The concept of dynamic emerging coordination is better suited to model the inter-organisational communication where agencies have a tendency to establish, drop, and enhance communication links over time in order to achieve the optimal coordination scheme [18]. Hence using the networked approach, emerging coordination can be best modelled as a complex adaptive system where the organisations are interacting dynamically with each other within a large meshed networked environment.

The organisations interacting during pandemic process represents a unique form of inter-organisational coordination. They create a matrix of inter-disciplinary agencies coordinating within certain time constraints (i.e., disease infectivity characteristics). It is essential to capture such communication patterns to investigate its dynamics and further analyse its performance.

## Methodology and Data Collection

In order to understand the complexity of such a task, the first step was to explore some of the activities that are usually performed during disease outbreaks. Some of these tasks are:

- *Surveillance and monitoring*: Is the ongoing collection, reporting and analysis of public health data in a systematic manner to detect and monitor communicable diseases [19].
- *Public communication*: communicating outbreak information updates to the public via different media outlets (TV, radio, internet, leaflets…).
- *Case definitions*: Set of criteria used to classify patients of having a defined illness.
- *Logistics*: transporting different material that deals with the outbreak management and intervention such as, pathology samples, PPE (Personal protective equipment), Anti-pathogen etc.…
- *Outbreak information updates* between different public/private/international organisations.
- *Population screening*: Testing certain population against infection. Like border quarantine services.
- *Epidemiological services:* Usually monitors disease incidence a specific region to develop and analyse statistical data to determine at-risk populations and geographical locations of occurrences.
- *Coordination services*: Some agencies role is to route data and coordinate actions between different organisations. This activity is usually performed by state or federal management agencies for dealing with the crisis emerging from the disease outbreaks.
- *Diagnosis and treatment*: Done by hospitals and other health service centres.

After elaborating the heterogeneity of tasks and organisations that collaborate during infectious disease outbreaks; such diversity mandates the creation of the inter-organisational links. Below is the type of data needs to be collected:

- Organisations: What type of services does the organisation provides? This will determine whom and why the links are formed and will provide reason for creating the Inter-organisational coordination (IOC) structure;
- Organisational links: The process of receiving or initiating link to another agency. This will form the IOC structure which will be further studied and researched;
- Link initiation: Usually the agency that is initiating the link to another one suggests that it is in need of the services of the second one implying a dependency relationship of the first to the second;
- Tie strength: This is the number of links between two specific organisations. These might be created at different periods of the coordination lifetime. The intensity will quantify dyadic dependency between both organisations;
- Links timeline: It is assumed that the need for services/ resources will change during different phases of the outbreak. Hence, some organisations might need to interfere at earlier or later stages of the outbreak timeline;
- Link purpose: This deals with investigating the reason that enticed one organisation to outreach the other and explores whether it is due to resource need or information demand or other.

However, there is a lack of international consensus regarding best practice for collecting data on natural disasters. Along with the complexity of collecting information in disasters due to the constraints of time, funding, and the complexity of the situation, there also remains huge variability in definitions, methodologies, sources, and data points collected [20].

**Multiagency coordination data collection design process**

This section discusses the two phases of the data collection.

***Exploratory phase:***

After deciding the data that is needed; we decided to start with the qualitative data collection method by interviewing subject matter experts responsible for managing and participating in the H1N1 2009 coordination efforts.

Initiating data collection qualitatively provides valuable insight about the culture and practices within emergency management organisations as well as the agencies involved in disease outbreak incidents. This will also provide a cumulative view about how the organisations coordinate during the outbreak and may answer important research questions such as what are the characteristics of the organisations that play a central role during the coordination evolution. Qualitative data collection will enable us to identify the initiation points and end points for the multi-agency coordination process. It may further assist in closely examining the flow of information within organizations and enable better understanding the information flow in this large complex network. In summary, qualitative approach described here enables us to gain the following understanding:

- An exploratory exposure about the type of organisations that work together during infectious diseases;
- Understanding the meta-value of these links, as in what does these links convey between the organisations whether it is information or resources exchange; and,
- Quantifying the links that exist between these organisations.

