Endotracheal reintubation in post-operative cardiac surgical patients

Abdul-Zahoor MD, FCPS*, Nor Azlina MD, MSc**

*Consultant Anesthesiologist
King Khaled Eye Specialist Hospital, P. O. Box 7191, Riyadh 11462 (Saudi Arabia)

**Consultant Anesthesiologist
National Heart Institute, 145, Jalan Tun Razak, 50400, Kuala Lumpur (Malaysia)

Correspondence: Dr. Abdul-Zahoor MD, FCPS, Consultant Anesthesiologist, King Khaled Eye Specialist Hospital, P. O. Box 7191, Riyadh 11462 (Saudi Arabia); Phone: +966 509003709; Fax No: +966 1 4821908; E-mail: armanzahoor@hotmail.com or armanzahoor@yahoo.com

ABSTRACT

Background: The reported incidence of reintubation in patients who were weaned from mechanical ventilation after cardiac surgery is 6.6%/4 in a retrospective study, but little work has been done prospectively to find out the incidence and causes for reintubation in a cardiac surgical ICU. We conducted this study to find out incidence and the causes of endotracheal reintubation in patients who were electively ventilated after open heart surgery and were extubated after fulfilling preset criteria for extubation.

Methodology: A total of 1229 consecutive patients were included in the study. On arrival to ICU after cardiac surgery, all patients were electively ventilated with standardized ventilatory parameters. Routine monitoring of all patients was done and patients were extubated once they met the criteria for extubation. The patients, who met the reintubation criteria, were reintubated and the reason(s) noted. Once they stabilized and fulfilled the extubation criteria, they were extubated.

Results: A total of 47 (3.82%) patients required reintubation after weaning from the ventilation during the study period, and in 5 (10.63%) patients out of these, reintubation was needed more than once. We found a higher incidence of reintubation, 11.84% and 10.63%, in patients after single and double valve replacement surgery respectively. The incidence was much lower (2.14%) among coronary artery bypass grafting (CABG) patients.

Conclusion: The patients undergoing valve replacement surgery are more prone to reintubation in postoperative period as compared to CABG patients. Impending respiratory failure, cardiovascular (hemodynamic) instability and impaired conscious level are the common indications for reintubation.

Key Words: Extubation failure; coronary artery bypass grafting; reintubation; cardiac surgery intensive care unit; open heart surgery; valve replacement.


INTRODUCTION

Endotracheal reintubation is not uncommon among critically ill patients after open heart surgery1. The overall incidence for reintubation in a general surgical intensive care unit is generally considered 4%, but varies dramatically between 1-13%, depending on the underlying disease process 2. Similarly a 10% incidence has been reported in 745 consecutive admissions in medical ICU patients that were mechanically ventilated for a minimum of 6 hours3. The reported incidence of reintubation in patients who were weaned from mechanical ventilation after cardiac surgery
is 6.6% \(^4\) in a retrospective study but little work has been
done to find out the incidence and causes for reintubation
in a cardiac surgical ICU prospectively.

Reintubation is not only associated with increased duration of
mechanical ventilation but also the ICU and hospital
length of stay\(^5\). Reintubation is known to be an independent
cause, which adds to the mortality; patients who required
reintubation have poor prognosis with a mor tality rate
exceeding 30-40% \(^6\), irrespective of the cause for
reintubation. The major causes of reintubation are usually
related to respiratory or cardiovascular system but could
be multi-factorial\(^6\) and may possibly be prevented, to some
extent, by improving the care\(^7\).

We studied the incidence and the causes of endotracheal
reintubation in patients who were electively ventilated after
open heart surgery and were extubated after fulfilling the
preset criteria for extubation.

METHODOLOGY

After approval by the institutional review board of our
hospital, all adult patients, who underwent open heart
surgery and were electively ventilated after the surgery in
the post-cardiac surgery intensive care unit (CICU),
were included in the study. It was a descriptive study. The data
was prospectively collected for a period of seven months,
from January to July 2008. A total of 1229 patients, admitted
during this period, were enrolled in the study.

