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CLINICAL PAPER

The effect of severe acute respiratory syndrome (SARS) on emergency airway management☆

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Summary From early March 2003 to late May 2003, severe acute respiratory syndrome (SARS) was detected in Singapore. The increase in workload and new infection control procedures were thought to affect resuscitation and airway management. Our aim was to study the effects of wearing of personal protective equipment (PPE) and powered air-purifying respirator (PAPR) and the restriction in the number of resuscitation personnel on airway management during the SARS crisis.

Data was collected prospectively through an ongoing emergency airway registry. The data was divided into three periods: (1) before PPE was instituted from 1 November 2002 to 31 March 2003; (2) during SARS (when PPE use was mandatory) from 1 April to 31 July 2003; (3) post-SARs (when PPE use was non-mandatory but encouraged) from 1 August to 31 March 2004.

There was no change in patient demographics during the three periods. There were significant increases in the proportion of resuscitation cases and airway interventions during the SARS period compared to the pre-SARS period. The resident medical officer intubation rate decreased from 45.1% pre-SARS to 35.2% during SARS and 17.7% post-SARS. The complication rates were 10.5%, 9.9% and 9.4% in periods 1—3, respectively.

Restriction in the number of healthcare staff attending to each patient may have influenced the department's decision to allow only the most confident or experienced personnel to manage the airway. The exposure of junior medical officers in emergency airway management during SARS and the immediate post-SARS period was decreased. This trend should be monitored further and intervention may be necessary should it continue to decline.

Introduction

Severe acute respiratory syndrome (SARS) is a new infectious disease first described in early 2003.[1—5] It is transmitted by a coronavirus and presents as an atypical pneumonia. The morbidity and

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mortality associated with SARS is high. From early March 2003 to late May 2003, SARS was detected in Singapore. Two hundred and thirty-eight patients were infected of which 33 died. Ninety-seven (42%) of those infected were health care workers. Five of them died. The whole medical system in the country was put under stress. One major hospital became the designated SARS hospital and stopped receiving other cases. Emergency cases were then diverted to the other remaining public hospitals; the Singapore General Hospital was the main recipient of diverted cases. The increase in workload of critically ill cases, new infection control procedures including mandatory wearing of the powered air-purifying respirator (PAPR) and personal protective equipment (PPE), and limiting the number of person-contacts with each patient were thought to affect resuscitation and airway management. Our aim was to study the effects of the wearing of PAPR, PPE and the restriction in the number of resuscitation personnel on airway management during the SARS crisis.

Methods

The Emergency Department has an ongoing airway registry that captured prospectively patient demographics, diagnosis, indications for tracheal intubation, the details of the physician attempting intubation, number of attempts, method of intubation, success rates and complications. Data is collected using a study form and is completed by the intubating physician immediately after the procedure. This project had the approval of the hospital's ethics committee.

For the purpose of this study, the data was divided into three periods:

1. before PPE was instituted from 1 November 2002 to 31 March 2003;
2. during SARS (when PPE use was mandatory) from 1 April 2003 to 31 July 2003;
3. post-SARs (when PPE use was non-mandatory but encouraged) from 1 August 2003 to 31 March 2004.

Even though SARS was detected in early March 2003, it was not until 1 April 2003 when the medical community realised the severity of the disease that the use of PPE and PAPR were made mandatory.

The data is analysed using the Statistical Package for the Social Sciences (SPSS) software for Windows (version 10.1; SPSS Inc). The Pearson χ^2 test is used to determine statistically significant differences among categorical data with the Fisher's exact test being used if one or more cells had a value of less than 30. Any comparison of outcome measures with a confidence interval that does not cross one (1.0) indicates that the difference is statistically significant.

Results

The number of emergency department visits during the pre-SARS, SARS and post-SARS periods were 49,462, 34,844 and 83,596, respectively (Table 1). There was a significant increase in the proportion of resuscitation cases managed during the SARS period compared to the pre-SARS period (OR 1.434, CI 1.357, 1.514) but no difference between those of the pre- and post-SARS periods. There were 162, 162 and 209 emergency airway interventions during these three periods resulting in the airway intervention rates as 3.3, 4.6 and 2.5 per 1000 emergency department visits respectively. There was a significant increase in the airway intervention rate in the SARS period compared to the pre-SARS period (OR 1.421, CI 1.143, 1.768). There was no difference in the airway

Table 1 Demographics

	Pre-SARS	During SARS	Post-SARS
ED visits	49462	34844	83596
ED visits/day	330	286	344
Resuscitation cases	2772 (5.6%)	2733 (7.9%)	4774 (5.7%)
Median age	62	64	65
Gender			
Male	109 (67.3%)	101 (62.3%)	132 (63.2%)
Female	53 (32.7%)	61 (37.7%)	77 (36.8%)
Total	162	162	209
Intubation rate[a]	3.2	4.6	2.5
Mortality	60 (37.0%)	79 (48.8%)	79 (37.8%)

ED: emergency department.
[a] Per 1000 emergency department visits.