***Introducing the qualitative questionnaire***

These initial high-level requirements enabled developing the qualitative questionnaire. Prior to instrument development and validation of preliminary ideas of initial conceptual model, it was decided that the ideas need to be confirmed from the field – that is, the disease outbreak personnel themselves. Therefore, in order to elicit a richer understanding of disease outbreak coordination structure and performance (from the disease outbreak personnel's perspective), semi-structured in-depth interviews were conducted. The interview questions were designed and planned carefully so that when executed, a systematic flow to the data collection process was achieved [21, 22]**.** The questions were constructed in such a way so as to avoid resistance, prejudice and any sorts of negative forces within the interview environment. The main interview questions are outlined in table 1 below.

| Section: | Example Questions |
|---|---|
| Situational information | How is outbreak detected?<br>How is information routed?<br>What are the outbreak criteria?<br>What are the containment criteria? |
| Actors | Identifying the organizations involved.<br>Identifying organizational characteristics (jurisdiction/domain/location…)<br>Organizational role: how and when do they get involved in the outbreak?<br>What is their communication plan and protocols? |
| Processes | Information production filtering and distribution. |

| | |
|---|---|
| | Identifying parties involved in each part of information routing phases.<br>The inputs feeds and outcome of the decision support system. |
| Determinants | How to measure coordination gaps?<br>What are the criteria to determine that coordination is successful?<br>Can we use epidemiological measures as performance indicators? Historical data? |

Table 1. Qualitative questionnaire main questions.

*Targeted Audience*

The qualitative questionnaire was designed to target the decision makers, coordinators and middle level managers within the public health system. These usually act as gatekeepers for incoming and outgoing communication within their organizations. Table 2 presents the proposed matrix for each section of the questions along with the proposed interviewees – these positions has been generalized to suite different health authority structures or names that might differ from one state or country to another.

| Section | Proposed Interviewee |
|---|---|
| A. Situational Information | Policy and decsions makers/Biosecurity authorities/Emergency management authorities. |
| B. Actors | Coordination units / Clinical managers/Logistics/Public Health Units/ Emergecy management authorities |
| C. Processes | Mid level or unit managers/Logistics / Epidemiologists/Clinical and suveillance |

| | |
|---|---|
| | units/ Biosecurity authorities. |
| D. Determinants | Policy and decsions makers/ coordination units. |

Table 2. Qualitative questionnaire intended interviewees

The responses to the qualitative questionnaire were aimed at establishing the two following repositories:

- *Domain schema*: A basic knowledge of the terminologies/processes/ workspace environment and sphere of the outbreak management; and,
- *Organizational matrix*: An initial pool of organizations / units that will be used to select the interviewees during the following quantitative phase.

***Quantitative corpus***

In conjunction with qualitative interviews conducted with subject matter experts, the framework was used to further develop and refine a valid and reliable survey instrument. The quantitative method includes a non-traditional "networks" method of data collection and analysis to serve as a fine complement to traditional research methods in behavioural studies. The survey for this study is essentially designed to cover three broad constructs – social networks, coordination and performance. More importantly, the quantitative research method adds further empirical weight to the disease outbreak coordination model by explaining with quantitative evidence how network properties are associated with coordination.

The relational quality of network methods requires shift in thinking when it comes to research methodology. Network approach focus on relations between nodes (organisations in our case) rather than relationships between subjects' attributes. Hence study design, data collection, and data analysis incorporate this relational perspective

requiring unique approaches to each [23]. Data collection perspective will focus on data about nodes and their relations which each other:

- Nodes: As discussed, these represent organisations that have a role in the outbreak management and containment. Table 3 below presents a corpus that links variables to data type. These variables can be used for computational data analysis.
- Relationships: These are usually expressed by exchange of communication or resources and are called “ties” or “links”. They are actually what creates the coordination dynamics. These ties represent the existence of coordination event between two nodes at a point of time and are presented in table 4 below.