Routine monitoring of all patients was done including
ECG, arterial oxygen saturation (SaO\(_2\)), end tidal carbon
dioxide (EtCO\(_2\)), central venous pressure and in vasive
arterial blood pressure. Pulmonary artery pressure, pulmonary capillary wedge pressure or left atrial pressure
were monitored where indicated (Table 3).

Arterial blood gases were checked hourly for the first four
hours and were subsequently repeated after every change
in the ventilatory parameters. Urine output and surgical
bleed through the chest drains was measured on an hourly
basis. Haematocrit was aimed to be kept at 30% or above
and appropriate transfusion was given when indicated.

All patients, on arrival to ICU, were put on standardized
ventilatory parameters unless indicated otherwise. They
were initially put on volume controlled or pressure controlled
mode (Table 3). A positive end expiratory pressure (PEEP)
of 5 cmH\(_2\)O or more was added where indicated. An
inspired oxygen fraction (FiO\(_2\)) of \(^2\)50% and a tidal
volume of \(^2\)10ml/kg body weight was set to all patients.

The ventilatory parameters were adjusted according to the
results of arterial blood gases (ABG’s).

An early extubation was aimed in all patients but no time
schedule was fixed like a fast track. All patients were
extubated without any delay, when they met the preset
criteria for extubation (Table 1).

### Table 1: Pre-set Criteria for extubation

**Respiratory:**
- **Minimal respiratory support (1-2 h):**
  - SIMV rate \(^2\) 6 breaths/min; Pressure support \(^2\)10cmH\(_2\)O;
  - PEEP \(^2\) 5cmH\(_2\)O; FiO\(_2\) \(^2\) 50%.
- **Arterial blood gas:**
  - SaO\(_2\) \(^2\) 90% on Fio2 \(^2\) 50%, PaO\(_2\) \(^2\) 80mmHg on Fio2
  - \(^2\) 50%, PaCo\(_2\) 30-45mmHg
- **No frequent airway suctioning needed**

**Cardiovascular:**
- Mean arterial pressure 70-110mmHg.
- Stable (sinus) rhythm or a rhythm other than sinus not adversely affecting the BP.
- Heart rate 60-110/min.

**Conscious level:**
- Mentally alert, obeying verbal commands, protecting airway, intact cough
  and gag reflex.

**Vasoactive drugs:**
- Dopamine \(^2\) 10 \(^\mu\)g/Kg/min; Dobutamine \(^2\) 10 \(^\mu\)g/kg/min; Epinephrine
  \(^2\) 0.05\(^\mu\)g/min; Norepinephrine \(^2\) 0.2 \(^\mu\)g/kg/min; Glyceryl
  Trinitrate (GTN) \(^2\) 5 \(^\mu\)g/kg/min; Milrinone \(^2\) 0.5 \(^\mu\)g/kg/min and Sodium
  nitroprusside (Nepride) \(^2\) 2 \(^\mu\)g/kg/min.

**Miscellaneous:**
- Chest drainage \(^2\) 100 ml/hr
- Muscle power \(^2\) grade-3

A consideration was also given to the frequency of
requirement and dosage of inotropic, chronotropic,
vasodilator and/or vasoconstrictor drugs used. Extubation
was delayed if a patient was on more than three drugs at
that same time. Diaphoresis, confusion, stroke, renal failure
or compromised renal functions and anxiety were also
considered as causes for extubation delay. Patients were
re-intubated when indicated according to preset criteria
for reintubation (Table 2).

