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The Need to Change the Roles of the Emergency Medical Service System in the National Response System Due to the Middle East Respiratory Syndrome Coronavirus (MERS-CoV) Crisis in the Republic of Korea in 2015

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Abstract: The purpose of this study was to determine the need to change the roles of the emergency medical service system in the national response system due to the Middle East Respiratory Syndrome Coronavirus (MERS-CoV) crisis in the Republic of Korea in 2015. For this purpose, the data from the Ministry of Health and Welfare (MOHW) and the Korea Centers for Disease Control and Prevention (KCDC) were used. The data released from the Korean Broadcasting System (KBS) supervising disasters at the national level were used. The MERS outbreak duration in the Republic of Korea ranged from May 20 to December 23, 2015. The data were analyzed using SPSS for Windows 12.0 Version. During this duration, 186 persons were officially diagnosed with MERS. Super-spreaders #1, 14-16 and 76 infected 154 (82.7%) out of 186 deaths. Of these, #14 infected 85 (55.2%) patients. The 52.6% of the infections by the 5 super-spreaders occurred in "emergency room". The period between after diagnosis and death was 16.78 days on average. The period between after diagnosis and discharge was 20.06 days on average. On the basis of these results, there is a need for the emergency medical service system in the national response system to play an efficient role.

Key words: Disaster, emergency medical service, MERS, infection, super-spreader, diagnosed

INTRODUCTION

The World Health Organization (WHO., 2015) reported that MERS infection broke out in a total of 26 countries: 9 in Middle East, 8 in Europe, 3 in Africa, 5 in Asia and 1 in Americas.

Cotten *et al.* (2013) reported that MERS broke out in Saudi Arabia in 2012. Zaki *et al.* (2012) noted that it was related to bats. Chu *et al.* (2014) reported that MERS CoV was associated with camels. Hemida *et al.* (2014) also reported that it was associated with camels. Assiri *et al.* (2013) noted that the median incubation period for the condition was estimated at 5.2 days with the serial interval of 7.6 days.

Hunter *et al.* (2016) found that MERS infection might involve such symptoms as chest pain, fever, cough and difficulty in breathing. Banik *et al.* (2015) estimated that MERS-CoV (40.0%) was at higher risk of causing death than SARS (10.0%). Hunter *et al.* (2016) contended that a medical employee and a patient could primarily transmit MERS to each other. Kim (2015) noted that as the number of MERS patients increased that of healthcare providers infected with MERS also increased, possibly resulting in safety problems and its spread.

The MERS outbreak on May 20, 2015 has changed the social system and awareness in South Korea. The infection-related disaster resulted in closure of schools and changes in the pattern of using public transportation and in the tourism industry. Kim (2015) contended that the failure of the government to cope with the MERS infection immediately after its outbreak increased fear of the infection among citizens. It lead to serious economic and social spin-off effects due to closure of schools, the depressed tourism industry and the depressed industry for domestic demand.

It can be said that the MERS infection is one of the infection-related disasters that can spread anxiety and fear at both social and psychological levels. This study aimed to determine the need to change the roles of the emergency medical service system in the national response system due to the MERS infection outbreak.

It intends to help the emergency medical service system reinforce its personnel, facilities, equipment and

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systems due to the MERS infection outbreak. It also aimed to help make a plan, take a measure and make restoration more efficiently when an infection-related disaster breaks out and to provide basic data that could help activate programs related to the emergency medical service system in the national response system.

MATERIALS AND METHODS

Research tools: This study aimed to determine the need for the emergency medical service system in the national response system to play a role due to the MERS infection outbreak in South Korea in 2015. The MERS crisis lasted 7 months from May 20, 2015 when it broke out until December 23, 2015 when the end of MERS was finally declared. During the period of 7 months, 186 persons were officially diagnosed with MERS infection.

Both the data from the "briefing concerning the daily status" by MOHW (2016) and KCDC (2016) and those concerning the "MERS infection status" as disclosed by KBS (2015) supervising disasters at the national level were used.

The "briefing concerning the daily status" by MOHW (2016) and KCDC (2016) mentioned the number of MERS infections, deaths, discharge, treatment, infection stage, infection place and so on. The briefing was given in the morning.

The data concerning the "MERS infection status" as disclosed by KBS (2015) supervising disasters at the national level were updated online in terms of the number of MERS infections, death, discharge, treatment, infection phase, infection place and so on. These data made up for the missing data in the "briefing concerning the daily status" by MOHW (2016) and KCDC (2016).