These two schema tables (tables 3 and 4) were designed so that it will be populated with the quantitative results. The first one presented in table 3 below is used to store information about the characteristics of each organisation. Each variable has certain data associated with it. This is meant to build a meta-data about each organisation that will facilitate more analysis at later stage.

| Variable | Data | Notes |
|---|---|---|
| ORG_NAME | Organisation name | |
| ORG_TYPE | Organisation type:<br>• International.<br>• Federal.<br>• Local.<br>• Private.<br>• Other. | Identify the jurisdictional level of each organisation. |
| ORG_ROLE1....n | • Leadership and guidance.<br>• Information collection. | Deals with organisational role |

| | | |
|---|---|---|
| | • Information analysis and dissemination.<br>• Training.<br>• Liaison with other organisations.<br>• Resource provisioning.<br>• Logistical support.<br>• Epidemiology.<br>• Community education.<br>• Care. (Hospitals)<br>• Emergency Care. | of the coordination process.<br>Organisations might have multiple roles. |
| ORG_PRE | Has this organisation been predefined as one that involvement in outbreak coordination? | In many disasters: New organisations that were not part of the plan are usually pulled to the coordination structure as result of unpredicted need. |

Table 3. Organisational characteristics schema.

Also networked relationships requires links between the organisations, hence another schema is used as a repository for information about these links. Table 4 below shows this schema along with the interpretation of each variable.

| Variable | Data | Notes |
|---|---|---|
| LINK_NUM | Number of coordination instances between ORG_1 and ORG_2 | Number of links between two organisations. |
| LINK_INI | [ORG_Name] | Organisation that initiates the link |

| | | |
|---|---|---|
| LINK_END | [ORG_Name] | The organisation that the link is directed to. |
| LINK_TYPE | Type of Coordination: can be:<br>● Providing information.<br>● Receiving information.<br>● Resource request.<br>● Resource supply.<br>● Fieldwork.<br>● Other. | Information about the resource or information exchange that this link facilitated. |
| LINK_FREQ | Coordination frequency:<br>● Daily.<br>● Weekly.<br>● Monthly.<br>● Semi Annually.<br>● Annually. | Link frequency measures the link strength and dependencies between organisations. |
| LINK_COMM_METH | Coordination method:<br>● Land line Phone<br>● Mobile Phone<br>● Fax<br>● Email.<br>● Messages.<br>● Web portal<br>● Social Media | Communication media. |

Table 4. Relational corpus

*Targeted Audience*

In order to build an understanding of the epidemic management network, a diverse type of health professionals in various positions and skill sets will be need to provide input to populate the quantitative schema. These positions range from emergency care provider

to clinicians and epidemiologists. Table 5 below shows some of those positions that would participate in the survey.

| Working Field | Positions Example | Notes |
|---|---|---|
| Clinical care | Doctors, Nurses. | |
| Policy decision makers | Senior public health officials. | |
| Emergency Management | Emergency care professionals, Intensive care unit professionals. | |
| Logistics | Ambulance Services. | |
| Public Health | Public Heath unit, epidemiologists. | |
| Detection and Surveillance | Labs, GPs, Infectious disease centres. | |

Table 3. Participants Job title and responsibility

**Results**

In this section, we provide a preliminary overview of the results of both qualitative and quantitative surveys we performed within “Hunter New England” Area Health Service of the New South Wales (NSW) state in Australia. The intention of this overview is only to demonstrate the usage and applicability of the qualitative questionnaire and the quantitative corpus.

Our case study examines the coordination scenario that took place in 2009 when WHO declared the swine flu H1N1 2009 virus endemic. Australia had its first confirmed swine flu case in Brisbane on 7 May 2009 on an international flight. Worldwide WHO figures reported 4.4 fold case increases during June 2009 in confirmed cases whereas in Australia there were 13.4 fold case increases for the same period. The higher Australian rate can be partially attributed to the coinciding influenza season due to the southern winter season [24].

