Declining Emergency Department Visits and Costs During the Severe Acute Respiratory Syndrome (SARS) Outbreak

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Background: The immediate and long-term impact of severe acute respiratory syndrome (SARS) outbreak on emergency department (ED) visits and hospital expenditures for these visits has not been thoroughly investigated. The objectives of this retrospective observational study investigated the impact of SARS outbreak on ED visits and the cost of these visits in a designated SARS medical center.

Methods: Data related to the total number of ED visits and their costs were collected for the SARS epidemic period in 2003 and the same period in the preceding year in 2002. Data collected included total number of ED visits, services provided, triage categories, and total expenditures for all patients. Data for before and during the outbreak were retrieved and compared.

Results: At the peak of the SARS epidemic, the reduction in daily ED visits reached 51.6% of pre-epidemic numbers \(p \leq 0.01\). In pediatric, trauma and non-trauma patients, the maximum mean decreases in number of visits were 80.0% \(p \leq 0.01\), 57.6% \(p \leq 0.01\) and 40.8% \(p \leq 0.01\), respectively. In triage 1, 2 and 3 patients, the maximum mean decreases were 18.1% \(p \leq 0.01\), 55.9% \(p \leq 0.01\) and 53.7% \(p \leq 0.01\), respectively. The maximum decrease in total costs was 37.7% \(p \leq 0.01\). The maximum mean costs per patient increased 35.9% \(p \leq 0.01\). The proportions of increases in mean costs for each patient were attributed to laboratory investigations (31.4%), radiography (21.9%) and medications (29.5%).

Conclusion: The SARS outbreak resulted in a marked reduction in the number of ED visits which persisted for 3 months after the end of the epidemic. Total cost of treating individual patients showed a simultaneous marked increase, while overall operational costs in the ED showed a marked decrease. The increased total cost for each patient was attributed to the increased number of diagnostic procedures to screen for possible SARS in the ED. [J Formos Med Assoc 2006;105(1):31–37]

Key Words: cost, emergency department (ED), epidemiology, severe acute respiratory syndrome (SARS)
(EDs), especially those who had low-emergency and non-severe diseases. The immediate effect of SARS was to decrease the number of patient visits to the ED. Analysis of the impact of SARS on ED visits and costs may be useful in developing plans to optimize limited health care resources when the next outbreak of a highly infectious disease occurs. The purpose of this study was to investigate the impact of the SARS epidemic on ED visits and expenditures in a designated SARS facility.

**Methods**

Taipei Veterans General Hospital (TVGH) is a 2700-bed tertiary-referral and teaching medical center in northern Taiwan. From 1999–2002, the ED of this hospital handled an average of 84,991 visits (95% confidence interval [CI], 82,799–87,182). The SARS epidemic period in Taiwan was from March 14 to July 5, 2003. TVGH was one of 15 designated SARS hospitals across the island. It was established as an appropriate facility for identifying potential SARS patients in the ED and had 70 negative pressure isolation beds for SARS patient care during the outbreak period.

Data on the number of patient visits, services provided, triage categories, and costs of all patient visits to the ED were retrieved from the hospital computer database for analysis. The total expenditure for services provided and items for each patient included the costs of ED registration and bed, physician services, laboratory investigations, radiography, ancillary procedures and treatments, prescription medications, and other costs per item or service. These costs were included in the computer files of each patient’s bill, which listed all the items and services consumed. The expenditures of all patients visiting the ED were covered under the National Health Insurance program.

To eliminate possible confounding effects due to yearly changes in total attendances, total costs, and mean cost per patient between 2002 and 2003, the mean yearly change in total ED attendance was calculated based on a rate of increase of 5.1 \times 10^{-3}%, which was equal to a yearly increase of 4.3 patients during the 4 years preceding the outbreak (1999–2002). The yearly increase in total costs of all patients was 2.7%, and in mean cost per patient was 2.8% during this period. Based on the average changes in total number of visits and costs, and yearly per-patient costs, 2003 data were analyzed and adjusted for comparison with those on the same day in 2002 to evaluate the influence of the SARS outbreak on the changes in the demographic pattern and costs.

This study was approved by the hospital review board. SPSS version 10.0 for Windows (SPSS Inc, Chicago, IL, USA) was used for data analysis. The chi-square test was used for categorical data, and independent Student’s t-test for continuous data. A p value of less than 0.05 was considered to indicate statistical significance.

