Factors associated with the number of emergency department visitors

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Objective: Uncontrolled emergency department (ED) visits lead to crowding and increase the time patients are in the ED. Following the 2015 Middle East respiratory syndrome (MERS) outbreak in Korea, EDs began to regulate visitors. The purpose of this study was to examine the results of regulating ED visits and to identify factors associated with increased ED visits.

Methods: We conducted a cross-sectional observational study using patient information recorded in a visitor’s book during the MERS outbreak from July 6 to July 26, 2015. The visitor’s book included the patient’s and visitor’s names, their relationship, and the day and time of the visit. The collected patient information included sex, age, mode of visit, length of stay in the ED, and disposition. The risk ratio and 95% confidence interval for each variable were calculated using Poisson regression. The primary outcome of this study was the number of visitors per patient according to their characteristics.

Results: Overall, 4,139 patients and 5,642 visitors were registered during the study period. More people visited during weekdays and office hours. The characteristics of patients that increased visitors per patient were when the mode of visit was a public ambulance and when the length of stay in the ED was longer than 12 hours.

Conclusion: During the study period, ED visits were strongly controlled by a government guidance, but there was still a significant number of visitors. If we do not restrict visitors, infection control in the ED will be difficult. It is urgent to develop policies and cultural improvement to control ED visits.

Keywords: Infection control; Visitors to patients; Hospital emergency service

INTRODUCTION

A large outbreak of the Middle East respiratory syndrome (MERS) occurred in the Republic of Korea; it is the largest outbreak of MERS to occur outside the Arabian Peninsula since 2015 [1,2]. Within approximately 2 months, 9,793 persons were thought to have been exposed to MERS-coronavirus (CoV); 1,499 were quarantined and 8,294 were under active monitoring. One hundred eighty-six cases were confirmed, including 36 deaths [3,4].

After the MERS outbreak, the Republic of Korea-World Health Organization (WHO) Joint Mission announced the causes which exacerbated the spread of MERS-CoV in Korea: close and prolonged contact with MERS-CoV-infected patients in crowded tertiary care hospital emergency departments (EDs), multi-bed hospital rooms, and the custom of many visitors or family members staying with infected hospitalized patients [5,6].
first MERS patient in Korea, who had traveled to the Middle East, was a visitor to local hospitals and infected another 36 persons, including patients admitted to the same hospital ward. The secondary patient remained in the ED of another tertiary-level hospital for another 3 days and spread MERS-CoV to 91 persons sharing the same space; this included patients, caregivers, medical providers, and visitors [4,7,8]. This ED saw countless patients from all over the country and drew a lot of visitors whose entrance was not controlled. This crowded environment brought people in close contact and helped spread the MERS infection [3,7]. Of the laboratory-confirmed cases of MERS, 38% occurred among people who were not healthcare providers or shared the same ward; they visited infected cases in hospitals such as family members, health care aides, and acquaintances who were patients [3]. Thus, visitors to the ED were a major vector for disease spread. Hence, some social consensus was required to control ED visitors.

During the outbreak, the Korean Centers for Disease Control (CDC) obligated hospitals to control the flow of people in the ED to manage the infection. They required hospitals to start recording the name, contact number, and visiting time of all ED visitors and accompanying persons [9]. After the official announcement from the CDC, we documented such information, which was entered by the visitors themselves, in a visitor’s book [9]. Furthermore, we instituted the rule that only one visitor per patient was allowed to enter the ED at a time; two or more visitors had to alternate. Before these policies were introduced, ED visitors could enter the facility without control.

This study aimed to share the experience of controlling ED visitors in a tertiary-level hospital during the MERS outbreak in Korea. We also identified the characteristics of patients that led to an increase in the number of ED visitors using the data collected in the visitor’s book.

METHODS

Study setting and design
This study was a cross-sectional observational study conducted from July 6 to July 26, 2015 in the ED of a tertiary-level hospital. This ED serves the local area and treats an average of 80,000 patients a year. It has 47 beds and operates three isolation wards. During the MERS outbreak, five security personnel were deployed to the ED. They enforced the rule that only one visitor per patient could enter the ED; and informed visitors that registering in the visitor’s book was mandatory.

Study participants and data collection
We included all ED visitors, including public or private emergency medical service (EMS) ambulance staff and emergency medical technicians (EMT). Multiple visits by the same person within a day were considered as one visit. We excluded visitors with missing information, such as the visitor’s or patient’s name. Finally, visitors who refused to provide the personal information described above were excluded from the study.

We asked each visitor for consent before collecting personal information. Data collected included the date and time of the ED visit; the visitor’s name, age, and phone number; and the name of the patient to visit as well as their relationship. These were categorized into an immediate family members, other relatives, or acquaintances.