In this case, study, we explore the multi-agency coordination and communication that took place in Hunter New England Area Health Services (HNEAHS) during the endemic. HNEAHS is located in northern NSW within a geographical area of over 130,000 square kilometres, spans 25 local council areas, and has a population of about 870,000 inhabitants. HNEAHS is unique in that it is the only health service in NSW with a major metropolitan centre (Newcastle/Lake Macquarie) as well as a mix of several large regional centres and many smaller rural centres as well as remote communities within its borders. HNEAHS activates the Health Service Functional Area Coordination (HSFAC) centre during major health crises. HSFAC is responsible for leading the management of response operations from the high-level perspective, providing intelligence and guidance, as well as monitoring the cases reported by the "Front Line" (i.e., ED, GPs and other relevant health professionals).

The qualitative questionnaire was first used in the first wave of interviews conducted in November 2010 with three HSFAC senior personnel in HNEAHS so to get the first insights of the agencies, methodologies and procedures of the H1N1 2009 outbreak coordination efforts. The interviews questions we extracted from the ones presented in table 1 and discussed in Semi structured interviews with the three HSFAC senior managers. Below are some of the results of these interviews.

***Qualitative Results***

The interview results presented in this section are the extracts of the responses of the qualitative interviews organised so to address the main research questions discussed in the *methods* section. These results will not be presented here critically rather we will suffice with demonstrating them.

*Situational information*: How is the outbreak is detected?

The outbreak is detected in different methods:

a. Patients presenting themselves at the emergency departments (EDs) within the public hospitals. Those patients might have ILI (Influenza like illness). The patients are “swabbed” to confirm that they are H1N1 positive. Furthermore, all patients details are added to the PHREDDS system (Public Health Respiratory Emergency Department System) which is a state wide system. This system provides a holistic view of the respiratory cases details and numbers within NSW enabling to discover geographical clusters through data mining and pattern analysis.
b. It was thought that general practitioners GPs would play a secondary role in detecting the outbreak where the forecast – and plan - was that potential patients would be channelled to the public hospitals emergency departments. Yet this turned out not to be the case as people with flu symptoms continued to present themselves to their local GPs
c. Containment was a hard criterion to measure since outbreaks do not drop suddenly rather they tail off for a period of time. Yet, “tailing off” provides a good indicator that the number of reported cases is withering away.

*Actors:* Many organisations played role in H1N1 2009 outbreak management, intervention and containment. These range from the international ones down to federal / commonwealth then state and lastly local level. Table 6 below is a list of the organisations, roles and jurisdictional level. This list is by no means comprehensive.

| Name | Jurisdiction | Role |
|---|---|---|
| World Health organisation | Global | Provide advise, information (Such as |

| | | |
|---|---|---|
| | | "case definitions") and surveillance |
| Chief Medial Officer | Commonwealth | Heads the states meetings and makes decisions on change epidemic phases (delay, contain, protect) |
| Chief Health officer | State | Makes State wide decisions, coordinate between different Area Health Services, Resource provisioning |
| Communicable Disease Branch | State | Collect, aggregate and analyse state wide communicable disease data. Provide advice to Area Health Services. |
| Public Health Unit (PHU) | Local | Communicate with hospitals about cases and follow up on patients, provide information to local community. |
| Emergency department | Local | Receive patients, test and provide medical treatment. |
| Intensive care unit | Local | Clinical treatment to ill patients who need special care (ventilators). |
| HSFAC | Local | Coordinate information flow and resources. |

| | | |
|---|---|---|
| Ambulance | State | Provide Personal Protective Equipment (PPE) from the state stockpile. |

Table 6. Some of the organisations that participated in H1N1 2009 Coordination in Hunter New England, NSW, Australia

