THE ROLE OF TELEHEALTH IN DISASTER MANAGEMENT: LESSONS FOR THE PHILIPPINES

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Abstract

According to the WorldRiskIndex 2016, the Philippines is the third country most at risk of disasters in the world. Typhoon Haiyan, the strongest on local record, caused widespread destruction of life and property. Current disaster management strategies in the country do not include telehealth as a formal tool in disaster mitigation, response, or recovery. This study reviewed research incorporating telehealth in disaster management from multiple low and lower middle income countries like the Philippines to address this gap by identifying lessons the country might be able to adopt. Studies show that most initiatives centre on evaluating telehealth's effectiveness during the response phase. Unsurprisingly, mobile technology and satellite communications predominated, and most projects were launched using donor funding. Use of telehealth in disaster management in the Philippines could begin by recognising and including telehealth in formal government protocols. The government could leverage the National Telehealth Service Program of the University of the Philippines National Telehealth Center. Documentation and systematic research on telehealth's expected positive contributions to disaster preparedness and response should also be initiated.

Keywords: telehealth; disaster management; low resource setting; Philippines

Introduction

A disaster is "a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources".[1] Disasters may be natural or man-made and include earthquakes, typhoons and fires. They overwhelm the capacity of a system in a way that often leads to considerable loss of life or property. Disaster management is the "coordination and integration of all activities necessary to build, sustain and improve the capabilities to prepare for, respond to, recover from, or mitigate against threatened or actual disasters".[2]

Disaster management is described as a cycle with four phases: mitigation, preparedness, response, and recovery. These phases do not always occur in order, and phases may even overlap. The course and length of each phase are determined by the severity of the disaster,[3] and also by the capacity for response by disaster-related organisations before and during disasters. The four phases and the activities included in each of the phases are shown in Figure 1.

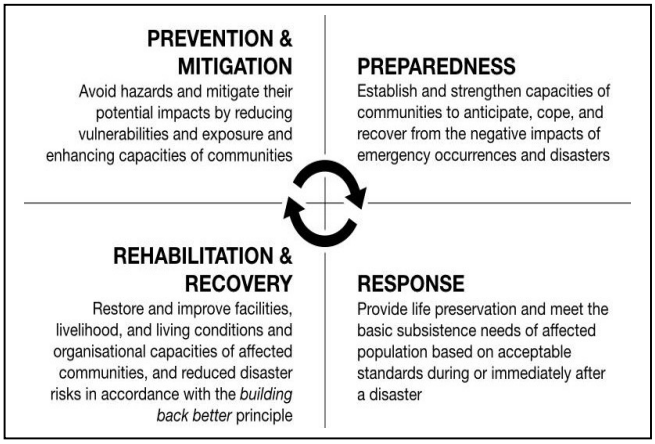

Figure 1. Thematic areas of the National Disaster Risk Reduction and Management Plan (NDRRMP) 2011-2028 of the Philippines.

The mitigation phase of the cycle focuses on minimising the effects of a disaster. Activities may include improving infrastructure, analysing vulnerabilities and hazards, and educating the public. The preparedness phase centres on planning response activities and allocating resources to building capacity and establishing warning systems. Typically, this occurs when a hazard has been identified, for example when a storm warning is in place. The response phase happens after the disaster. The main objective of this phase is to minimise loss of life and property.

Activities in this phase may include search and rescue activities and delivery of care. The recovery phase is characterised by the community's attempt to restore normal functions and return to normal activities. Activities may include rebuilding of houses and other infrastructure and debris management. This phase flows into the mitigation phase, which should be now informed by the community's previous experience with disasters.[3]

The number of disasters worldwide per year has increased 60% from the period 1994-1998 to 1999-2001.[3] More alarming is that the increase seems to affect low and lower-middle income countries more with an increase of 142%.[4] It is imperative for these countries to look towards novel approaches for disaster management such as telehealth.

