

The Development of MRI: A Tool for Quality Assessment of MERS-COV Infection in Healthcare Facilities

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ABSTRACT

The risk of spreading the Middle East Respiratory Syndrome Coronavirus (MERS-CoV) has become a global concern. In the era of evidenced-based practice, adequate quality assessment tools should be available to evaluate health facilities when confronted with infectious diseases. This study has combined literature reviews and experts judgment to develop a tool used to assess healthcare institution's readiness when confronted with MERS-CoV. A mixed-method design was employed using meta-analysis and Delphi procedure. The meta-analysis was used to extract themes and developed an initial list of indicators to assess MERS-CoV readiness. The results of the conducted literature reviews were used to produce an evidence-base list of possible items for inclusion in the readiness index. The expert's opinions have constituted the validity and reliability of the developed tool. Field trial was also conducted to and construct validity and consistency were done. A total of seven experts in the field of research, infection control and healthcare management took part in the Delphi procedure. The Delphi procedure reached up to three rounds to finalize the list of indicators used in MRI: MERS-CoV Readiness Index tool. The initial list of 40 items were reduced to 38 items in the final tool. Items retained were then grouped according to dimensions namely administrative and managerial activities; knowledge, skills, and attitude of healthcare providers; environmental control; and personal protective equipment. In the field trial, Cronbach alpha yielded high reliability of 0.93. This study has produced valid

and reliable evidence-based assessment tool for assessing healthcare readiness in catering MERS-CoV cases.

Keywords: MERS-CoV, readiness index, dimension, healthcare

INTRODUCTION

The risk of spreading the Middle East Respiratory Syndrome Coronavirus (MERS-CoV) is becoming a global concern. The outbreak of MERS-CoV in Arabian Countries alarmed many nations, as this caused fatality worldwide. As observed, a large number of Overseas Filipino Workers (OFWs) are working in Middle East countries alone, where large numbers of MERS-CoV cases are identified. It must be noted, that last February 2015, a Filipina nurse who worked in one of the hospitals in Saudi Arabia was confirmed to have MERS-CoV, and almost 224 passengers were exposed. This was the first case in the Philippines but definitely not the last if no comprehensive action will be done.

In light with this reality, the World Health Organization (2013) and Center for Disease Control (2011) have openly recognized the need for a readiness plan to prevent the spread of infectious diseases. CDC (2011) has created an essential tool for infection control professionals and healthcare epidemiologist in responding to a real or suspected MERS-CoV infection. The essential tools includes administrative support (Pronovost et al., 2004; DOH, 2011; Larson, 2000; Friedman et al., 1999), infection control (CDC, 2007; O'Boyle et al., 2002; Goldrick, et al., 2002), environmental control (WHO, 2013; WHO, 2011; Rutala et al., 2004; Malik et al., 2003) and personal protective equipment (Tubadeza, 2015; WHO, 2007; CDC, 2007; Tenorio, 2001). The Philippine government, on the other hand, has created Executive Order No. 168, creating an interagency task force to assess, monitor, contain, control and prevent the spread of any infectious diseases in the Philippines (Balita, 2014; Official Gazette, 2014).

Similarly, the Department of Health has recommended preventive measures such as proper hand hygiene; practice of proper cough etiquette; avoidance of contact with farm animals; avoid contact with sick or infected with MERS-CoV; for health workers, strictly follow infection control protocols; practice health habits and do not panic nor believe in rumors (DOH, 2015). The said DOH management corresponds with the WHO infection control measures

which placed utmost importance in harmonizing and strengthening infection prevention and in the preparedness and response to outbreaks (WHO, 2014). In addition, the Department of Health-Hong Kong (2014) suggested all must observe personal and environmental hygiene to prevent MERS-CoV. However, the Technical Working Group on Development of Standards in Infection Control for Healthcare Facilities (2015) has placed the ultimate responsibility for prevention and control of infectious diseases with the administrative management. It is believed that all environmental controls in combination with the right administrative controls will reduce the risk of infection but are not a guarantee to protect staff and patients 100% (DOH, 2015).

