Patient recollection of airway suctioning in the ICU: routine versus a minimally invasive procedure

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Published in:
Intensive Care Medicine 2003, 29, 3, 433-436
Abstract

Study Objective:

Many patients have an unpleasant recollection of routine endotracheal suctioning after discharge from the Intensive Care Unit (ICU). We hypothesized that through minimally invasive airway suctioning discomfort and stress may be prevented, resulting in less recollection.

Design:

A prospective randomized clinical trial.

Setting:

Two ICUs at the University Hospital of Groningen, the Netherlands.

Patients and Participants:

Adult patients with an intubation period exceeding 24 hours were included.

Interventions:

Patients received either routine endotracheal suctioning (RES) or minimally invasive airway suctioning (MIAS) during the duration of intubation.

Measurements and results:

Within 3 days after ICU discharge all patients were interviewed, regarding recollection and discomfort of suctioning. The level of discomfort was quantified on a visual analogue scale (VAS).

We analyzed data from 208 patients (RES: n=113, MIAS: n=95). A significantly lower prevalence of recollection of airway suctioning was found in the MIAS group (20%) compared to the RES group (41%) (P=0.001). No significant difference in level of discomfort was found between the RES and the MIAS group (P=0.136).

Conclusions:

Minimally Invasive Airway Suctioning results in a lower prevalence of recollection of airway suction than in Routine Endotracheal Suctioning, but not in discomfort.

Keywords: Recollection - Airway suctioning - Mechanical ventilation
Introduction

Patients may have a recollection of interventions after discharge from an intensive care unit [1]. Some interventions, such as endotracheal suctioning, may be remembered as being extremely unpleasant. The prevalence of unpleasant recollection of endotracheal suctioning ranges from 44% to 60% [2,3]. Endotracheal suctioning is an intervention routinely performed in patients [4] who require mechanical ventilation in order to remove accumulated mucus and thereby prevent pneumonia. On the other hand endotracheal suctioning may cause complications [5]. We developed a minimally invasive airway suctioning (MIAS) procedure, cleaning only the endotracheal tube. This procedure resulted in a significantly lower incidence of increased systolic blood pressure when compared to conventional routine endotracheal suctioning, and was comparable in duration of intubation, mortality or incidence of pneumonia. Thus, MIAS appeared to be at least an equally safe intervention to maintain airway patency.

The purpose of this study was to compare recollection of routine endotracheal suctioning with minimally invasive airway suctioning.

Materials and methods

This prospective randomized clinical trial was approved by the Medical Ethics Committee. They waived the informed consent. All adult patients, admitted to a cardio-thoracic or general surgical Intensive Care Unit, were included if they were intubated longer than 24 hours. Exclusion criteria were: intubation at another hospital, non-regular tube type (double lumen tube, wired tube, tracheostomy tube) or requiring a closed suction system. Randomization of patients to one of the intervention arms was done by using consecutively numbered opaque sealed envelopes with a group code and study number in blocks of ten.
Patient recollection of airway suctioning

Protocol guidelines were as follows:

**Routine endotracheal suctioning (RES).** In RES the patient was disconnected from the ventilator, and was manually hyperinflated. Then a CH12 suction catheter with an effective length of 49 cm (Maersk Medical, Denmark), was introduced into the endotracheal tube and a negative pressure (200-400 mmHg) was applied for a maximum duration of 3 seconds. This procedure was repeated in 3-4 cycles. Manual hyperinflation was applied between the cycles of suctioning. Normal saline was instilled between the cycles of suctioning. Treatment frequency was set at a minimal rate of three times a day. Additional suctioning was allowed if clinically required.

**Minimally invasive airway suctioning (MIAS).** MIAS was done with a custom made CH12 short suction catheter, with an effective length of only 29 cm (Maersk Medical). All patients in the MIAS group had an endotracheal tube of the same effective length (29 cm) as the suction catheter. Hence, it was impossible to touch the trachea or bronchi with the suction catheter. In case of MIAS the patient was disconnected from the ventilator, the suction catheter was introduced through the endotracheal tube, and negative pressure (200-400 mmHg) was applied for a maximum duration of 3 seconds. The procedure could be repeated in cycles depending on the patients’ requirement. The patient was reconnected to the ventilator. No minimal treatment frequency was set, and patients were treated on demand, only according to clinical needs.

Suction-related adverse events were defined as any of the following occurring within 10 minute after suctioning: 1) a decrease in oxygen saturation measured by transcutaneous pulse-oxymetry of 5% or greater; 2) bradycardia of 40 beats per minute or less; 3) the occurrence of any new sustained cardiac arrhythmia; 4) the occurrence of more than three premature beats per minute; 5) a rise in systolic blood pressure of 10% or more above baseline level; 6) an increase in pulse pressure rate (mean arterial blood pressure times heart rate) of 30% or more above baseline level; and 7) the visual presence of new blood in the aspirated mucus. Data for the registration of adverse events were collected from the Marquette Medical Systems monitor using version 9A software. Vital signs (oxygen saturation, heart rate, systolic blood pressure, mean blood
pressure) were measured at 1-minute intervals from the 2-minute period preceding the suctioning intervention until 10 minute after.