The World Health Organisation defines telehealth as "computer-assisted telecommunications to support management, surveillance, literature and access to medical knowledge" which "includes surveillance, health promotion and public health functions".[5] It traditionally includes services such as consultation (with a specialist or general practitioner), remote patient monitoring, consumer medical and health information and medical education and training. The term encompasses the term telemedicine which merely refers to "the use of telecommunications to diagnose and treat disease and ill-health".[5]

While different, telehealth and telemedicine are commonly used interchangeably and are both sharply delineated from health informatics which pertains to the use of electronic medical records, medical databases and information systems.[6] Both telehealth and health informatics are part of the greater term eHealth, which refers to the use of information and communications technology (ICT) for health.[5]

Telehealth has been applied in the different phases of the disaster management cycle through various projects throughout the world. It was first used in the context of disaster management by the National Aeronautics and Space Administration or NASA in 1985.[7] A magnitude 8.1 earthquake which struck Mexico City, destroyed all terrestrial telecommunications infrastructure. Satellite technology, using NASA's Advanced Communications Satellite (ATS-3) provided the vital lines of communication between ground personnel and international rescue and relief teams.[8] For 24 hours, the ATS-3 prioritised channelling communication and information in order to aid relief and rescue efforts. Since NASA's use of the ATS-3, many projects applying telemedicine and telehealth in disaster management have been conducted throughout the world, but mainly during the response phase.[1]

Telehealth in the Philippines first came about as a response to the needs of doctors practicing in rural and remote areas of the country for specialist advice in the management of difficult cases. Through its research-cum-service activities conducted with the support of the Department of Health, the National Telehealth Center (NTHC) of the University of the Philippines Manila was the first to implement a nationwide telemedicine project in the country, the National Telehealth Service Program (NTSP).[9] Started in 2004, the program currently supports 774 primary care physicians all over the Philippines.

While telehealth has long been used to improve healthcare access in the country, its use in disaster management has not been well established or thoroughly studied. The Philippine National Disaster Risk Reduction and Management Plan (2011-2028),[10] which outlines priority government efforts in disaster management, does not mention telehealth or telemedicine or even the use of information and communication technology in any of the phases of disaster management. Neither does the Philippines' Department of Health (DOH) and Department of Science and Technology (DOST), in its eHealth Strategic Framework and Plan (2013- 2017), recognise telehealth as an indispensable tool in disaster management.[11]

The Philippines is a country uniquely vulnerable to disasters. Its location on the Pacific Ring of Fire and fronting the Pacific Ocean exposes the country to strong typhoons and earthquakes which can cause flash floods, mudslides, and storm surges. In recent history, the strongest storm to ever make landfall, Typhoon Haiyan, devastated the country in 2013 leaving 6,000 people dead and PHP 60 trillion ($1.3

trillion USD) worth of property damage in its wake.[12] A month earlier in the same year, the island of Bohol in central Philippines experienced its first earthquake in centuries, destroying historical landmarks, property and crops, and claiming lives. Two years after Haiyan, the United Nations Office for Disaster Risk Reduction (UNISDR) estimated that the Philippines suffered $1.9 billion USD in economic damages from disasters in 2015 alone.[13]

With the huge economic burden of disasters, the role of telehealth in disaster management in the Philippines should be explored. In 2013, the NTHC launched a telemedicine initiative to aid the government's response efforts for Super Typhoon Haiyan called the Yolanda Response Information System (YRIS).[14] Built on top of the existing processes and protocols of NTSP, YRIS was mounted with the help of the Sahana Foundation. The objective was to create a channel through which health workers from areas affected by ST Haiyan could communicate with the DOH. YRIS was able to receive requests for support from physicians currently enrolled in the NTSP in areas affected by Typhoon Haiyan and receive pledges from potential donors through the website. Volunteers from NTHC matched pledges and requests, and reports were submitted from YRIS to the DOH daily. While noble and novel, YRIS failed to assimilate into the response infrastructure within the DOH. It was never reactivated.[14]

Methods

This study is intended to create a telehealth implementation model fit for the Philippines through conducting a thorough review of different disaster-related research studies from Low and Lower Middle Income countries (LLMICs). We aimed to understand the role of telehealth in each phase of the disaster management cycle and determine the limitations on the use of telehealth in disaster management in LMICs. Ultimately, this paper seeks to identify the best process with which to mainstream telehealth into the disaster management cycle of the Philippines.