While it is important that health practitioners carry out their duties in promoting infection control measure, it is but essential that the health care practitioners should ensure that they are healthy in carrying out their duties. The Center for Disease Control observes that MERS-CoV is highly contagious thus it is essential for all health practitioners to increase their immune response to prevent transmission (CDC, 2007). Moreover, the need for collaborative policies and procedures for health care personnel has been strongly emphasized through the use of Personal Protective Equipment (Tubadeza, 2015), frequent monitoring of high risk areas (DOH, 2015), health and safety education, immunization programs, evaluation of potentially harmful infectious exposures, implementation of appropriate prevention measures, and coordination of plans for managing outbreaks among personnel (WHO, 2014). The aforementioned literature and studies avouch that infection control, managerial activities, staff's knowledge, skills and attitude, environmental control and PPE were important tools in preventing disease transmission. These infection control measures and other managements pave way to a clear understanding on the readiness assessment among hospitals in the Philippines.

Although the foregoing data underscore the utmost importance of awareness and preparation in decreasing MERS-CoV infection, there is still much to be desired in terms of the quantity/ quality of infection control measures. In the era of evidenced-based practice, appropriate and quality assessment tools should be available to evaluate health facilities when confronted with infectious diseases. The need for MERS-CoV standardized approach in creating an assessment tool is vital to avoid bias and preconceived ideas during evaluation. Furthermore, there is a call for individual health care facilities to identify and determine the extent of readiness when confronted with infectious diseases like

MERS-CoV. Thus, developing a readiness assessment tool is essential in evaluating degree of preparedness of various hospitals in the Philippines.

These gaps can be addressed by developing a readiness index using formal consensus method. The index will help health care institutions understand the interactions of different elements, thereby improving the promptness and preparedness of every healthcare organization. Moreover, the index can improve the response capacity of every health care institution by incorporating the needed dimensions essential in preparation for a real or suspected MERS-CoV infection.

FRAMEWORK

This study is anchored on Florence Nightingale's Environmental Theory (1860) and Center of Disease Control (CDC) Framework for Preventing Infectious Diseases (2011).

Florence Nightingale's Environmental theory focused on organizing and manipulating the physical, social and psychological environment in order to put the person in the best possible conditions for nature to act. The manipulation of the physical environment serves as a major component of nursing care providing an explanation as to why it is important to carry out infection control measures. The theory is further supported by the Center of Disease Control (CDC) Framework for Preventing Infectious Diseases (2011). Aside from the role of environment, the framework prepares the health institutions to prevent and control transmission of infectious diseases thereby protecting the populations and individuals. It recognizes three critical elements such as strong public health fundamentals, high-impact interventions and sound health policies as effective measures to prepare and reduce the risk of spreading infections in health care settings. This provides a roadmap for improving the ability of the health care facilities to prevent highly dangerous diseases, and newly emerging threats like MERS-CoV infection.

In application, Nightingale's theory and CDC's Framework produces major concepts in developing the MRI: MERS-CoV Readiness Index. These concepts comprises the four dimensions that are seen to be interrelated as illustrated in Figure 1.

Readiness index is therefore the result of the synergistic interaction among dimensions namely, Managerial and Administrative activities, Health Care Workers (HCWs) knowledge, Skills and Attitude, Environmental control and

Personal Protective Equipment (PPE). De Hock (1997) specified in modern concepts of management that interactions of the elements in an organization were found to obey multiple feedback loop systems rather than the traditional linear type of interactions. It represents the main components and processes needed by every health institution in creating a positive readiness when confronted with MERS-CoV cases.