During ventilation a proper level of sedation was achieved with a continuous infusion of midazolam (range 1-4 mg/h) and fentanyl (range 50-150 μg/h).

The number of endotracheal tube changes during the duration of ventilation was recorded.

All patients who were discharged from the ICU were interviewed within 3 days. The questions concerned their recollection of suctioning and how much discomfort either RES or MIAS caused expressed on a visual analogue scale in cm. Two questions were asked: 1) “Do you recall having had the treatment of being suctioned within the lungs?”, and 2) “If so, how much discomfort do you recall, marked on this line ranging from no discomfort to maximum, worst imaginable, discomfort?”

Statistical analysis

Differences between the two intervention groups were analyzed using the Chi-squared test for nominal variables, the Mann Whitney U-test for ordinal variables and the Students t-test for interval and ratio variables. Analysis of potential determinants for recollection of airway suctioning was done, using logistic regression analysis. Recollection was entered as dependent variable, method of suctioning (RES or MIAS), age (in years), APACHE-II score, gender, duration of intubation, and number of treatments were entered (method stepwise forward) as independent variables.

Results

Two hundred and seventy patients (RES: n=142, MIAS: n=128) were asked to participate in this study. Sixty-two patients (RES: n=29, MIAS: n=33, P-value 0.296) were unable to answer the questions because they felt too ill. Data from 208 patients were taken for analysis.
Patient recollection of airway suctioning

Table 1. Patient characteristics.

<table>
<thead>
<tr>
<th></th>
<th>RES (n=113)</th>
<th>MIAS (n=95)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (sd)</td>
<td>62 (15)</td>
<td>63 (16)</td>
<td>0.559</td>
</tr>
<tr>
<td>Gender: male in %</td>
<td>71</td>
<td>66</td>
<td>0.487</td>
</tr>
<tr>
<td>Previous history of pulmonary disease, in % no/moderate/severe</td>
<td>84 / 13 / 3</td>
<td>79 / 18 / 3</td>
<td>0.534</td>
</tr>
<tr>
<td>Emergency admission, in %</td>
<td>42</td>
<td>58</td>
<td>0.485</td>
</tr>
<tr>
<td>APACHE II score median, (min-max)</td>
<td>12 (2 - 29)</td>
<td>13 (2 - 29)</td>
<td>0.537</td>
</tr>
<tr>
<td>Type of patient (trauma/medical/surgical) in %</td>
<td>4 / 6 / 90</td>
<td>6 / 3 / 91</td>
<td>0.510</td>
</tr>
<tr>
<td>Duration of intubation, median (min-max)</td>
<td>5 (1 - 43)</td>
<td>4.5 (2 - 57)</td>
<td>0.935</td>
</tr>
</tbody>
</table>

Characteristics of patients included are described in Table 1. No significant differences were found in any of the characteristics.

Table 2. Recollection and discomfort of airway suctioning.

<table>
<thead>
<tr>
<th></th>
<th>RES (n= 113)</th>
<th>MIAS (n= 95)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of patients who had recollection of airway suction.</td>
<td>40.7</td>
<td>20.0</td>
<td>0.001</td>
</tr>
<tr>
<td>Discomfort expressed on VAS in cm, median (min - max).</td>
<td>5.9 (0-10)</td>
<td>5 (0-10)</td>
<td>0.136</td>
</tr>
</tbody>
</table>

Fewer patients in the MIAS group showed a recollection of airway suctioning as compared to the patients in the RES group (table 2). Patients, who had recollection of airway suctioning, showed no significant difference in discomfort between RES and MIAS group. The number of endotracheal tube changes was similar in the RES group and the MIAS group (P=0.967). Ten endotracheal tube changes occurred in the RES group [median (min-max) per patient: 0(0-3)], and six in the MIAS-group [median (min-max) per patient: 0(0-1)] (P=0.967).

The incidence of suction related adverse events per intervention is described in table 3; the incidence of decreased saturation, increased systolic blood pressure, and blood in mucus. The incidence of suction related adverse events is almost everywhere lower in the MIAS group as compared to the RES group.
Table 3. Incidence suction related adverse events per intervention.