**Results**

Sporadic cases of SARS began to be identified after March 14, 2003, when the first SARS victim was identified in Taiwan. The fulminant period of the SARS epidemic was from April 22 to May 22, 2003, with an average of 9.3 (95% CI, 7.4–11.1) patients per day with a confirmed diagnosis. In the study hospital, 273 suspected SARS patients were admitted via the ED and 75 had a confirmed diagnosis of SARS. As shown in Figure 1, a significant decrease in daily ED attendance occurred in April, reaching a nadir in May with a mean (standard deviation of 115.4 ± 16.7 vs. 238.3 ± 33.4 (95% CI of mean difference, 109.4–136.3; p < 0.01) in 2003 vs. 2002, respectively (Figure 1A). The mean decrease in daily ED visits had a significantly positive correlation with the monthly number of confirmed SARS patients island-wide (p = 0.01). The maximum mean decrease in the percentage of monthly visits during the outbreak compared to 2002 was 51.6% in May (95% CI of mean difference, 47.8–54.1%; p < 0.01). Monthly visits then gradually increased, reaching comparable pre-outbreak levels in November 2003, 4 months after the end of the SARS epidemic (Figure 1B).
In the ED, patients were categorized into non-trauma, trauma, pediatric (age < 15 years), and others (Figure 2). As patients in the first three categories comprised approximately 97.4% of patient visits among total ED attendances, and there was no significant variation between the "others" category and the three main categories, the others category was not displayed in the graphical analysis for convenience. During the epidemic, all categories of patients decreased to their lowest levels in May, with a maximum mean decrease of 40.8% in non-trauma patients (Figure 2A; 95% CI of mean difference, 35.5–46.0%; p < 0.01), 57.6% in trauma patients (Figure 2B; 95% CI of mean difference, 48.3–67.0%; p < 0.01), and 80.0% in pediatric patients (Figure 2C; 95% CI of mean difference, 64.2–95.9%; p < 0.01). The proportion of non-trauma patients increased during the early epidemic period (Figure 2D) in comparison with those in 2002. The World Health Organization officially removed Taiwan from the list of SARS epidemic countries on July 5. The number of trauma visits returned to pre-epidemic levels in July (Figure 2B).

To reduce interobserver bias in validating the triage categories (2002–2003), we compared individual percentages of four triage categories monthly by using one-way ANOVA with Scheffe’s post hoc test. No significant differences were found in the percentages of patients in the individual triage categories except in May 2003, at the peak of the SARS epidemic, when the percentage of triage patients was significantly higher than in the other months (p < 0.05). The percentage of patients in all of the triage categories significantly decreased during the epidemic, with a maximum mean percentage decrease in triage 1 patients (Figure 3A) of 18.1% (95% CI of mean difference, 5.6–31.0%; p < 0.01), triage 2 patients (Figure 3B) of 55.9% (95% CI of mean difference, 49.6–62.3%; p < 0.01), and triage 3 patients (Figure 3C) of 53.7% (95% CI of mean difference, 44.8–62.5%; p < 0.01). The percentage of patients categorized to triage 4 was 1.8% (95% CI, 1.7–1.9%), and this category was not included in the figures due to the lack of a significant change and for convenience in presentation. At the peak of the epidemic in May, the proportion of triage 1 patients increased by a mean of 96.4% (Figure 3D; 95% CI of mean difference, 62.6–130.2%; p < 0.01).

As shown in Figure 4A, daily total expenditures for total visits decreased significantly, with a maximum mean decrease of 37.7% (95% CI of mean difference, 30.2–45.3%; p < 0.01) in May, and returned to levels similar to pre-epidemic ones in July. The mean costs for each patient increased from March to August, with a maximum mean increase of 35.9% (95% CI of the mean difference, 26.3–45.5%; p < 0.01) in June (Figure 4B). The mean cost of each admission (Figure 4C) and discharge (Figure 4D) were higher than in 2002. The mean costs of each admission (Figure 4C) showed a maximum mean increase of 35.5% (95% CI of mean difference, 25.5–45.5%; p < 0.01) and corresponded to similar increases in the mean cost per patient (Figure 4B) during the epidemic period. During the epidemic, there were increased laboratory costs of 31.4% (Figure 5A; 95% CI, 16.3–46.5%; p < 0.01), increased radiography costs of
Figure 2. Comparisons for the total number of emergency department (ED) visits between 2002 and 2003 by patient category: (A) non-trauma; (B) trauma; (C) pediatric. (D) Percentage changes in the proportions of these three patient categories. Values presented are mean ± standard deviation. *p < 0.05 vs. comparable months in 2002 (Student’s t test).

Figure 3. Comparisons for the total number of emergency department (ED) visits between 2002 and 2003 by patient triage category: (A) triage 1; (B) triage 2; (C) triage 3. (D) Percentage changes in the proportions of patients in these three triage categories. Values presented are mean ± standard deviation. *p < 0.05 vs. comparable months in 2002 (Student’s t test).
Figure 4. Comparisons between 2002 and 2003 for: (A) total cost of all emergency department visits; (B) mean cost per patient; (C) mean cost of patient admission; (D) mean cost of patient discharge. Values presented are mean ± standard deviation. *p < 0.05 vs. comparable months in 2002 (Student’s t test).

Figure 5. Comparisons between 2002 and 2003 for: (A) mean cost of laboratory investigations per patient; (B) mean cost of radiographic examinations per patient; (C) mean cost of ancillary procedures per patient; (D) mean cost of prescription medications per patient. Values presented are mean ± standard deviation. *p < 0.05 vs. comparable months in 2002 (Student’s t test).
21.9% (Figure 5B; 95% CI, 12.2−31.6%; \( p < 0.01 \)), increased costs of ancillary procedures of 20.4% (Figure 5C; 95% CI, 9.5−31.2%; \( p < 0.01 \)), and increased costs of prescription medications of 29.5% (Figure 5D; 95% CI, 19.1−40.0%; \( p < 0.01 \)).