This study was a review of the available literature on the use of telehealth in disaster management in low and lower middle-income countries. This review was conducted to develop recommendations on the use of telehealth in disaster management for the Philippines. Specifically, this study aimed to answer the following questions:

i) What are the characteristics of telehealth for disaster management projects in LMIC's?
ii) What are the limitations on the use of telehealth in disaster management in LMIC's?
iii) How can telehealth be integrated into mainstream disaster management in the Philippines?

This review, conducted in January 2014, included studies conducted in low and lower-middle income countries, as defined by the World Bank, regarding the use of telehealth or telemedicine in disaster management In order to generate the studies for review, an online literature search using PubMed, PubMed Central, Google Scholar and Google with the search terms telemedicine or telehealth and disaster or disaster management was conducted. Blog posts and news articles were also excluded in the study.

No date restrictions were applied. Inclusion criteria were that a study must: discuss the use of telehealth or telemedicine in disaster management, be conducted in low and lower middle income or developing countries, reference natural disasters, such as typhoons, floods, or earthquakes, and be available as open access articles written in English.

Resources describing Humanitarian emergencies due to civil wars were excluded.

Full texts of the selected studies were retrieved and studied. Each resource was analysed according to ttype of study, year of publication and locale of the study. The studies were then read thoroughly to generate themes that would answer the questions. Relevance to low-income countries such as the Philippines was subjective in nature, as different contexts come into play, but relevance was determined in relation to the overall National Disaster Risk Reduction and Management Plan 2011-2028 of the Philippines.

Results

A total of 155 free full text articles were found on the topic of which 14 were reviewed (Figure 2). Of these, only 73 were in English. After the abstract review, 31 articles (41%) were eliminated as the studies referred to non-LIC or LMIC countries. Further study of the abstracts revealed only 14 articles which met the study criteria. Most of the excluded studies did not deal with the use of telehealth or telemedicine in disaster management *per se*. The remaining 14 studies were classified according to the type of study, year of publication and locale of study and are summarised in Table 1.