After the MERS infection outbreak, the "briefing concerning the daily status" by MOHW (2016) and KCDC (2015) and the data concerning the "MERS infection status" as disclosed by KBS (2015) were coded until the declaration of its end. The daily MERS status was updated.

The common variables between the "briefing concerning the daily status" and the data concerning the "MERS infection status" were classified into gender, age, infection stage, infection place, patient category, health status, date of diagnosis, date of death. Date of discharge and super-spreader status. For the purpose of this study, the incubation period, the period between diagnosis and death and the period between diagnosis and discharge were recoded. The variables were coded for the purpose of this study to obtain results.

Analytical method: The "briefing concerning the daily status" by MOHW (2016) and KCDC (2016) were coded using an SPSS for Windows 12.0 Version Program. Frequency analysis, cross-tabulation analysis, descriptive statistics, t-test and ANOVA were performed. The significance level was set at $p<0.05$.

RESULTS AND DISCUSSION

MERS crisis characteristics by gender: The MERS crisis characteristics by gender are as shown in Table 1. Both males (38.7%) and females (44.0%) in their "60's" were more likely to get infected with MERS. Both males (86.5%) and females (68.0%) who were "ordinary people" were statistically significantly more likely to get infected with MERS ($p<0.001$). Both males (74.8%) and females (84.0%) were more likely to be "discharged".

MERS crisis characteristics by health status: The MERS crisis characteristics by health status are as shown in Table 2. The most frequent infection place was an "emergency room" for deaths (50.0%) and discharges (43.8%). The most frequent infection stage was "tertiary" for deaths (81.6%) and discharges (63.0%). The largest patient category was "ordinary people" for deaths (97.4%) and discharges (74.0%).

MERS crisis characteristics by super-spreader: The MERS crisis characteristics by super-spreader are as shown in Table 3. Super-spreaders #1, 14-16 and 76 infected 154 (82.7%) out of 186 deaths. Of these, #14 infected 85 (55.2%) patients.

The infection place were statistically significantly more likely to be "emergency room (52.6%)" ($p<0.001$). Super-spreader #1 infected in a "sick ward", #14 in an "emergency room", #15 in a "sick room and sick ward", #16 in a "sick room and sick ward" and #76 in a " sick ward".

Table 1: MERS crisis characteristics by gender

	Gender (N:186)				
	Male	Female	Total		
Variables	111 (59.7)	75 (40.3)	(N:186)	χ^2	p-values
Age					
10's	1 (0.9)	-	1 (0.5)	7.118	0.310
20's	4 (3.6)	9 (12.0)	13 (7.0)		
30's	18 (16.2)	8 (10.7)	26 (14.0)		
40's	19 (17.1)	11 (14.7)	30 (16.1)		
50's	26 (23.4)	14 (18.7)	40 (21.5)		
≤60's	43 (38.7)	33 (44.0)	76 (40.9)		
Patient category					
Ordinary person	96 (86.5)	51 (68.0)	147 (79.0)	27.354	0.000***
Healthcare provider	7 (6.3)	16 (21.3)	23 (12.4)		
Caregiver	-	8 (10.7)	8 (4.3)		
Medical assistant	8 (7.2)	-	8 (4.3)		
Health status					
Death	26 (23.4)	12 (16.0)	38 (20.4)	3.044	0.218
Discharged	83 (74.8)	63 (84.0)	146 (78.5)		
Treatment	2 (1.8)	-	2 (1.1)		