Discussion

The SARS epidemic in Taiwan occurred from March 14 to July 5, 2003. There were 346 affected patients with a median age of 42 years (range, 0−93 years); there were 37 (10.7%) deaths.\(^{12}\) Before April 22, there were only sporadic SARS cases, and the utilization of medical services,\(^{9}\) including inpatient care, ambulatory care, dental care and Chinese medicine, remained at pre-epidemic levels. On April 22, a large outbreak of SARS in a community hospital occurred and led to uncontrolled intra- and interhospital transmission and spreading of SARS in the following 2−3 months.\(^{12,13}\) After this nosocomial outbreak, fears of SARS transmission began to keep patients from visiting hospitals, which led to significant reductions in inpatient care (35.2%), dental care (23.9%), and ambulatory care (16.7%) at the peak of the SARS epidemic in Taiwan.\(^{9}\) Man et al reported a mean reduction of 51.4% in overall ED visits during the SARS epidemic in a teaching hospital ED in Hong Kong.\(^{8}\) In contrast, an increase of about 30% in daily visits was reported during the early SARS outbreak period at a public hospital in Singapore\(^{14}\) designated for treatment and hospitalization of SARS patients only. The number of ED visits decreased by 39% after SARS cases were diagnosed among health care workers, which changed the public’s perception of the risk of visiting hospitals.\(^{14}\) This study found that a substantial mean reduction in the number of ED visits occurred during the SARS epidemic, with a peak of 51.6% and a mean of 32.1% (95% CI of the mean difference, 27.6−36.6%) during the 4-month (April−July) epidemic period in a designated SARS hospital in Taiwan (Figure 1). Compared with a non-designated private medical center in central Taiwan,\(^{15}\) the reduction in the percentage of total ED visits was higher at this hospital. These results suggest that there is a need for a policy that will accommodate greater flexibility in emergency personnel staffing during future outbreaks of highly contagious diseases.

At the end of the epidemic in July 2003, the volume of trauma patients returned to pre-epidemic levels (Figure 2), while both non-trauma and pediatric patients remained at significantly lower levels than those in 2002 (\( p < 0.01 \)). This phenomenon may be attributable to the decrease in daily activities due to the SARS outbreak,\(^{8}\) the recovery of which may have contributed to the increases in accidents and trauma patients after the epidemic. Nosocomial SARS infection did not occur among trauma patients during the epidemic (Figure 2B).

The triage categories in this study were previously established based on patients’ clinical presentations, with special focus on conscious levels and vital signs, and the need for emergency or urgent management in the ED.\(^{11}\) The triage assignment for an emergency life-threatening or an urgent potentially life-threatening condition predicts the need for critical care, further examinations, and hospital admission.\(^{11,16,17}\) This study demonstrated a significant decrease in the number of ED visits in all triage categories during the SARS epidemic, especially in triage category 3. Less critical patients were likely to avoid visits to medical centers due to the perceived risk of nosocomial SARS transmission. In contrast, patients with emergency conditions or critical illnesses necessitating treatment were not able to avoid visiting the ED.

The overall expenditure for patients decreased and corresponded to the decrease in the number of patient ED visits.\(^{15}\) The costs of admission and discharge had mean increases of 25% and 28%, respectively, compared to the costs for the same period in 2002. The specific reason for the higher costs of admission and discharge may have been increased procedural complexity involving precautions to avoid SARS transmission. The higher total cost for each patient during the SARS epidemic was primarily attributed to increases
in the number of laboratory investigations, radiographic examinations, ancillary procedures and medications required (Figure 5). Many of these extra costs were attributable to the need to avoid potential failure to identify an occult super-spreader at admission.

This study had several limitations. First, how the duration or percentage decreases in patient attendances and costs in the ED might have been affected by a longer duration or greater number of SARS patients remains unclear. Second, it is possible that the progressive decrease in the number of patient visits to our ED may have been partly caused by other factors because the total ED census of 80,653 in 2004 was similar to that from 1999 to 2002. Third, this study only included data from a designated SARS public tertiary medical center. The effect of the SARS outbreak on non-designated SARS medical centers, community hospitals, and private hospitals or clinics was not evaluated. Fourth, we did not evaluate the impact of the SARS outbreak on utilization of individual medical resources, patient transfers or illness severity in the medical system or the closure of some emergency services during the outbreak.

**Conclusion**

The SARS outbreak markedly reduced patient visits to the ED of a designated SARS hospital in Taiwan, especially for non-emergency and less critical patients. As a result of the epidemic, there was a significant decrease in the total costs for patients, which remained low for 3 months after the end of the SARS epidemic. Increased total cost for individual patients was attributed to increases in the number of radiographic examinations and ancillary procedures required to exclude the possibility of SARS. Further study with the objective of developing a management strategy to deal with the re-emergence of SARS or highly-contagious infections in hospitals should consider the immediate and long-term effects of outbreaks on changes in patient census and medical costs.

**References**