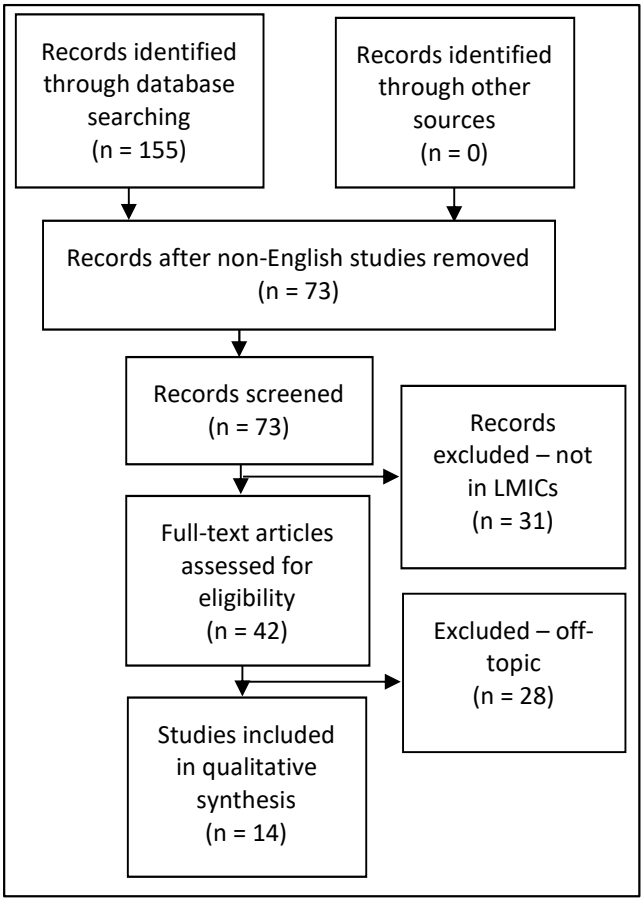

Figure 2. PRISMA flow diagram of the search results.

Seven of the 14 studies included in the review were case studies or case reports. The other half were narrative reviews which collated information from other case studies. All of the studies were descriptive in nature. This design might have been favoured because it allowed authors to discuss their projects thoroughly. Additionally, human emergencies, especially those that result from disasters and the attendant suffering, are a sensitive topic, making ethical randomised controlled trials or other rigorous research approaches difficult. Of the 7 case studies, three were conducted in Pakistan, two in the Philippines, one in Sub-Saharan Africa, and one in India. Other studies in this review were considered due to their relevance to LMICs, and did not have a specific locale/population (as indicated by an N/A in Table 1). The relative concentration of case studies in the Indian subcontinent may be due to the relatively advanced technology available in these areas compared to the rest of the countries belonging to the low and low-middle income classes. These areas are also prone to disasters and calamities, which explains why many of the initiatives originated from these countries.

After classifying the papers into these categories, the content of these studies was reviewed and the initiatives were grouped according to the thematic areas of the National Disaster Risk Reduction and Management Plan (NDRRMP) 2011-2028 of the Philippines (Table 1).

Discussion

Telehealth Use in Disaster Management in LMICs

Most of the studies about telehealth in disaster management dwell on its usefulness in the response phase of the disaster management cycle. The focus is on developing new ways to facilitate the work of first responders by exploring connectivity options, compacting medical equipment or miniaturising computers. These are intended for the field responder to have a substantial effect on the care of patients in the field with the help of remote specialists.

In the 1992 United States relief efforts in Somalia, telehealth was used to transmit images from the ground team onsite to the US. During the 13-month deployment of the team, many unnecessary medical evacuations and transfer of patients were avoided through telehealth.[7]

Telemedicine can not only help in acute management but also in long-term care. Researchers have recounted their experience in the aftermath of the Bagh earthquake in Pakistan where a physician and a few medical students set-up a mobile clinic equipped with telehealth services to decongest the hospitals.[20] Disasters create a scenario where a large number of people often need long-term follow-up, especially following injury and trauma.

One of the first telemedicine applications, The Spacebridge Programme, was implemented during the earthquake in Armenia 18 years ago. It used an Internet-based application linking clinicians through videoconferencing to address 240 medical cases resulting from the earthquake.[2,19]

Althwab and Norris cite other innovations such as remote triage of injured patients before arrival at hospital, telemonitoring of patients via wearable sensors, direction of medical teams to crisis areas identified by sensors, victim identification via Google person finder and crowdsourcing of situations for rapid response.[2] The authors further propose an

Table 1. Studies on telehealth and disaster management in LMICs.