*Processes:* Here, we elicit information flow for patients presenting themselves at the emergency departments (EDs). When someone presents himself/herself at the ED having respiratory illness she is "swabbed" – specimen taken from nasal discharge – and the swab is sent to the lab (either hospital or reference lab). The public health unit PHU is notified so it can follow up the patient if she discharged. The Lab later confirms back the results and the Communicable Disease branch (CDB) -which is a statewide organisation, and is notified if it the reported result was positive. Then a follow up process is initiated by the PHU depending on the policy and patient condition, for example, it might be decided that the patient will need to be home-isolated, hence the procedures will be explained to her over the phone and isolation pack which consists of masks, gel, and gloves will be dispatched to her.

*Determinants*: There are different ways to look at successful intervention and coordination for outbreaks; one of them is accurate and fast distribution of information and resources. Another is that procedures and plans are disseminated quickly to all EDs so to enable accurate and coherent patients' screening.

*Resource management*: Coordination not only aims to disseminate accurate and updated information, but resources such as vaccine, personal protective equipment (PPE). Such resources are managed by NSW Ambulance service at NSW state level and by department of Health and aging (DoHA) at the Federal level.

***Quantitative results***

After the preliminary understanding of the dynamics of the coordination results, follow up interviews with seven public health officials, health practitioners, and epidemiologists for the same geographical area, Hunter New England, were conducted.

Based on the interviews with the subject matter experts and the grounded data collected. A conceptual illustration of some of the tasks and organisations involved in outbreaks is illustrated in figure 2 below. This conceptual illustration of the model is divided into four quadrants so as to emphasize on the leading agencies for each task. These tasks start from surveillance and detection, to communication and management ending in logistics. These doesn't reflect any timely division of the tasks, rather it reflects their general categories. The Detection quadrant represents the sentinels that can be used to detect outbreaks early. These might be as simple as noting that the sales of specific drug surges in local pharmacies in certain area, the surge of the number of patients with certain symptoms -like influenza likes illness (ILI) - presenting themselves in Emergency Departments (EDs), or microbiology labs reporting a rise of positive results for specific communicable disease. These results are usually communicated to local public health authorities that can aggregate data from other sources and then analyse it against historical trends or other pattern analysis methods so as to determine the extent and the magnitude of the outbreak.