***p<0.001

Table 2: MERS crisis characteristics by health status

Variables	Health status (N: 186) Death 38 (20.4%)	Discharged 146 (78.5%)	Treatment 2 (1.1%)	Total (N: 186)	χ^2	p-values
Infection place						
Unidentified	-	2 (1.4)	-	2 (1.1)	6.629	0.998
Middle East	-	1 (0.7)	-	1 (0.5)		
Sickroom	8 (21.1)	19 (13.0)	-	27 (14.5)		
Sick ward	10 (26.3)	47 (32.2)	1 (50.0)	58 (31.2)		
Examination	-	3 (2.1)	-	3 (1.6)		
Emergency room	19 (50.0)	64 (43.8)	1 (50.0)	84 (45.2)		
Outpatient department	-	4 (2.7)	-	4 (2.2)		
Ambulance	1 (2.6)	2 (1.4)	-	3 (1.6)		
Radiation room	-	1 (0.7)	-	1 (0.5)		
Intensive care unit	-	1 (0.7)	-	1 (0.5)		
Family infection	-	2 (1.4)	-	2 (1.1)		
Infection stage						
Primary infection	-	1 (0.7)	-	1 (0.5)	8.780	0.361
Secondly infection	5 (13.2)	25 (17.1)	-	30 (16.1)		
Third infection	31 (81.6)	92 (63.0)	1 (50.0)	124 (66.7)		
Fourth infection	2 (5.3)	20 (13.7)	1 (50.0)	23 (12.4)		
Unidentified	-	8 (5.5)	-	8 (4.3)		
Patient category						
Ordinary person	37 (97.4)	108 (74.0)	2 (100.0)	147 (79.0)	11.109	0.085
Healthcare provider	-	23 (15.8)	-	23 (12.4)		
Caregiver	-	8 (5.5)	-	8 (4.3)		
Medical assistant	1 (2.6)	7 (4.8)	-	8 (4.3)		

Table 3: MERS crisis characteristics by super-spreader

Variables	Super-spreader #1 N: 9 (18.8)	#14 N: 85 (55.2)	#15 N: 6 (3.9)	#16 N: 23 (14.9)	#76 N: 11 (7.1)	Total (N: 154)	χ^2	p-values
Gender								
Male	17 (58.6)	54 (63.5)	3 (50.0)	13 (56.5)	9 (81.8)	96 (62.3)	2.720	0.606
Female	12 (41.4)	31 (36.5)	3 (50.0)	10 (43.5)	2 (18.2)	58 (37.7)		
Infection place								
Sick room	4 (13.8)	3 (3.5)	3 (50.0)	11 (47.8)	1 (9.1)	22 (14.3)	182.034	0.000***
Sick ward	23 (79.3)	3 (3.5)	3 (50.0)	11 (47.8)	4 (36.4)	44 (28.6)		
Examination	2 (6.9)	-	-	-	-	2 (1.3)		
Emergency room	-	77 (90.6)	-	1 (4.3)	3 (27.3)	81 (52.6)		
Outpatient department	-	2 (2.4)	-	-	-	2 (1.3)		
Ambulance	-	-	-	-	2 (18.2)	2 (1.3)		
Radiation room	-	-	-	-	1 (9.1)	1 (0.6)		
Infection stage								
Secondly infection	29 (100.0)	-	-	-	-	29 (18.8)	308.000	0.000***
Third infection	-	85 (100.0)	6 (100.0)	23 (100.0)	-	114 (74.0)		
Fourth infection	-	-	-	-	11 (100.0)	11 (7.1)		
Patient category								
Ordinary person	25 (86.2)	76 (89.4)	4 (66.7)	17 (73.9)	6 (54.5)	128 (83.1)	44.946	0.000***
Healthcare provider	4 (13.8)	6 (7.1)	1 (16.7)	-	2 (18.2)	13 (8.4)		
Caregiver	-	1 (1.2)	1 (16.7)	5 (21.7)	-	7 (4.5)		
Medical assistant	-	2 (2.4)	-	1 (4.3)	3 (27.3)	6 (3.9)		
Health status								
Death	4 (13.8)	20 (23.5)	-	11 (47.8)	2 (18.2)	37 (24.0)	16.800	0.032*
Discharged	25 (86.2)	64 (75.3)	6 (100.0)	12 (52.2)	8 (72.7)	115 (74.7)		
Treatment	-	1 (1.2)	-	-	1 (9.1)	2 (1.3)		

*p<0.05; ***p<0.001

The infections stage were statistically significantly more likely to be "third (74.0%)" (p<0.001). Super-spreader #1 was "secondly infection ", #14 "third infection", #15 "third infection", #16 "third infection" and #76 "fourth infection" (Cheonsoo, 2015).

The patient category were statistically significantly more likely to be "ordinary people (83.1%)" (p<0.001). All of the super-spreaders #1, 14-16 and 76 were "ordinary persons". The health status were statistically significantly more likely to be "discharge (74.7%)" (p<0.05). However, super-spreader #14 lead to as many as ≥20 "deaths".