Table 2 Diagnoses

	Pre-SARS	During SARS	Post-SARS
Trauma	22 (13.6%)	25 (15.4%)	31 (14.8%)
Medical	140 (86.4%)	137 (84.6%)	178 (85.2%)
Medical arrest	60 (37.0%)	73 (45.1%)	76 (36.4%)
Cardiovascular	34 (21.0%)	23 (14.2%)	43 (20.6%)
Neurology	20 (12.3%)	23 (14.2%)	22 (10.5%)
Respiratory	16 (9.9%)	10 (6.2%)	21 (10.0%)
Others	10 (6.2%)	8 (4.9%)	16 (7.7%)
Total	162	162	207

Table 3 Method of intubation (definitive)

	Pre-SARS	SARS	Post-SARS	Total
OTI, no meds	79 (48.7%)	96 (59.2%)	96 (45.9%)	271 (50.9%)
OTI, induction agent only	21 (13.0%)	11 (6.8%)	21 (10.1%)	53 (9.9%)
OTI, induction and NMBA	61 (37.7%)	55 (34.0%)	91 (43.5%)	207 (38.8%)
Surgical	1 (0.6%)	0 (0%)	1 (0.5%)	2 (0.4%)
Total	162	162	209	533
OTI (induction):OTI (NMBA) ratio	0.34	0.20	0.23	0.26
Complication rate (%)	10.5	10.5	9.6	9.8

OTI: oral-tracheal intubation; NMBA: neuromuscular blocking agent.

intervention rate between the post- and pre-SARS period.

There was no change in patient demographics during the three periods (Table 1). There were also no differences in the presenting diagnoses of the patients during the three periods (Table 2).

Oral tracheal intubation without medication was the most common method of intubation followed by intubation with induction and neuromuscular blocking agents during all three periods (Table 3). There was no significant difference in the method of intubation among the three periods.

Attending emergency physicians attempted 53.7% of intubations during the pre-SARS period. This increased to 56.2% during SARS and 81.3% in the post-SARS period (Table 4). There was no significant increase in the number of intubations attempted by emergency physicians during the SARS period compared with the pre-SARS period; however there was a significant increase in the number of intubations attempted by attending emergency physician during the combined SARS and post-SARS periods compared to the number of intubations attempted pre-SARS (OR 2.045, CI 1.398, 2.993). Comparing the post-SARS period and the pre-SARS period, this difference was more evident (OR 3.758, CI 2.36, 5.98). Conversely, medical officers attempted 45.1%, 35.2% and 17.7% of intubations pre-SARS, during SARS and post-SARS, respectively. There was no significant difference in the reduction in number of intubations attempted by medical officers in the SARS period compared to the pre-SARS period; however, there was a significant decrease in the number of intubations attempted by medical officers during the combined SARS and post-SARS periods compared to the number of intubations they attempted pre-SARS (OR 0.392, CI 0.267, 0.576). Comparing the post-SARS period and the pre-SARS period, this difference was more evident (OR 0.262, CI 0.164, 0.42). There

Table 4 Personnel attempting initial intubation

Personnel	Pre-SARS	During SARS	Post-SARS
Anaesthesia attending	2 (1.2%)	14 (8.6%)	0
Emergency physician	87 (53.7%)	91 (56.2%)	170 (81.3%)
Medical officer	73 (45.1%)	57 (35.2%)	37 (17.7%)
Surgery attending	0	0	2 (1.0%)
Total	162	162	209

Table 5 Speciality vs. success rate

Personnel	Pre-SARS (%)	During SARS (%)	Post-SARS (%)
Anaesthesia attending	50	100	100
Emergency physician	94.3	97.8	97.6
Medical officer	80.8	89.4	86.5
Surgery attending	—	—	50

Table 6 Number of intubation attempts made (all cases)

	Pre-SARS	During SARS	Post-SARS
One	132 (81.5%)	146 (90.1%)	183 (87.6%)
Two	19 (11.7%)	12 (7.4%)	17 (8.1%)
Three	7 (4.3%)	3 (1.9%)	6 (2.9%)
More than three	4 (2.5%)	1 (0.6%)	3 (1.4%)

were no significant differences in the success rates for all personnel comparing the SARS and post-SARS periods with the pre-SARS period (Table 5). Overall, 93.2%, 97.5% and 95.7% of intubations were successful after two attempts for all cases (Table 6) during the pre-SARS, SARS and post-SARS periods, respectively. With the exclusion of cardiac arrests, the success rates after the second attempt were 93.1%, 96.6% and 96.2%, respectively.