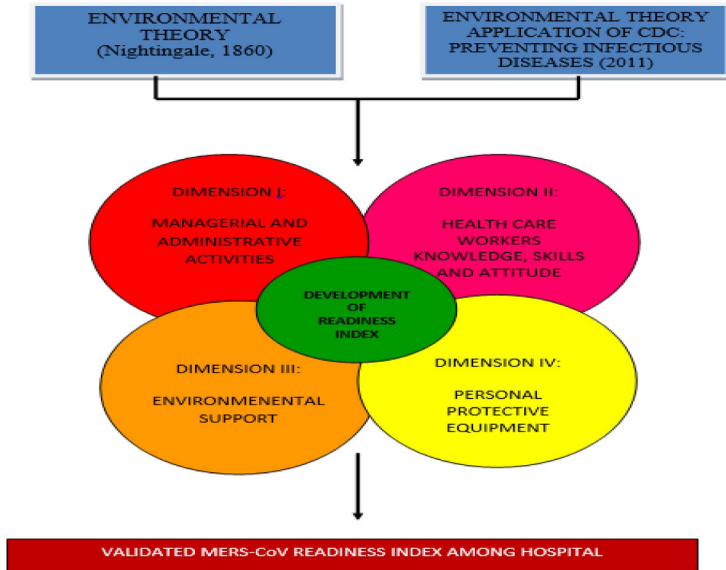


Figure 1: Framework of the Study

OBJECTIVES OF THE STUDY

The study was designed to develop an instrument to determine healthcare setting's preparedness when confronted with MERS-CoV. It specifically aimed to: (1) develop a MERS-CoV Readiness Index; (2) assess the validity and reliability of the instrument; (3) determine the optimal weights from the different dimensions; and (4) design a scoring method for the MERS-CoV readiness index.

METHODS

The study has utilized the combination of the literature reviews and expert opinions through a standardized approach in the development of MRI: MERS-CoV Readiness Index. Specifically, this paper used mixed-method design utilizing meta-analysis and Delphi procedure. Meta-analysis of related literatures and studies were used to generate an evidence-base list of possible items for inclusion in the readiness index. The results of conducted literature reviews were analyzed to identify emerging themes and concepts.

The Delphi method was chosen over other consensus techniques because of its ability to allow all group members equal participation and influence, even when separated geographically (Institute of Health Economics, 2012). A modified Delphi procedure was employed to refine the tool developed.

There were seven experts comprising the validation committee: one from the nursing administration, an expert in infection control and a trained nurse on emerging infectious disease, another one is a researcher and a medical practitioner who is trained in emerging infectious diseases, the third expert is a statistician by profession, who have been evaluating research papers for years, another expert is from the academe, a clinical instructor teaching Medical-Surgical Nursing, and an expert in qualitative research, another expert is from the Region X office of the Department of Health and was handling research and development in the said office, the other expert is researcher and a project based nurse of the Zuellig Family Foundation and the last expert is a language professor who have been teaching English and Science and an expert in English for specific purposes (ESP). The experts were all self-selected based on their specialization and expertise. Moreover, the panel were oriented on the process of evaluation. The Delphi process, their level of participation and questionnaires/tool were sent electronically through email. The experts were given 3 weeks to respond to each evaluation.

The Delphi process utilized in this study was adopted using the Institute of Health Economic Delphi Process (2012). The first Delphi round provided opportunities to allow the panelist to rank the importance of the indicators initially formulated. At this round, the experts can suggest new indicators if needed. The identified themes were then scrutinized at this round. The second Delphi round provides feedback on the revised indicators based on the revisions suggested in the first round. The developed MRI tool was then tried out to 183 healthcare practitioners. The Statistical Package for Social Sciences (SPSS)

Computer Software utilizing the Cronbach Alpha Formula was utilized to analyze reliability and consistency in a large population. While the third round comprises the final evaluation and refinement of the proposed instrument. At this round, the evaluation of refined instrument was conducted by the panel of experts. The computation of weighted scores were also appraised by the panel of experts.

RESULTS AND DISCUSSION

Development of MRI: MERS-CoV Readiness Index

Table 1

Phase 1 Analysis: Significant Statements and Corresponding Formulated Meanings and Themes Emerging from Related Literature Search

Theme	Formulated Meaning	Example	Study and Authors
Managerial	Implementation	“lines of communication”	DOH (2011), DOH-Memo (2013), Curtis et.al (2006), Provost et.al (2004), Cohort, Leope et al (2003)
Administrative	Human Resource	“manpower, triage”	DOH (2011), DOH-Memo (2013), CDC (2007), Anecdotal,
Protective Equipment	Precaution	“respiratory masks, hand hygiene”	DOLE (2015), Tubadeza (2015), DOH (2011), WHO (2007),
Infection Control	Education Monitoring	“timely training and update”	MOHE (2013), CDC (2015), DOH (2015) Case study, Virginia Department of Health (2011), WHO (2007)