Period between after diagnosis and death: The period between after diagnosis and death are as shown in Table 4. The incubation period of MERS was 11.36 days on average. The period between after diagnosis and death

Table 4: Period between after diagnosis and death

Variables	N: 186	Mean	SD
Incubation period	186	11.36	4.99
Period between after diagnosis and death	38	16.78	33.20
Period between after diagnosis and discharge	146	20.06	21.77

Table 5: Differencein period between after diagnosis and death by infection status

		Period between after diagnosis and death			
Variables	N: 38	Mean	SD	t/F	p-values
Gender					
Male	26	20.50	39.54	1.014	0.317
Female	12	8.75	7.26		
Infection place					
Sickroom	8	9.62	4.59	0.669	0.577
Sick ward	10	7.90	6.65		
Emergency room	19	24.00	45.93		
Ambulance	1	26.00	-		
Infection stage					
Secondly infection	5	7.40	5.63	0.237	0.790
Third infection	31	18.48	36.44		
Fourth infection	2	14.00	16.97		
Patient category					
Ordinary person	37	16.54	33.63	0.077	783.000
Healthcare provider	1	26.00	-		

was 16.78 days on average. The period between after diagnosis and discharge was 20.06 days on average.

Difference in period between after diagnosis and death by infection status: The difference in the period between after diagnosis and death by infection status is as shown in Table 5. The after diagnosis and death period was longer for the infected patients in emergency room (24.00 days) and ambulances (26.00 days).

RESULTS AND DISCUSSION

This study aimed to determine the need to change the roles of the emergency medical service system in the national response system due to the MERS crisis in South Korea in 2015. Super-spreaders #1, #14-16 and #76 infected 154 (82.7%) out of 186 deaths. Of these, #14 infected 85 (55.2%) patients.The mortality rate was higher for the five super-spreaders (24.0%) than for all the MERS patients (20.4%). The incubation period was 11.36 days on average. The period between diagnosis and death was 16.78 days on average. The high rate of third infection for super-spreaders may indicate that the system to cope with MERS infection was poor.

Kim (2015a, b) warned that many healthcare providers could be vulnerable to MERS infection because they needed to diagnose, treat and care MERS patients personally. His warning can be consistent with the finding that lots of MERS infections occurred in emergency room. In emergency room, healthcare providers seem to be at higher risk of infection due to frequent contact with patients. Hunter *et al.* (2016) found that one of the MERS symptoms was cough. Cough is a significant medium of transmission to the respiratory system. KCDC (2015) reported that respiratory diseases for MERS patients were associated with the mortality rate. Choi and Park (2016) found that patients with underlying diseases were more vulnerable to mortality. Ramkumar and Suresh (2015) noted that Ebola virus disease could put life in danger. If an infectious disease leads to a disastrous situation, it is expected to increase anxiety.

Kim and Oh (2016) found that anxiety was a factor affecting performance of the act to prevent infection. Their finding seems to have resulted from poor prevention measures and training against infection-related disasters. Usual education and training is expected to reduce anxiety. June and Choi (2016) suggested the need to develop a systematic infectious disease response and management system and systematic infectious disease management education at a hospital level. The best way to prevent infectious diseases is education. Education can maintain the entire process including planning, management, prevention and restoration. Kim (2015a, b) suggested rationalization of the infectious disease classification and reporting systems. This suggestion seems to mean consistent system management rather than confusion caused by any indiscreet classification system. A consistent management system can be an important means to give greater safety from infection-related disasters. Kim (2015a, b) suggested that any infected hospital be forced to be closed on the basis of the measures against infectious diseases. This suggestion seems to emphasize efficient measures at the national level as part of efforts to protect citizens from infection-related disasters more safely.

CONCLUSION

Infection-related disasters need to be managed rapidly and accurately in the national response system. In addition, emergency room are more vulnerable to infection, especially, third infection. To solve this problem, the emergency medical service system needs to play a central role in the medical part. It is possible to make the infection-related disaster response system more efficient by changing citizens sense of safety and reinforcing legal and administrative systems at the national level in case of sudden infection-related disaster outbreak.

SUGGESTIONS

The following suggestions can be made to prevent infection-related disasters: First, it is necessary to give regular education and training. Second, it is necessary to realize institutional reinforcement. Third, it is necessary to

develop an efficient manual. Fourth, it is necessary to realize institutional reinforcement of the central role of the emergency medical service system in case of an infection-related disaster. These measures are expected to help cope efficiently with infection-related disasters.

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