Research title	Author/s	Type of report	Year reported	Focal countries
Disaster E-Health: A New Paradigm for Collaborative Health care in Disasters[31]	D Parry, AC Norris, S Madanian, et al.	Conceptual report	2015	N/A
Use of telemedicine in disaster and remote places[7]	S Ajami, P Lamoochi	Narrative review	2014	Multiple LMICs
A Case Study of Telemedicine for Disaster Management in Underdeveloped Remote Districts of Balochistan, Pakistan[15]	WS Khawaja, Lu Xinhai	Case Study	2013	Pakistan
mHealth in Sub-Saharan Africa[16]	TJ Betjeman, SE Soghoian, MP Foran	Narrative review	2013	Sub-Saharan Africa
Ad hoc wireless Sensor Network Architecture for Disaster Survivor Detection[17]	N Ahmad, N Riaz, M Hussain	Case Report	2011	Pakistan
Disaster Management, Developing Country Communities and Climate Change: The Role of ICTs[18]	NT Yap	Narrative review	2011	Multiple LMICs
Pre-hospital Application of Telemedicine in Acute-Onset Disaster Situations[19]	M Turnock, N Mastouri, A Jivraj	Case Study	2008	Multiple LMICs
Role of Satellite Communications in Telemedicine During the Bagh Earthquake in Pakistan[20]	Asif Zafar Malik	Case Report	2008	Pakistan
India: Ready to Implement Mobile e-Telemedicine[21]	International Telecommunications Union	Case report	2009	India
Sahana: Overview of a Disaster Management System[22]	M Careem, C de Silva, R de Silva, et al.	Case study	2006	Philippines
ICT and Health in Low Income Countries: the potentials and constraints[23]	CP Chandrasekhar, J Ghosh	Narrative report	2001	India
Applications of Telemedicine and Telecommunications to Disaster Medicine: Historical and Future Perspectives[24]	V Garshnek, F Burkle	Narrative review	1999	N/A
The Scope and Development of Disaster eHealth[2]	A Althwab,AC Norris	Narrative review	2013	Multiple LMICs
TVWS in Disaster Response: A Breakthrough Technology for Rapid Communications after Typhoon Haiyan in the Philippines[25]	D Mapa, J Cann, J Yan	Case report	2014	Philippines

eHealth paradigm for disaster healthcare in all disaster management phases tailor made for LMICs, possibly following the model provided by Sieben, Scott, and Palacios.[26]

Use of mobile technology

The advent of mobile phones and personal digital assistants has amplified the effect of telehealth by allowing for the exchange of high-quality images and video enabling lay responders, who are often first to arrive on-site, to be guided as they help victims in need of rescue.[17] Two studies, both in Pakistan, reported on portable computers and satellite connectivity to enable rescuers to send patient data, text and images to base stations.[17,27]

In India, a system was developed to provide medical assistance and services such as mass gathering and earthquake relief in times of natural calamities. Disaster Management System or Disamed 2000 is a compact telemedicine disaster management kit within a Tele-mobile van, capable of providing full hospital services as well as transmitting information from the site to a base camp when necessary.[21]

One study reported on mobile healthcare apps introduced to victims, volunteers and responders for context-aware simulation and training programmes to prepare them in times of disaster, automated contextualised health advice to seek response, and for direction to resources such as food and water during the recovery phase.[2]

Similarly, the Philippines DOH developed and implemented an SMS-based reporting system Surveillance in Post Extreme Emergencies and Disasters (SPEED). It allows notification of clinical conditions and thus faster response in order to prevent potential disease outbreaks, especially in evacuation centres after a natural or man-made emergency.

Connectivity is key

During a disaster, land-based communication often becomes unusable. In the response phase, connectivity must be established in a matter of hours. Careem et al. assert that "disaster management solutions should work even when there is a lack of a communication infrastructure. Further, all solutions should work on commodity hardware wherever possible."[22] Telehealth should be a driving force behind shifting the paradigm from disaster response to disaster preparedness and mitigation. If telehealth systems are to work post-disaster, there should be adequate planning and preparation.

Satellite systems are often cited as the logical option: portable and easy to set-up and use. However, these are costly and in the setting of lower-middle income countries, impractical to keep running for the days or weeks until terrestrial communication lines are restored.[25]

The ITU provided TV White Space (TVWS) technology which was tested in the Philippines: it extends the connectivity from 'satellite systems to voice over internet protocol and small data packets'. This allowed communications from and to the Bohol earthquake and Haiyan-hit communities in Eastern Visayas, including real-time presentation of patients to Manila-based specialists under the national telehealth programme. However, the technology required that the necessary equipment be on–site before the disaster as the equipment is quite difficult to ship.