### Table 2: Pre-set criteria for re-intubation

**Respiratory:**
- Impending respiratory failure:
  - \(^\uparrow\) in PaCO\(_2\) \(^2\) 10 mmHg/hr, in the pH \(^2\) 0.10/hr, PaO\(_2\)
  - \(^2\) 60 mmHg or SaO\(_2\) \(^2\) 90% on FiO\(_2\) \(^2\) 50%.
- \(^\uparrow\) work of breathing
- Upper respiratory obstruction
- Excessive pulmonary secretions
• Pulmonary edema
• Tension pneumothorax
• Severe bronchospasm

Cardiovascular:
• Mean arterial pressure ≥ 60mmHg (for ≥ 1hr)
• Cardiac tamponade
• Dysrhythmias with hemodynamic instability
• Cardiopulmonary arrest

Impaired conscious level:
Miscellaneous:
• Chest drainage ≥ 100ml/hr
• Accidental extubation

The data for the indications for reintubation were collected under the categories of respiratory, cardiac, central nervous system and multisystem involvement. All other causes were grouped under miscellaneous, including accidental extubation and surgical bleeding.

RESULTS

Demographic data showed a mean age of 62±5.5 years. The number of male patients was almost three times more than females. Patients, who underwent a CAGB, were 933(75.91%), including 5(0.4%) patients who had had a redo procedure. Nine patients (0.73%) had severe renal impairment and underwent off pump bypass.

A total of 47(3.82%) patients required reintubation after weaning off ventilation. Fourteen (29.78%) patients were reintubated within 5-10 hours after extubation, but 18(38.29%) patients tolerated the extubation trial well for the first 24 hours and needed reintubation afterwards (Table 4).

Table 3: Reintubation data*  

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total No. of patients</th>
<th>Reintubation N(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients</td>
<td>1229</td>
<td>47(3.82)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>864(70.30)</td>
<td>32(3.70)</td>
</tr>
<tr>
<td>Female</td>
<td>365(29.69)</td>
<td>15(4.10)</td>
</tr>
<tr>
<td>Single valve replacement</td>
<td>152(12.36)</td>
<td>18(11.84)</td>
</tr>
<tr>
<td>Double valve replacement</td>
<td>65(5.28)</td>
<td>5(10.63)</td>
</tr>
<tr>
<td>CAGB</td>
<td>933(75.91)</td>
<td>20(2.14)</td>
</tr>
<tr>
<td>Coronary + valve replacement</td>
<td>79(6.42)</td>
<td>4(5.06)</td>
</tr>
</tbody>
</table>

Twenty six (55.31%) patients were reintubated because of impending respiratory failure due to various reasons but respiratory muscles weakness and hypoventilation were the most important cause (Table 5). Only 6 (12.76%) patients had cardiovascular reason for reintubation, where hemodynamic instability and hypotension were the important responsible factors. Five patients (10.6%) were re-intubated because of impaired conscious level that deteriorated after extubation. Only 2 (4.25%) patients were extubated accidentally and were reintubated immediately.

Surgical Procedure

The decision to reintubate was made on overall condition of the patient and the cause for reintubation was assigned to the physiological system that was predominantly involved in the failure. Only 4(8.5%) patients had a significant involvement of more than one body system and the cause was assigned to multi-organ failure category. The most

Table 4: Time to reintubation  

<table>
<thead>
<tr>
<th>Time of Reintubation</th>
<th>N(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within 24 hours</td>
<td>26(55.31)</td>
</tr>
<tr>
<td>2nd day</td>
<td>7(14.89)</td>
</tr>
<tr>
<td>3rd day</td>
<td>4(8.51)</td>
</tr>
<tr>
<td>4th day</td>
<td>7(14.89)</td>
</tr>
<tr>
<td>5th day</td>
<td>1(2.12)</td>
</tr>
<tr>
<td>&gt;5 days</td>
<td>2(4.25)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time since last extubation (hrs)</th>
<th>N(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>8(17.02)</td>
</tr>
<tr>
<td>2-4</td>
<td>5(10.63)</td>
</tr>
<tr>
<td>5-10</td>
<td>14(29.78)</td>
</tr>
<tr>
<td>11-24</td>
<td>2(4.25)</td>
</tr>
<tr>
<td>&gt;24</td>
<td>18(38.29)</td>
</tr>
</tbody>
</table>
common combination of multi-organ involvement was impending respiratory failure together with impaired conscious level.