Table 1 continued

Attitude	Readiness	“prompt identification”	DOH (2011), WHO (2013), Curtis, et.al (2006)
Environment	Facility	“regular cleaning & disinfecting”	WHO (2013), CDC (2007)
Ventilation	Special Resource	“negative pressure room”	Case study, Center for Disease Control (2015)
Knowledge	Symptoms	“fever, cough and shortness of breath”	Cohort study, Hong Kong Special Administrative Region (2014)
Work Skills	Surveillance	“assessment of suspected MERS-CoV individual”	Cohort study, Center for Disease Control (2013)

The systemic reviews from different published literature and studies produced significant statements describing and demonstrating a MERS-CoV ready facility. Table 1 illustrates the statements with its corresponding formulated meanings and the themes that emerged from the related literature search. This table revealed that the nine (9) themes surfaced from the prior search: managerial, administrative, protective equipment, infection control, attitude, environmental, ventilation, knowledge, and skills.

Using meta-analysis, the collected themes were grouped and summarized according to commonalities, achieving four (4) summarized dimensions namely: (1) administrative and managerial activities, (2) healthcare workers knowledge, skills and attitude, (3) environmental control, and (4) Personal Protective Equipment. A 40-item indicator was drafted on each dimension and was apportioned equally containing the 10-item statement for each indicator. This has generated an evidenced based list of potential items for inclusion in the readiness index.

Validity and Reliability of Instrument using the Delphi procedure

First Delphi Round

The panel of experts scrutinized the contents of the initial list of indicators based on their knowledge, experience and its practical relatedness of each item to its dimension. Following the results of this round, thirty-two items were retained, seven items were revised, and one item was deleted. Table 2 illustrates the summary of expert’s remarks and revisions made in round 1 of the Delphi procedure.

Table 2

Tabular Revisions made in the MERS-CoV readiness Index from the Experts Remarks

Dimension	Indicator No	Remarks/ Original Indicator	Revised Indicator
-	-	Consider stating the indicator to a questionnaire form	Restated all indicators to a questionnaire form.
Administrative and Managerial Activities	2	Restate this: There is an open coordinating system with the Department of Health in your Region	Is there a system for coordinating with the Department of Health in the Region?
Administrative and Managerial Activities	3	It is given fact that all healthcare facilities conducts regular monitoring of infection control measures since it is mandated by DOH, consider another indicator	Deleted this indicator
Administrative and Managerial Activities	4	Specify the timely bases stated in the indicator	Does your administration encourage and support infection control trainings in a regular basis? Please specify on the remarks column whether (monthly, quarterly, bi-annual, or as the need arises).

Table 2 continued

Dimension	Indicator No	Remarks/ Original Indicator	Revised Indicator
Administrative and Managerial Activities	6	Revised the statement: The administration encourages and supports infection control trainings in a timely basis.	Is there a prepared contingency plan for suspected MERS-CoV clients who cannot be readily accommodated?
Administrative and Managerial Activities	-	Please include items on Risk management & Regulation in case a healthcare provider is exposed to MERS-CoV	Is there available protocol and contingency plan for screening and exposed healthcare providers (symptomatic and/or asymptomatic) (e.g ensuring that healthcare provider has ready access to medical consultation and referral)?
Knowledge, skills and Attitude of the Healthcare providers	-	Revise Dimension's name from Healthcare workers Knowledge, Skills and Attitude. There is an indicator for knowledge and skills but none for the attitude.	Revised to Knowledge, skills and Attitude of the Healthcare providers Is it a common practice to use infection control measures when in contact with different patients?
Knowledge, skills and Attitude of the Healthcare providers	14	Add five moments of hand hygiene in the statement: five steps hand hygiene protocol before and after patient contact is practiced	Are five-steps and five-moments of hand hygiene protocol before and after patient contact regularly practiced?
Knowledge, skills and Attitude of the Healthcare providers	16	Please give example for this statement: Healthcare providers are knowledgeable on the internal and external referral system for MERS-CoV cases.	Are healthcare providers knowledgeable on the internal and external referral systems for MERS-CoV cases including referral to isolation triage, RITM, DOH, or MERS-CoV ready hospitals? <i>Please indicate in the remarks column specified referral.</i>
Knowledge, skills and Attitude of the Healthcare providers	18	These are part of the occupational safety measures: all healthcare providers practiced self-protective measures like taking vitamins and regular check-ups	Are there regular check-ups (annual or as necessary) as part of occupational safety measures instituted by the hospital?