Ethics statement
We collected the information of patients via a medical record review: demographics, mode of visit, day and time to visit, ED disposition, the length of stay in the ED. The Severance Institutional Review Board approved this study protocol (IRB No: 4-2016-0546).

Statistical analysis
We counted the daily number of ED visitors and patients and categorized the visitors’ characteristics: relationship to the patient (immediate family members vs. other relatives vs. acquaintances), day of the week (weekday vs. weekend), and time of the visit (office hours vs. non-office hours).

We also categorized the patients’ characteristics: age (adult vs. pediatric; where pediatric is defined as aged under 16-years-old), mode of visit (ambulatory vs. EMS; public EMS ambulance [119] vs. private EMS ambulance [129] vs. others [e.g., police]), ED disposition (discharge vs. admission to general ward [GW] vs. admission to intensive care unit [ICU]; transfer to other facilities vs. death); length of stay in the ED (more or less than 12 hours). We calculated the visitor-to-patient ratio based on the visitor and patient’s characteristics using multiple linear regression analysis. Each group was considered an independent variable and the dependent variable was the number of visitors per patient. We then analyzed whether there was a significant difference between the number of visitors within each subgroup.

The collected data were analyzed using SAS ver. 9.2 (SAS Institute, Cary, NC, USA). As the dependent variable, the number of visitors per patient was count data, it followed a Poisson distribution, not a normal distribution. Therefore, Poisson regression analysis was selected and performed using the SAS PROC GENMOD procedure. A P < 0.05 was considered statistically signifi-
cant. The goodness of fit test was performed using the deviance obtained from each regression model to target the seven variables; models with a $P < 0.05$ were considered suitable.

**RESULTS**

The outcome variable of our study is the number of visitors per patient (Table 1). From July 6 to July 26, 2015, 4,139 patients attended the ED. According to the visitor’s book, during the 21 days, 5,642 visitors entered the ED. Of these, 42 wrote the same name for “patient’s name” and “visitor’s name”; 84 did not identify the patient being visited; 15 registered in the book several times a day; 15 were regarded as erroneous entries as the handwriting was illegible or the information inaccurate. All these entries ($n = 156$) were excluded from the study, leaving 5,486 visitors for inclusion in the analysis (Fig. 1). Persons accompanying patients—such as direct family members, other relatives, or acquaintances—accounted for 3,949 of visitors (72%), while public or private EMS ambulance staff accounted for 1,414 (25.7%). Most accompanying persons ($n = 3,531$ [89.4%]) were direct family members (Table 2).

**Number of visitors according to the day of the week**

During the research period, the number of visitors on weekends was 0.8 times that of the number of visitors during weekdays (relative ratio [RR], 0.796; 95% confidence interval [CI], 0.744 to 0.851; $P \leq 0.001$) (Tables 3 and 4).

**Number of visitors according to the time of the day**

We defined office hours for possible outpatient medical treatment as from Monday through Friday, 9:00 AM to 6:00 PM. Hours outside of this range were designated as “non-office hours”. The number of visitors visiting during non-office hours was 0.8 times that of visitors during regular non-office hours (RR, 0.778; 95% CI, 0.721 to 0.839; $P < 0.001$) (Tables 3 and 4).

**Number of visitors of adult and pediatric patients**

Patients aged $> 16$ years were classified as adults and those $< 16$ years were classified as pediatric patients. Overall, 35.3% of adult patients and 26.0% of pediatric patients had no visitors. Despite