<table>
<thead>
<tr>
<th></th>
<th>RES</th>
<th>MIAS</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of interventions</td>
<td>3657</td>
<td>3044</td>
<td></td>
</tr>
<tr>
<td>Decreased saturation (%)</td>
<td>2.6</td>
<td>1.4</td>
<td>0.001</td>
</tr>
<tr>
<td>Bradycardia (%)</td>
<td>0.1</td>
<td>0</td>
<td>0.068</td>
</tr>
<tr>
<td>Arrhythmia (%)</td>
<td>4.6</td>
<td>5.6</td>
<td>0.002</td>
</tr>
<tr>
<td>Increased systolic blood pressure (%)</td>
<td>16.3</td>
<td>13.7</td>
<td>0.003</td>
</tr>
<tr>
<td>Increased pulse pressure rate (%)</td>
<td>1.6</td>
<td>1.0</td>
<td>0.053</td>
</tr>
<tr>
<td>Blood in mucus (%)</td>
<td>2.2</td>
<td>0.9</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Logistic regression shows the following regression coefficients for recollection of airway suctioning, RES: 1.016 (P=0.002) and age -0.025 (P=0.013). APACHE-II score, gender, duration of intubation) and number of treatments were excluded from the equation. Regression coefficients and P-values are expressed in table 4.

Table 4. Logistic regression for recollection of airway suctioning.

<table>
<thead>
<tr>
<th>Variables in the equation</th>
<th>Wald test statistic</th>
<th>P value</th>
<th>B</th>
<th>Exp(B)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>9.732</td>
<td>0.002</td>
<td>1.016</td>
<td>2.762</td>
</tr>
<tr>
<td>Age years</td>
<td>6.232</td>
<td>0.013</td>
<td>-0.025</td>
<td>0.975</td>
</tr>
<tr>
<td>Variables not in the equation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>2.018</td>
<td>0.155</td>
<td></td>
<td></td>
</tr>
<tr>
<td>APACHE II score</td>
<td>2.929</td>
<td>0.087</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration of intubation</td>
<td>3.163</td>
<td>0.075</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of suctioning treatments</td>
<td>3.838</td>
<td>0.050</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*odds-ratio

The odds-ratio of 2.76 for RES indicates that patients who were treated with RES have a 2.76 times higher risk for recollection of airway suctioning as compared to patients treated with MIAS. The odds-ratio of 0.97 for age indicates that for every additional year the recollection of airway suctioning is 1.03 times lower.
Patient recollection of airway suctioning

Discussion

The results of our study show that the prevalence of recollection of airway suctioning is considerably lower when endotracheal suctioning was done according to a minimally invasive protocol as compared to conventional endotracheal suctioning. Of the mainly surgical patients in our study discharged from an ICU, 40.7% have a recollection of endotracheal suctioning, which they experienced as unpleasant. This is in agreement with two other studies by Turner. Turner found in a group of 68 ventilated, mainly medical, patients [2] a prevalence (95% Confidence Interval) of recollection of endotracheal suctioning of 44% (32-57%), and in 26 mainly surgical patients [6] a prevalence of recollection of endotracheal suctioning of 47% (26-70%). The estimate of the prevalence of recollection of conventional endotracheal suctioning in our study extends the results of Turner's studies to a larger population producing higher reliability.

General recollection of ICU stay is reported to range between 35% and 66% [7,8], and may be dependant on the use of medication like benzodiazepines [9] and propofol [10]. These types of medication are used routinely in our ICU's. A considerable number of patients were not able to answer the questions, but they were distributed equally over both treatment protocols, therefore creating no bias.

MIAS results in a lower incidence of recollection of endotracheal suctioning compared to RES. We also found that in the MIAS group a lower incidence of increased systolic blood pressure, which may indicate that the patients in the MIAS group experienced less stress. MIAS is designed to clean only the length of the endotracheal tube due to the identical length of tube and suction catheter. No physical contact can be made between the suction tube and the trachea or main bronchi. This procedure then probably induces less stress in the patient. The design of our study does not allow a distinction between the separate components of the endotracheal suctioning procedure such as airway manipulation, saline instillation, and manual hyperinflation. The duration of intervention is shorter in MIAS than in RES, which also may have contributed to a lower prevalence of recollection of suctioning. MIAS causes
fewer physical stimuli, and is shorter, resulting in less stress during the intubation period. Less stress may explain the lower number of patients having recollection of airway suctioning in case of MIAS. Our study also shows that elderly patients tend to have a lower risk of recollection of airway suction. This can be explained by the general decline in memory with age [11]. Other variables like APACHE-II score, gender, duration of intubation, and number of treatments did not show to be a significant factor in recollection. This may be due to level of sedation of patients or the bias created by selection in this study.

The level of discomfort, expressed by a visual analogue scale in centimetres, is not significantly different between RES and MIAS. We would expect a lower level of discomfort in MIAS, due to the no-physical airway contact and the shorter duration of MIAS. Potential explanations for equal levels of discomfort found in both treatments imply that the patient is disconnected from the mechanical ventilator, resulting in loss of positive pressure and a disturbance in their breathing pattern. A second explanation may be the fact that patients were addressed by the nursing staff to inform them about the treatment. This may have resulted in a change in daily rhythm and waking them from their sleep.

Conclusions

Minimally invasive airway suctioning results in a lower prevalence of recollection of airway suction than routine endotracheal suctioning. Presumably, this difference is due to fewer physical stimuli and a shorter procedure during the MIAS treatment. Furthermore, when patients have a recollection of airway suctioning, this recollection is a moderately distressful experience.
Reference List