Table 2 continued

Dimension	Indicator No	Remarks/ Original Indicator	Revised Indicator
Knowledge, skills and Attitude of the Healthcare providers	20	These are all part of the isolation guidelines: standard and airborne precautions are practiced by all healthcare providers	Are isolation guidelines practiced by all healthcare providers?
Environmental Control	21	Are the respondents to choose which is applicable? Or both will be rated?	Inserted an additional instruction: Please encircle the letter whichever applies in your hospital.

A review of the contents and a repeat meta-analysis was conducted to revise the readiness index, based on the expert’s review. The summary of suggestions and comments were consolidated, and the tool was sent back to the panelist for the second round.

Second Delphi Round

The panelist had the opportunity to evaluate the 39 remaining items after the first round. All of the experts judged the tool as very relevant in assessing the degree of readiness of various hospitals. It is further suggested to include one more item under environmental control relevant in assessing MERS-CoV Readiness. Also, the seven experts have agreed to use the tool in a large population. The instrument was tried out in selected hospitals across geographical locations in Bukidnon. The trial conducted underwent reliability measurement using correlation to Cronbach alpha.

The instrument was given to 183 healthcare practitioners in the province of Bukidnon. The result of the first try out is shown in Table 3. The tabular value showed Cronbach alpha of $\alpha=0.935$. Note that a reliability coefficient of 0.70 or higher was considered “acceptable” in most social science research situations.

Table 3

Phase II Analysis: Reliability Statistics of Bukidnon tryout

Cronbach alpha	Cronbach's Alpha Based on	
	Standardized Items	No of Items
0.935	0.931	40

Table 3 reveals that the developed readiness index had high reliability showing internal consistency. It can be surmised that the respondents in

Bukidnon understood each statement in each dimension. Out of 40 items, 2 were discarded, and 38 were accepted based on the Cronbach alpha for the Item deleted and Corrected Item –Total Correlation.

Table 4

*Phase II Analysis: Summary of discarded items after the first trial
(n= 183, Bukidnon Hospitals)*

Dimension	Item No.	Indicator	Corrected Item-Total Correlation	Cronbach alpha if Item Deleted	Decision
Environmental Control	27	Is there presence of institutional policies on safe waste management?	.100	.936	Discarded
Personal Protective Equipment	34	Is there a presence of disposal area for infection-soiled equipment and PPE materials?	.187	.936	Discarded

Furthermore, Table 4 summarizes the items that were discarded after the tryout. The discarded items were from the Environmental Control dimension (item number 27) with the lowest corrected item-total correlation of 0.100, and from Personal protective Equipment Dimension (item number 34) with the second to the lowest corrected item-total correlation of 0.187. This means that the two items both had weak correlations in terms of describing the institution's preparedness when confronted with MERS-CoV. This was explained by the fact that the two items were already mandated by the DOH to be present in all health facilities not only specific to the presence of MERS-COV. It can be surmised that the item/indicators do not measure the unique features of the disease (MERS-CoV) being assessed.

Furthermore, there were 38 items that were retained. These items show either moderate or high Cronbach Alpha item correlations. This illustrates that the items were perceived by healthcare providers as a good tool to assess MERS-CoV Readiness. In the revised instrument, Dimension 1: Administrative and Managerial Activities have 10 indicators; Dimension 2: Knowledge, Skills, and Attitude of the Healthcare Providers have ten indicators; Dimension 3:

Environmental Control has nine indicators; and Dimension 4 has nine indicators.

Other revisions made after the tryout were the reconstruction of the statement to specify the timeliness of certain indicators. The revisions were based on remarks given by some participants. There were also several item indicators which were reworded to improve its consistency and clarity. For Dimension 1, item number 3 was revised by categorizing the word *regular basis* to *annual*; thus changed to *Does your administration encourages and supports infection control trainings annually?*. For Dimension 4: Personal Protective Equipment, item number 38 was restated from *regular training* to *Does your institution conducts annual training on the proper use of PPE?*. Most of the restatements were based on the minimum requirement of the Department of Health in terms of timeliness of certain activity or criteria (DOH, 2011).

The instrument was then revised after the tryout. The result of the Cronbach Alpha and the revisions made were all emailed to the experts. Also, the revised instrument was provided through email for review and comments.