| Day of visit | Total | Number of visitors per patient | Minimum | 1Q | Median | 3Q | Maximum |
|--------------|-------|--------------------------------|---------|----|--------|----|---------|
| 2015-07-06   | 264   | 0                              | 0       | 0  | 1      | 2  | 7       |
| 2015-07-07   | 268   | 0                              | 0       | 0  | 1      | 2  | 16      |
| 2015-07-08   | 240   | 0                              | 0       | 0  | 1      | 2  | 7       |
| 2015-07-09   | 252   | 0                              | 0       | 0  | 1      | 2  | 8       |
| 2015-07-10   | 283   | 0                              | 0       | 0  | 1      | 2  | 7       |
| 2015-07-11   | 274   | 0                              | 0       | 0  | 1      | 1.75 | 8       |
| 2015-07-12   | 364   | 0                              | 0       | 0  | 1      | 2  | 6       |
| 2015-07-13   | 296   | 0                              | 0       | 0  | 1      | 2  | 17      |
| 2015-07-14   | 303   | 0                              | 0       | 0  | 1      | 2  | 8       |
| 2015-07-15   | 294   | 0                              | 0       | 0  | 1      | 3  | 10      |
| 2015-07-16   | 252   | 0                              | 0       | 0  | 1      | 2  | 9       |
| 2015-07-17   | 271   | 0                              | 0       | 0  | 1      | 2  | 6       |
| 2015-07-18   | 283   | 0                              | 0       | 0  | 1      | 1  | 8       |
| 2015-07-19   | 267   | 0                              | 0       | 0  | 1      | 1  | 5       |
| 2015-07-20   | 277   | 0                              | 0       | 0  | 1      | 2  | 6       |
| 2015-07-21   | 270   | 0                              | 0       | 0  | 1      | 2  | 8       |
| 2015-07-22   | 170   | 0                              | 0       | 0  | 1      | 2  | 8       |
| 2015-07-23   | 185   | 0                              | 0       | 0  | 1      | 1  | 7       |
| 2015-07-24   | 223   | 0                              | 0       | 0  | 1      | 2  | 11      |
| 2015-07-25   | 185   | 0                              | 0       | 0  | 1      | 1  | 5       |
| 2015-07-26   | 265   | 0                              | 0       | 0  | 1      | 1  | 5       |
| Total        | 5,486 | 0                              | 0       | 0  | 1      | 2  | 17      |

Q, quartile.
5,642 Visitors who entered the ED according to the visitor’s book

156 Visitors excluded.
• 84 did not identify the patient being visited.
• 42 wrote the same name for “patient’s name” and “visitor’s name.”
• 15 had illegible handwriting or inaccurate information.
• 15 multiple visits by the same person within a day.

5,486 Enrolled visitors

3,949 Personal visitors
Visitors who came to the ED to meet patients.
• 3,531 Immediate family members
• 93 Other relatives
• 325 Acquaintances

1,437 Non-personal visitors
Visitors who visit the ED for official purposes related to the patient.
• 0 Emergency medical technician
• 1,136 Public ambulance
• 278 Private ambulance
• 23 Police officer

100 Others
• Visitors who came because of the medical equipment applied to patients.
• Employees of a medical device company.

Fig. 1. Relationship of persons accompanying patients. ED, emergency department.

Table 2. Breakdown of visitors by purpose and their relationship with patients for each day

| Date       | Total | Immediate family members | Other relatives | Acquaintances | Ambulance staff | Other emergency service | MDC employee |
|------------|-------|--------------------------|-----------------|---------------|-----------------|-------------------------|--------------|
| 2015-07-06 | 199   | 264                      | 174             | 4             | 9               | 54                      | 16           |
| 2015-07-07 | 161   | 268                      | 172             | 9             | 19              | 57                      | 10           |
| 2015-07-08 | 165   | 240                      | 148             | 3             | 6               | 54                      | 24           |
| 2015-07-09 | 177   | 252                      | 153             | 1             | 11              | 64                      | 13           |
| 2015-07-10 | 193   | 283                      | 183             | 6             | 14              | 51                      | 15           |
| 2015-07-11 | 222   | 274                      | 181             | 3             | 24              | 53                      | 11           |
| 2015-07-12 | 283   | 364                      | 223             | 1             | 22              | 99                      | 14           |
| 2015-07-13 | 181   | 296                      | 186             | 4             | 17              | 65                      | 20           |
| 2015-07-14 | 181   | 303                      | 186             | 6             | 24              | 75                      | 15           |
| 2015-07-15 | 164   | 294                      | 163             | 16            | 14              | 74                      | 20           |
| 2015-07-16 | 152   | 252                      | 150             | 5             | 10              | 64                      | 18           |
| 2015-07-17 | 180   | 271                      | 163             | 3             | 17              | 61                      | 14           |
| 2015-07-18 | 231   | 283                      | 187             | 2             | 25              | 59                      | 7            |
| 2015-07-19 | 282   | 267                      | 172             | 4             | 18              | 63                      | 9            |
| 2015-07-20 | 204   | 277                      | 184             | 3             | 11              | 61                      | 13           |
| 2015-07-21 | 182   | 270                      | 190             | 5             | 19              | 34                      | 12           |
| 2015-07-22 | 139   | 170                      | 108             | 7             | 10              | 17                      | 19           |
| 2015-07-23 | 164   | 185                      | 132             | 3             | 15              | 27                      | 4            |
| 2015-07-24 | 175   | 223                      | 139             | 4             | 12              | 55                      | 10           |
| 2015-07-25 | 219   | 185                      | 143             | 0             | 13              | 20                      | 9            |
| 2015-07-26 | 285   | 265                      | 212             | 4             | 15              | 29                      | 5            |

Total 4,139 5,486 3,531 (64.4%) 93 (1.7%) 325 (5.9%) 1,136 (20.7%) 278 (5.1%) 23 (0.4%) 100 (1.9%)

MDC, medical device company.

a) Persons who came to the emergency department to visit patients, except visitors for official purposes.
b) Public emergency medical service ambulance crew.
c) Private emergency medical service ambulance crew and emergency medical technicians.
this, adult and pediatric patients did not have a significantly different number of visitors (RR, 0.955; 95% CI, 0.894 to 1.021; P = 0.178) (Tables 3 and 4).