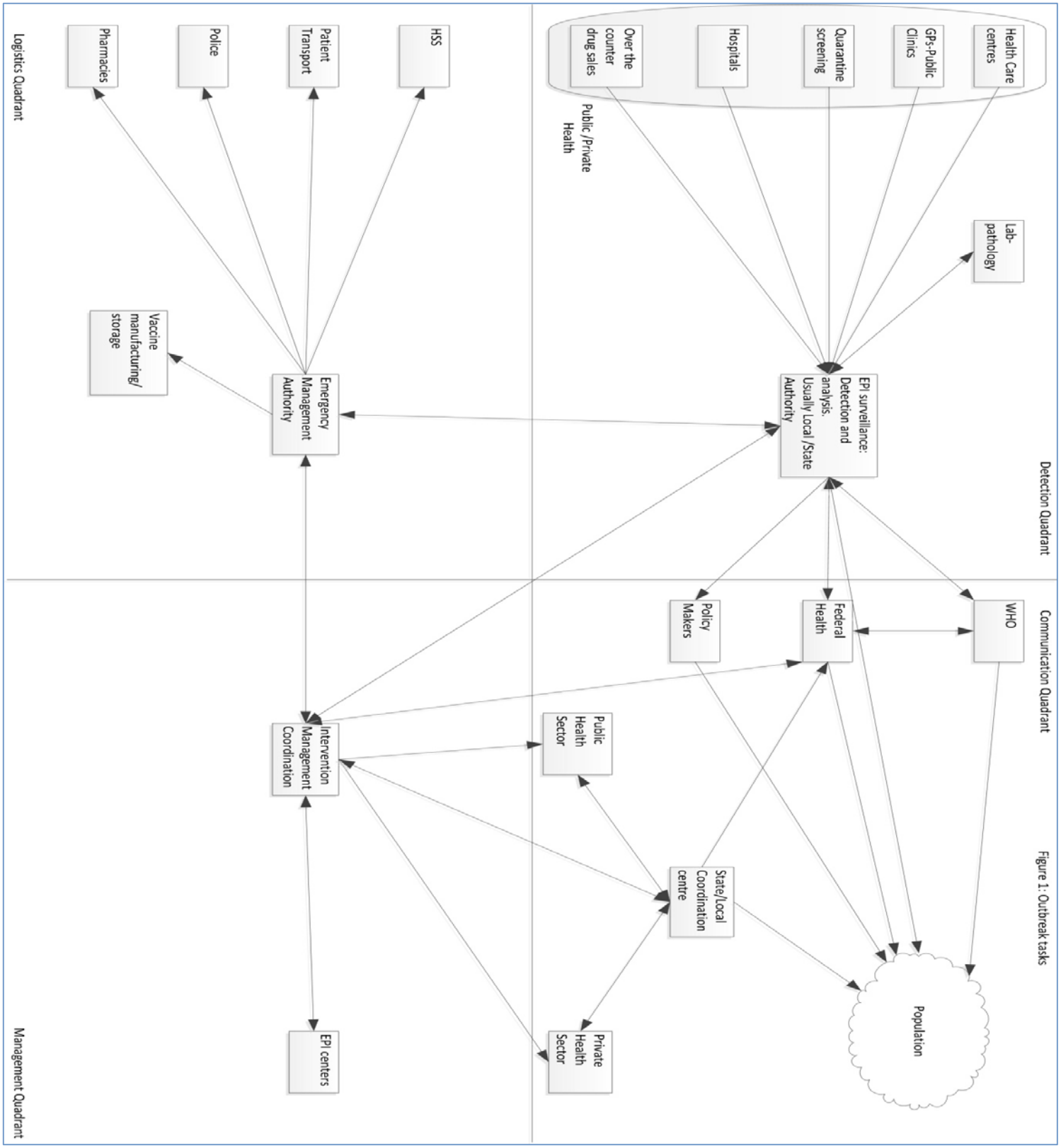


Figure 2. Organisational communication quadrants.

The communication quadrant demonstrations the expected communication channels after detection. The local health authorities act according to protocols in place and report to “higher level” health authorities being state/federal or the like. Consequently, local health authorities also maintain communication with other authorities such as WHO, emergency management centres, etc. Local health authorities further formulate a communication strategy to keep the public and media informed. Such strategies are built around transparency and not arousing public panic rather creating health awareness and promoting safe contact procedures.

Most of the communication in this quadrant takes place according to pre-defined protocols and communication lines. Yet messages –especially ones that are addressing the public – can’t be premeditated whereas the general schema of the disease dictates some of the content. Another important type of communication in pandemics is the “case definition”, which is a set of criteria and conditions that defines who is infected. Case definitions need to be normalised and standardised for many reasons one of which is to accurately determine the cases and hence report them. In global pandemics case definitions are produced by World Health Organisation (WHO) and disseminated to countries’ health authorities that would decide to customise and adapt them.

The management quadrant is where most of the communication and information are made available for decision makers. They utilise these data to initiate the response by activating different emergency management authorities. The agencies within this quadrant usually make high-level management decisions like on which sections of the management plan are to be activated. All the information gathered from health authorities and other parties are analysed and invested to decide the intervention strategy, which in turn is communicated back to combat agencies.

The Logistics quadrant is where agencies mobilise different resources to organisations or individuals who need them. These might be vaccines, Personal Protective Equipment (PPE), isolation packs, ventilators and the like. Performing these activities effectively requires constant feedback from intervention management committees and feedback about the available resources who are part of combat agencies.

Furthermore, the quantitative interviews aimed at populating the data in tables 3 and 4 above hence building a matrix of relationships between different organisations and trying to understand the context of their coordination links.