Third Delphi Round

After the expert’s review, the instrument was accepted by all panel members, and no further comments were given. The computation of optimal weights was determined after the acceptance of the panel. The computation of the weights was based on the idea that the item weight was equal to the stability measure divided from the total of the stability measures for all items. Table 5 shows the summary of weights per dimension.

Table 5

Summary of Weights per Dimension and specific Indicators

Dimension	Weight
<i>Administrative and Managerial activities</i>	27%
<i>Knowledge, Skills and Attitude of the Healthcare providers</i>	26%
<i>Environmental Control</i>	23%
<i>Personal Protective Equipment</i>	24%

Among the four dimensions, Dimension 1: Administrative and Managerial Activities, had the highest optimal weight of 27%. This showed that Dimension 1 greatly influenced the outcome of the MERS-CoV readiness

index in the healthcare settings. DOH (2011) clearly recognized managerial activities as an essential separate set of measures to facilitate the smooth implementation of the other components of infection control (IC). It was further recommended that within each healthcare facility, there shall be a coordinated institutional program with sufficient and adequate designated personnel with clearly defined responsibilities, commensurate authority, clear lines of communication, and other resources to facilitate the effective prevention, detection, and control of healthcare-associated infections among patients, staff and visitors (DOH, 2011).

On the other hand, data revealed that Dimension 3: Environmental Control has the least weight comprising only 23%. It can be quoted from the expert panel's review and noted from that of DOH (2011) that it clearly identified environmental control as the second line of defense, but budget allocation did not speak for its significance. It was believed that all environmental controls in combination with the right administrative controls would reduce the risk of infection but cannot be a guarantee to protect staff and patients at 100% (DOH, 2011).

It was interesting to note that there was less disparity of weights among the four dimensions. This showed that the four dimensions were essential in determining the MERS-CoV Readiness of the healthcare institution. MERS-CoV Readiness was, therefore, sensitive to the interaction of the four dimensions. In related studies (De Hock, 1997) on modern concepts of management, the interactions of the elements in an organization were found to obey multiple feedback loop systems rather than the traditional linear type of interactions. In other words, there will be a constant state of interaction between the elements and over time throughout the interaction. If the results of the interaction elevate the state of the system, then a positive readiness index would be observed.

Based on the computed weights, scoring and qualifying statements were developed and validated by the same panel of experts. The scoring and qualifying statements helped in interpreting and describing the MERS-CoV readiness index in different healthcare facilities. Moreover, Table 6 shows the range of scores and qualifying statements that were used in the study. The scores are evaluated and suggested by the panel of experts.

Table 6

Score Range and Interpretation System for MERS-CoV Readiness Index

Scoring Index	Description	Interpretation
0 – 33%	Low	Minimal application of managerial activities, slow administrative control, poor implementation of environmental control and non-compliance to PPE measures
34% - 67%	Moderate	Minimal application of managerial activities, limited administrative control, limited implementation of environmental control and limited compliance to PPE measures
68% - 100%	High	Maximum application of managerial activities, fast administrative control, very good implementation of environmental control and full compliance to PPE measures

The optimal weights and scoring were emailed to the panel for feedback and comments. All of the experts have accepted the computation of the weights and scoring of the instrument. The instrument was packaged for use by other researchers.

The MRI: MERS-CoV Rediness Index

The instrument is structured to determine the synergistic interactions among four dimensions namely, administrative control & managerial activities, knowledge, skills, and attitude of the healthcare workers, environmental control and personal protective equipment. Therefore, the extent of readiness index is mathematically expressed as:

$$\text{MERS-CoV RI} = \text{summation of scores from administrative control \& managerial activities} + \text{administrative control \& managerial activities} + \text{environmental control} + \text{personal protective equipment}$$

The MRI is scored using two responses namely PRESENT and ABSENT. The response as PRESENT (scored as 1 point) indicates that the indicators are *practiced* and *evident*. While response as ABSENT (scored as 0 point) indicate that indicators are *not practiced* and are *not readily evident*.

CONCLUSIONS

The paper has produced the first systematically developed evidence-based MRI: MERS-CoV Readiness assessment tool for different healthcare settings. In addition, the scores and qualifying statements can help describe the readiness of the hospitals when confronted with MERS-CoV.

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