Table 3. Comparison between the number of visitors and registered patients, according to various factors

| Variable                        | Visitor | Patient | Visitor per patient |
|---------------------------------|---------|---------|---------------------|
| Day of the week                 |         |         |                     |
| Monday                          | 592     | 584     | 1.01                |
| Tuesday                         | 612     | 524     | 1.17                |
| Wednesday                       | 475     | 468     | 1.01                |
| Thursday                        | 480     | 493     | 0.97                |
| Friday                          | 541     | 548     | 0.99                |
| Saturday                        | 578     | 672     | 0.86                |
| Sunday                          | 671     | 850     | 0.79                |
| Weekday                         | 2,700   | 2,617   | 1.03                |
| Weekend                         | 1,249   | 1,522   | 0.82                |
| Time of the day                 |         |         |                     |
| Office hours                    | 1,195   | 998     | 1.20                |
| Non-office hours                | 1505    | 1619    | 0.93                |
| Age of patient (yr)             |         |         |                     |
| Adult (≥ 16)                    | 2669    | 2756    | 0.97                |
| Pediatric (< 16)                | 1280    | 1383    | 0.93                |
| Mode of visit                   |         |         |                     |
| 119 (a)                         | 669     | 538     | 1.24                |
| 129 (b)                         | 372     | 264     | 1.41                |
| Non-ambulance                   | 2,908   | 3,337   | 0.87                |
| Length of stay in the emergency department (hr) |         |         |                     |
| ≥ 12                            | 814     | 446     | 1.83                |
| < 12                            | 3,153   | 3,693   | 0.85                |
| Patient disposition             |         |         |                     |
| General ward                    | 621     | 538     | 1.15                |
| Intensive care unit             | 131     | 109     | 1.20                |
| Discharge                       | 3,147   | 3,431   | 0.92                |
| Transfer                        | 31      | 32      | 0.97                |
| Died                            | 12      | 8       | 1.50                |
| Dead on arrival                 | 7       | 21      | 0.33                |

(a) Public emergency medical service ambulance crew. (b) Private emergency medical service ambulance crew and emergency medical technicians.

Number of visitors according to mode of visit
The means of arrival at the ED were classified into three major categories: public EMS ambulance, private EMS ambulance, or by car or on foot. Patients who arrived by car or on foot had a significantly lower number of visitors: 0.7 times that of patients who arrived by public EMS ambulance (RR, 0.701; 95% CI, 0.645 to 0.763; P ≤ 0.001) (Tables 3 and 4).

Number of visitors according to the patient’s disposition
We divided the disposition of patients into hospitalization to the GW, hospitalization to the ICU, discharge from the hospital, transfer, death while hospitalized, and dead on arrival and analyzed the number of visitors for each group. The number of visitors of patients discharged was 0.8 times that of the number of visitors of patients admitted to a GW (RR, 0.792; 95% CI, 0.727 to 0.863; P < 0.001) (Tables 3 and 4). When we analyzed the number of visitors according to the patients’ length of stay in the ED before being admitted to the GW, the visitor-to-patient ratio tended to increase with longer lengths of stay (Table 5).

DISCUSSION

The major findings of our study were that the majority of visitors were accompanying persons, and the number of visitors per patient of those using EMS was more than that of ambulatory patients. The length of stay in the ED and ED disposition were also associated with the number of visitors per patient.

ED patients usually need some assistance from visitors. Totten et al. [10] defined the roles of visitors, especially persons accompanying patients to the ED, as providing emotional support and physical help to patients and helping bridge the gap between doctors and patients. However, despite the positive role of visitors, because they come in close contact with patients with infectious diseases, they are able to facilitate the spread of infectious diseases; this is why frequent, unlimited visits to the ED need to be controlled. Therefore, registration in a visitor’s book in the ED was an essential step in preventing the spread of infection. We will also install a security gate that will only allow entry to those with a visitor’s tag and limit distribution to one per patient. Although the Korean CDC recommended the registration of ED visitors in a guest’s book, it was not legally enforceable. If a visitor refused to register in the visitor’s book, we could not get the information we needed to control and track them. In fact, 2% of the visitors to the ED refused to register or provided incorrect information during our study. In addition, when a patient has entered...
In such cases, measures should be in place to minimize the contact between the visitors and other ED patients.