Complications related to airway management during all the periods included cardiac arrest, hypotension, mainstem bronchus intubation discovered on chest radiographs, oesophaegal intubation, multiple attempts at intubation, aspiration, dysrrhythmias, equipment failure (e.g. tracheal tube cuff leak), oropharygeal and dental trauma, medication error and failed intubation. There were no significant differences in the overall complication rate among the three periods (10.5% pre-SARS, 10.5% during SARS and 9.6% post-SARS). There were no deaths resulting from a failed airway. However, there was a significant increase in the number of patients who died from their medical condition during the SARS period compared to the pre-SARS period (OR 1.618, CI 1.039, 2.521) (Table 1).

Discussion

Severe acute respiratory syndrome (SARS) is a newly recognised serious infectious disease and nosocomial infections from infected patients to healthcare workers (HCW) accounted for almost half of all infections in Singapore.

During the SARS crisis, despite the diversion of emergency cases from the designated SARS hospital to the other public hospitals there was a drop in the total number of emergency department attendances. This was due to the general avoidance of hospitals by patients for fear of contracting SARS. However, the proportion of ill cases requiring resuscitation and intubation rose significantly as a result of the diversion and possibly also due to the delayed presentation of patients as a result of the avoidance of hospitals by the public.

In a previous study done by Wong et al.[6] in the same department of the period just preceding this study (1999—2002),[6] the airway intervention rate was 2.3 per 1000 emergency department visits. This was significantly lower than that during pre-SARS period of this study of 3.2 per 1000 ED visits (OR 1.407, CI 1.192, 1.66) and the SARS period of 4.6 per 1000 ED visits (OR 2.0, CI 1.694, 2.36). The intubation rate of 2.5 per 1000 emergency department visits in the post-SARS period was not different from that of the previous study and probably reflected the baseline rate. There was no difference in the patient demographics and diagnoses in the two studies. The increase in the proportion of intubated cases in the pre-SARS period was probably an anomalous occurrence as there was no difference in the proportion of resuscitation cases between the pre- and post-SARS periods (Table 1).

Wong et al.[6] showed in the previous study[6] that oral tracheal intubation (OTI) without medication constituted 51.5%, OTI with induction agents 19.0% and OTI with induction and neuromuscular blocking agent used in 28.9% of intubations. The ratio of OTI with an induction agent only, compared to induction agent and neuromuscular blocking agent, ratio was 0.65 in the previous study while the combined ratio in this study is 0.26 (Table 3). There is a significant difference in the method of intubation between the periods of these two studies (OR 0.39, CI 0.275, 0.553) reflecting a trend towards

less usage of an induction agent only and more use of both induction and neuroblocking agents.

Healthcare workers who performed oral tracheal intubation in SARS patients were at higher risk of contracting the disease than those who did not.[7] The use of personal protective equipment (PPE) is believed to reduce the likelihood of SARS infection among healthcare workers.[8,9] Did the use of PPE and the cumbersome powered air-purifying respirator (PAPR) affect the success and complication rate of emergency intubations? This study seems to dispel the myth that it would. The success and complication rates were the same during the SARS period compared to the pre/post-SARS periods. The success and complication rates were similar to that of the 1999—2002 study where the first attempt success rate was 90.2% and the complication rate was 9.5%.[6]

An interesting phenomenon is observed as a result of SARS. In the pre-SARS period and in the 1999—2002 study, medical officers attempted 45.1% and 40.5% of intubations, respectively. During SARS and immediately post-SARS there was a significant decline in the proportion of intubations performed by them (35.2% and 17.7%, respectively) (Table 4). This could be due to the fact that there was a restriction in the number of healthcare workers in contact with each patient in an attempt to minimise the risk of spreading SARS. As a result, the most experienced or confident personnel performed the intubation and this was usually the attending emergency physician. The higher first attempt success rate during SARS compared to the other periods could have been a combination of factors including competent emergency physicians performing more intubations and an increase in the number of patients with cardiac arrest during SARS who generally are easy to intubate. What is difficult to comprehend is the observation that the medical officer intubation rate dropped even further after the SARS crisis. Was it because attending emergency physicians found it more convenient to perform the intubations themselves rather than to supervise the medical officers? Or did the medical officers shun from managing ill patients for fear of contracting SARS? This trend will possibly affect the training of medical officers in emergency airway management and should be monitored closely. Intervention may be necessary if the trend persists.

Conclusions

The use of personal protective equipment, including the powered air-purifying respirator, by doctors of the emergency department of the Singapore General Hospital, did not affect the success rate of tracheal intubation during the SARS outbreak.

We observed that in the presence of a highly infectious disease where person-contacts with patients are limited, the more confident and experienced personnel would be most likely to perform emergency intubations. This phenomenon persisted even after the outbreak had passed and may have implications on training.

Conflict of interest statement

There are no conflicts of interest.

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