International exchange of disaster healthcare experience and on-line big data compilations to counter epidemics were made possible through cloud computing. Websites to support crisis patients and their carers, Gmail groups for healthcare support when and where needed, and organised crowdsourcing to deploy scarce health resources were all part of social networking that is becoming essential in the recovery phase of disaster.

Donor funding Almost all of the projects presented in these papers were funded externally which included the technology training, maintenance, and shipment. Donor dependence has to transition towards long term sustainable disaster risk mitigation.

Institutionalising telehealth in disaster management

In 2004, an administrative order in the Philippines was issued declaring a national policy on health emergencies and disaster. The policy included establishing

1. an emergency preparedness and response plan,
2. a crisis and consequence management committee to handle major emergencies and disasters, and
3. a health emergency management team.

There is a health emergency management system that monitors all health emergencies and disasters. This also informs the public of health emergencies and enforces standards and regulates facilities in the implementation of health emergency procedures.[28]

The medical profession has been traditionally slow to adopt technology[2] and it is no different for the use of telehealth in disaster management because the practice attempts to integrate clinicians, telehealth experts, and disaster management experts.

Studies reveal that the only way forward is to ensure integration at an early stage, through policy or otherwise, in order to be successful. Education and training in this new discipline is likewise key. It was natural for the National Telehealth System to extend telehealth to disaster response, building on the existing relationships with communities already enrolled in the system, and technologies familiar to users.

Of consideration is the digital divide – not only present between different countries but even within the countries themselves, with the majority of the population being excluded from benefitting from technology due to lack of access, knowledge or skill.

Lessons for the Philippines

This study has limitations but its findings are compelling, highlighting that there is a role for telehealth in disaster management in lower-middle income countries like the Philippines. In terms of the technology and the innovation, the Philippines is not far behind its neighbours and will surely be able to catch-up. There is, however, a need for the country to institutionalise its telehealth systems and to begin to gain awareness on the usefulness of telehealth in disaster management.

House Bills 6336[29] and 4119[30] filed in the Philippine Congress in 2012 and 2014, respectively, outline the institutionalisation of telehealth as a practice and as a service in the Philippines. The bills recognise the role of telehealth in disaster management and allow for government to have the mandate and the resources to incorporate telehealth in existing programmes for disaster management. Legislation would solve the issue of dependence on donors. A logical first step to institutionalise telehealth in disaster management would be to revive and push for the approval of this into law.

The agenda for the integration of telehealth and disaster management should be taken up by the National eHealth Steering Committee which is jointly chaired by the Department of Health (DOH) and the Department of Science and Technology. Disaster management should be incorporated into the eHealth Strategic Framework and Plan. The National Disaster Risk Reduction and Management Council (NDRRMC), innovators, developers and implementers from the public and private sectors as well as academia should likewise be welcomed into the fold. Since DOH is a council member of NDRRMC, the health department could lead and facilitate monitoring, responding and assisting local government units in times of disaster and health related emergency through the integration of telehealth in disaster management. Research into this field, especially concentrating on novel solutions on the problems of connectivity and cost and those leveraging the power of mobile phones, should be supported.

Conclusion

Despite lack of integration, the role of telehealth in disaster management has been long established by precedent in developed countries where access to sophisticated equipment and technology is readily available. In lower-middle income countries like the Philippines, implementing telehealth in the context of disaster management is an opportunity for the country to shift from being a place where disasters 'happen' to becoming a place where disasters are studied and managed through telemedicine.