These results are then presented as network chart visualising the organisations and their links. We discuss here two networks only. The first is the flow of *case definition* from the global level to the local level and the second from to the local level to the "front line" being the ED in this scenario.

*1. Global Case definition inbound flow*

Case definitions are one-page brief communication stating the symptoms and criteria under which the people can be considered as "cases" i.e., positively treated as being infected. Then the procedures of patient management (isolation, treatment…) apply to them. It is very important to communicate the case definition from the originating authority to the front line as fast and accurate as possible since this will ensure shared understanding and management across the health system. Case definition is also the basis for the filtering procedures which increases the accuracy of detected cases hence reducing the costs and logistics for managing. Usually case definitions are created by the world health organisation (WHO), and then disseminated to countries whom can either adopt them without change or modify them according to their local environment and procedures.

Figure 3 below shows inbound H1N1 2009 case definition communication path starting from the World Health Organisation to the HNE HSFAC. Such communication was through the standard hierarchal communication channels that ensured standardised case definitions nationwide

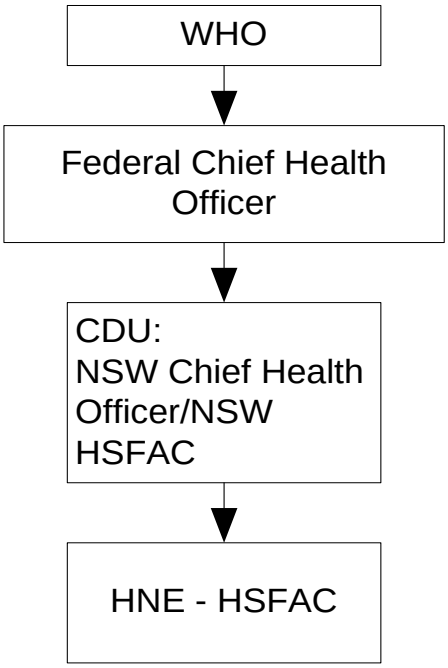


Figure 3. Global Inbound Case definition

2- *Local Case definition communication to EDs*

The communication plan displayed in figure 4 below represents the communication links starting from the state public health and ending at the 37 EDs in all the HNE hospitals. These links are primarily used to distribute quick and intelligent information such as case definitions rather than standard operating manuals and polices which in turn were posted on the HNE website for further reference. Also, the same structure is used to receive feedback acknowledgment of case definition deployment into the system.