Public and private EMS ambulance staff and EMTs also accounted for a considerable proportion (26%) of all visitors. In many hospitals in Korea, when patients arrive, they are usually triaged in the inner zone of the ED. If patients are triaged outside the ED, except when a patient is in a life-threatening condition, the ambulance staff will be able to hand over the patient to the medical staff without entering the ED. After the MERS outbreak, all patients who arrived at our hospital, including those who arrived in an ambulance, should be triaged outside the ED unless they required immediate life-saving medical interventions.

The number of visitors tended to increase with increasing time spent in the ED; patients with an extended stay had twice as many visitors as patients with a shorter stay. This result is similar to that of patients admitted to the GW. As the number of visitors increases, congestion in the ED increases, and the chance of close contact with infected patients increases. Therefore, reducing the number of visitors is essential for infection control in the ED. To achieve this, in addition to the suggestions we mentioned earlier, we strictly implemented the ‘2-4-8 rule’, which was already in place in our hospital. It aims to complete a consultation within two hours, make a disposition decision within four hours, and ensure that the patient is moved to a ward bed within eight hours of registration in the ED. We were able to reduce the length of stay in the ED by holding monthly meetings to ensure that these rules were being implemented and find where improvements were needed.

In addition to controlling the number of visitors to prevent the spread of infection, the space and structure inside the ED were also improved. In EDs in Korea, the spacing between beds is very narrow (1−1.2 m), with only curtains separating the beds. Additionally, EDs have a shortage of negative-pressure isolation rooms.

### Table 4. Poisson regression analysis predicting the number of visitors for a patient in the emergency department

| Variable | Value | Relative risk | 95% CI          | P-value |
|----------|-------|---------------|-----------------|---------|
| Day of the week | | | | |
| Tuesday vs. Monday | 1.156 | 1.032−1.294 | 0.012 |
| Wednesday vs. Monday | 1.005 | 0.890−1.134 | 0.940 |
| Thursday vs. Monday | 0.964 | 0.854−1.087 | 0.548 |
| Friday vs. Monday | 0.977 | 0.870−1.098 | 0.698 |
| Saturday vs. Monday | 0.851 | 0.759−0.955 | 0.006 |
| Sunday vs. Monday | 0.781 | 0.700−0.873 | <0.001 |
| Weekend vs. weekday | 0.796 | 0.744−0.851 | <0.001 |
| Time of the day | | | | |
| Office vs. non-office hours | 0.778 | 0.721−0.839 | <0.001 |
| Age of patient | | | | |
| Pediatric<sup>a</sup> vs. adult | 0.955 | 0.894−1.021 | 0.178 |
| Mode of visit | | | | |
| 129<sup>b</sup> vs. 119<sup>c</sup> | 1.104 | 0.971−1.255 | 0.130 |
| Non-ambulance vs. 119<sup>c</sup> | 0.701 | 0.645−0.763 | <0.001 |
| Length of stay in the emergency department | | | | |
| ≥ 12 hr vs. < 12 hr | 2.143 | 1.984−2.315 | <0.001 |
| Patient disposition | | | | |
| ICU vs. GW | 1.039 | 0.860−1.254 | 0.693 |
| Discharge vs. GW | 0.792 | 0.727−0.863 | <0.001 |
| Transfer vs. GW | 0.837 | 0.584−1.201 | 0.335 |
| Expire vs. GW | 1.296 | 0.732−2.295 | 0.373 |
| Death on arrival vs. GW | 0.288 | 0.137−0.607 | 0.001 |

CI, confidence interval; ICU, intensive care unit; GW, general ward.
<sup>a</sup>Aged <16 years. <sup>b</sup>Private emergency medical service ambulance crew and emergency medical technicians. <sup>c</sup>Public emergency medical service ambulance crew.

### Table 5. Comparison between the number of visitors and patients hospitalized in the general ward

| Length of stay (hr) | Visitor/hospitalized patient | Ratio |
|---------------------|------------------------------|-------|
| 0–3 | 73/86 | 0.85 |
| 3–6 | 238/221 | 1.08 |
| 6–9 | 151/125 | 1.21 |
| 9–12 | 84/57 | 1.47 |
| > 12 | 76/49 | 1.55 |
| Total | 621/538 | 1.15 |

According to the length of their stay in the emergency department.
CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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