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References

1. United Nations International Strategy for Disaster Reduction (UNISDR). (2009). UNISDR Terminology for Disaster Risk Reduction 2009. Available at: http://www.unisdr.org/files/7817_UNISDRTerminologyEnglish.pdf accessed 23 October 2017.
2. Althwab A, Norris T. (2013). The scope and development of disaster e-health. Available at: https://www.slideshare.net/HINZ/the-scope-and-development-of-disaster-ehealth accessed 23 October 2017.
3. Vasilescu L, Khan A, Khan H. Disaster

management cycle - a theoretical approach. *Management & Marketing Craiova* 2008;(1):43-50. Available at: http://www.ceeol.com/content-files/document-142487.pdf accessed 23 October 2017.

4. Ansari, U. *The Ecology & Environment Compendium for IAS Prelims General Studies CSAT Paper 1, UPSC & State PSC*. Malviya Nagar, New Delhi, Disha Publications, 2017. Available at: https://market.android.com/details?id=book-RLctDwAAQBAJ accessed 23 October 2017.
5. World Health Organization (WHO). eHealth. eHealth at WHO. Available at: http://www.who.int/ehealth/about/en/ accessed 23 October 2017.
6. American Telemedicine Association. (n.d.). About Telemedicine. Available at: http://www.americantelemed.org/main/about/about-telemedicine/telemedicine-faqs accessed 23 October 2017.
7. Ajami S, Lamoochi P. Use of telemedicine in disaster and remote places. *J Educ Health Promot* 2014;3:1-8.
8. Garshnek V. Applications of space communications technology to critical human needs: rescue, disaster relief, and remote medical assistance. *Space Commun* 1991;8(3-4):311-317. Available at: https://www.ncbi.nlm.nih.gov/pubmed/11540154 accessed 23 October 2017.
9. National Telehealth Center. (n.d.). National Telehealth Service Program. National Telehealth Center. Available at: https://telehealth.ph/project-ntsp/ accessed 23 October 2017.
10. National Disaster Risk Reduction and Management Council. National Disaster Risk Reduction and Management Plan (NDRRMP) 2011-2028. Available at: http://www.ndrrmc.gov.ph/attachments/article/41/NDRRM_Plan_2011-2028.pdf accessed 23 October 2017.
11. Department of Health (DOH). (2013). Philippines eHealth Strategic Framework and Plan 2013-2017. Available at: http://www.doh.gov.ph/sites/default/files/Philippines_eHealthStrategicFrameworkPlan_February02_2014_Release02.pdf accessed 23 October 2017.
12. National Disaster Risk Reduction and Management Council. NDRRMC Update Situation Report 108: Effects of Typhoon "YOLANDA" (HAIYAN). Available at: http://www.ndrrmc.gov.ph/attachments/article/1329/Effects_of_Typhoon_YOLANDA_(HAIYAN)_SitRep_No_108_03APR2014.pdf accessed 23 October 2017.
13. Domingo RW. (2016). Natural disasters cost PH $1.9B in 2015. Available at: http://business.inquirer.net/207030/natural-disasters-cost-ph-1-9b-in-2015 accessed 23 October 2017.
14. Magtubo KM, Fernandez-Marcelo PG. YRIS: Yolanda Response Information System.
15. Khawaja WS, Xinhai L. A case study of telemedicine for disaster management in underdeveloped remote districts of Balochistan, Pakistan. *J Econ Sustain Develop* 2013;4(20):1-13. Available at: .http://www.iiste.org/Journals/index.php/JEDS/article/viewFile/9802/10169 accessed 23 October 2017
16. Betjeman TJ, Soghoian SE, Foran MP. mHealth in Sub-Saharan Africa. *Int J Telemed Appl* 2013;6:1-7.
17. Ahmad N, Riaz N, Hussain M. Ad hoc wireless sensor network architecture for disaster survivor detection. *Int J Adv Sci Technolgy* 2011;34:9-16. Available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.359.7416&rep=rep1&type=pdf accessed 23 October 2017.
18. Yap NT. *Disaster Management, Developing Country Communities & Climate Change: The Role of ICTs*. Manchester United Kingdom, Center for Development Informatics; 2011. Available at: http://pt.esacproject.net/sites/intranet.esacproject.net/files/yapdisastermanagementdevelopmenticts.pdf accessed 23 October 2017.
19. Turnock M, Mastouri N, Jivraj A. *Pre-Hospital Application of Telemedicine in Acute-Onset Disaster Situations*. McMaster University; 2008. Available at: http://www.un-spider.org/sites/default/files/Prehospital%20telemedicine%20in%20disasters.pdf accessed 23 October 2017.
20. Malik AZ. Role of satellite communications in telemedicine during Bagh earthquake in Pakistan. In: Khan HA, Qurashi MM, Hayee I, eds. Better Healthcare through Tele-Health. Islamabad:

COMSATS' Series of Publications; 2008;101-106.
21. International Telecommunications Union . (2009). India: Ready to Implement Mobile E-Telemedicine. Available at: https://www.itu.int/ITU-D/cyb/app/docs/Question14.pdf accessed 23 October 2017.
22. Careem M, de Silva C, de Silva R, Raschid L, Weerawarana S. Sahana. (2006). Overview of a disaster management system. *Proceedings of the International Conference on Information and Automation*. Available at: ftp://ftp.umiacs.umd.edu/pub/louiqa/PUB06/Sahana6.pdf accessed 23 October 2017.
23. Chandrasekhar CP, Ghosh J. Information and communication technologies and health in low income countries: the potential and the constraints. *Bull World Health Organ* 2001;79(9):850-855. Available at: https://www.ncbi.nlm.nih.gov/pubmed/11584733 accessed 23 October 2017.
24. Garshnek V, Burkle FM Jr. Applications of telemedicine and telecommunications to disaster medicine: historical and future perspectives. *J Am Med Inform Assoc*. 1999;6(1):26-37. Available at: https://www.ncbi.nlm.nih.gov/pubmed/9925226 accessed 23 October 2017.
25. Microsoft Philippines. (2014). TVWS in Disaster Response: A Breakthrough Technology for Rapid Communications after Typhoon Haiyan in the Philippines. Available at: https://s3.amazonaws.com/oi2_kf_prod/attachments/132a206b-1739-45fc-8079-eac64abd039a.pdf accessed 23 October 2017.
26. Sieben C, Scott RE, Palacios M. e-Health and the Disaster Management Cycle. *Global Telemed eHealth Updates: Knowl Resources* 2012:368-372.
27. Gul S, Ghaffar H, Mirza S, et al. Multitasking a telemedicine training unit in earthquake disaster response: paraplegic rehabilitation assessment. *Telemed J E Health* 2008;14(3):280-283.
28. Department of Health. (2004). Department of Health Administrative Order 168: National Policy on Health Emergencies and Disasters. Available at http://koha.nlp.gov.ph/cgi-bin/koha/opac-detail.pl?bib=341158 accessed 23 October 2017.
29. Abaya J. (2012). An Act Promulgating a Comprehensive Policy for a National System for Telehealth Service in the Philippines. Available at: http://www.congress.gov.ph/legisdocs/basic_15/HB06336.pdf accessed 23 October 2017.
30. Espina R. (2014). An Act Promulgating a Comprehensive Policy for a National Telehealth System with the Use of Advanced Communications Technology in the Philippines and to Provide Funds Thereof. Available at: http://www.congress.gov.ph/legisdocs/basic_16/HB04199.pdf accessed 23 October 2017.
31 Parry D, Nordic AC, Madanian S, et al. Disaster E-Health: A New Paradigm for Collaborative Healthcare in Disasters. *Proceedings of the ISCRAM 2015 Conference.* Available at: https://pdfs.semanticscholar.org/c232/ba894de866e0ef5decef8ae6097292efc70c.pdf accessed 23 October 2017.