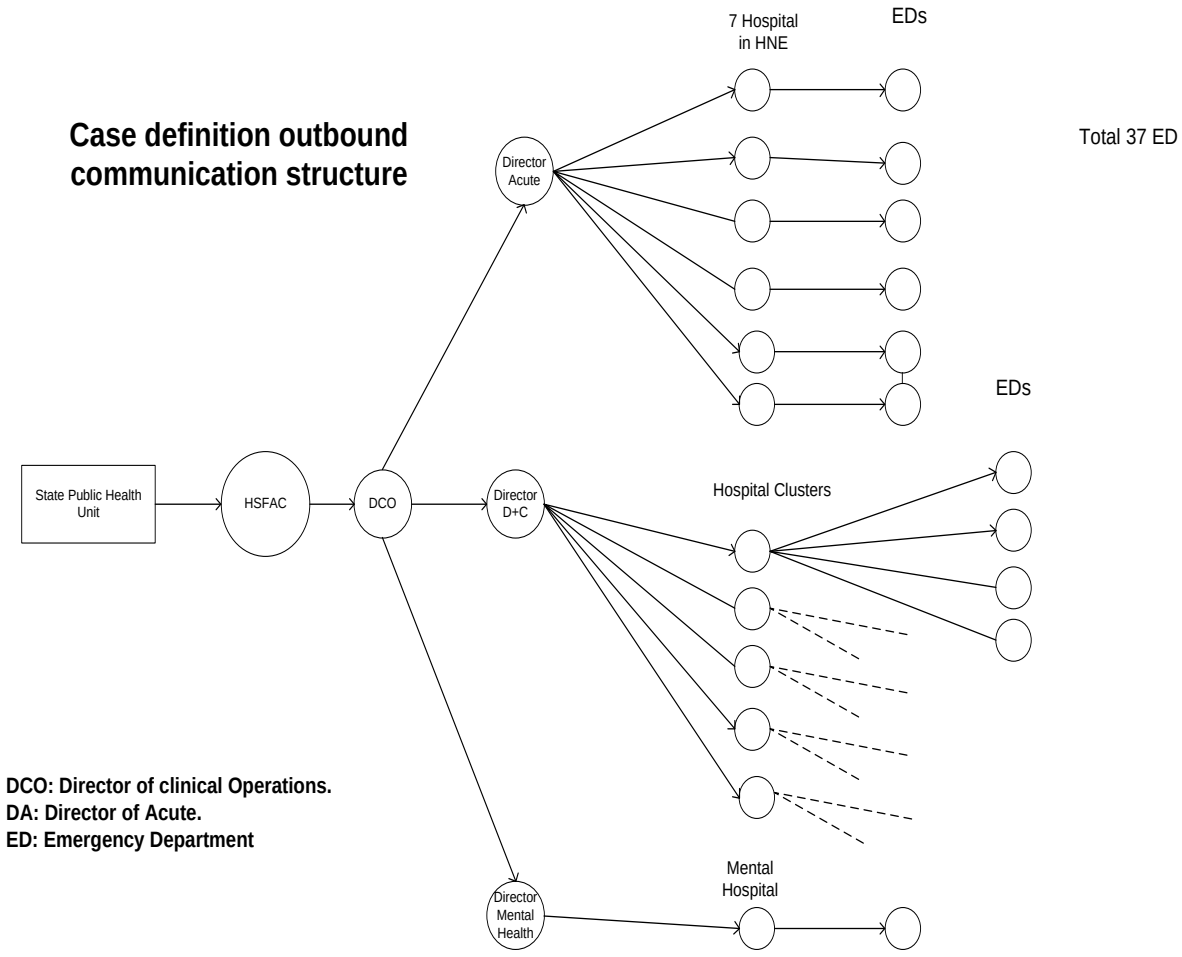


Figure 4. Outbound communication

The HSAFC has strategically positioned itself on the path of communication that bridges the state public health system and the director of clinical operations (DCO). By covering this structural hole, they are able to control and filter the information flow between the two nodes to the benefit of the ED nodes that are linked to the DCO. Hence, the dissemination of the case definition is reduced from four hours to thirty minutes including the acknowledgment from the EDs that the new case definition has been imported into the system. It can be noticed that HSFAC wasn't positioned in highly central location with lots of branches so that it is not overburdened with a

communication overhead. They actually elicited the DCO's high degree centrality and its existing communication channels to pass the intended communication.

## Conclusion

This paper seeks to contribute to an improved interorganisational data collection during pandemics. To do so, a qualitative questionnaire and a quantitative corpus is proposed to capture Inter-organisational coordination data and prepare it for further analysis. This approach help facilitates closer view into the disease outbreak's culture and practices and discover the characteristics of Inter-organisational disease outbreak coordination. Beyound data collection, the next step is to arrange, clean and organise the data to perpare it for analysis. It would be useful then to conduct organisational collaboration evaluation and statistical analysis to investigate disease outbreak coordination from a social networks perspective. Furthermore, whole network analysis conceptual tools such as centrality, cliques and structural equivalence analyses can then be conducted which would provide an indepth picture for the understanding of network and performance patterns at the macro-level. For further research, it would useful to apply the existing data collection procedure to the context of another domain, preferably one that shares characteristics of uncertainty and unstable environments. For example, the tool could be applied to a range of other crisis and emergency events (e.g. floods) to capture social network and coordination data.

## Competing interests

The authors have no competing interests.

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