Table 5: Causes of reintubation

<table>
<thead>
<tr>
<th>Causes</th>
<th>N(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impending respiratory failure:</td>
<td></td>
</tr>
<tr>
<td>Due to Pneumonia / excessive secretions, non cardiac pulmonary edema, lung collapse, aspiration, bronchospasm, respiratory muscle weakness, upper airway obstruction, hypoventilation syndrome and kinked / blocked tube.</td>
<td>26(55.31)</td>
</tr>
<tr>
<td>Cardiovascular: Severe myocardial ischemia or acute infarction, severe arrhythmia with Hemodynamic instability, severe hypotension (low output syndrome), congestive heart failure and cardiac arrest.</td>
<td>6(12.76)</td>
</tr>
<tr>
<td>Impaired conscious level</td>
<td>5(10.6)</td>
</tr>
<tr>
<td>Accidental extubation</td>
<td>2(4.25)</td>
</tr>
<tr>
<td>Surgical bleeding</td>
<td>2(4.25)</td>
</tr>
<tr>
<td>Multi organ involvement</td>
<td>4(8.5)</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>2(4.25)</td>
</tr>
<tr>
<td>Total</td>
<td>47(100)</td>
</tr>
</tbody>
</table>

Eighteen patients (38.29%) that were reintubated once or more than once eventually died. None of them had a tracheostomy because they all died for various reasons within two weeks of reintubation. The cause of death determination was beyond the scope of this study; hence, has been ignored.

Five (10.63%) patients needed reintubation more than once (Table 3). The incidence of reintubation was not different between male and female patients and corresponded closely to their ratio. We found a higher incidence of reintubation, 18/152 (11.84%) and 5/65 (10.63%), in single and double valve replacement surgery respectively. The incidence was much lower [20/933 (2.14%)] among CABG patients.

DISCUSSION

We admitted 1229 consecutive patients after cardiac surgery in our ICU over a period of 7 months and studied them prospectively. A total of 47 (3.82%) patients failed the extubation trial. Patients undergone a single or double valve surgery had a higher incidence of reintubation in comparison to CABG surgery. The incidence of reintubation was 4/79 (5.06%) in patients who had CABG together with a valve replacement.

The higher incidence of reintubation among the valve replacement surgery indicates some correlation between the extubation failure and valve surgery. The exact cause is unclear but it is known that pulmonary functions might deteriorate in the immediate postoperative period and might take time to return to the preoperative values. The possible mechanism could be the poor compliance of the lungs to accommodate the corrected cardiac output after valve surgery. The reported incidence of persistent pleural effusion for weeks after valve replacement surgery is 45% and that could have been contributed to pulmonary malfunction and subsequent need for reintubation in our valve replacement patients.

Our overall incidence (3.82%) of reintubation was almost half of the reported incidence (6.6%) after cardiac surgery. The reasons of this difference may be related either to the difference in the type of surgery or to a difference in the policy of fast track protocol at some centers, in an attempt to reduce the ICU stay and cost.

The most common (55.31%) cause for reintubation in our study was impending respiratory failure that manifested with increased work of breathing, accessory muscle use, hypoxia and/or hypercapnia, hypoventilation and respiratory acidosis, especially for those who were reintubated within the first 24 hours. Half of our reintubated patients developed pneumonia. In a case control study, the incidence of pneumonia was significantly higher (47% vs 10%) in patients needing reintubation. Dries and colleagues also found an increased incidence of nosocomial pneumonia in patients who failed extubation trial, which confirms our findings.

Pulmonary edema and upper airway obstruction were among the important respiratory causes for reintubation, especially for those who were reintubated after the second day of extubation. Interestingly, causes related to airway patency and secretions manifested only after extubation.

The incidence of asymptomatic myocardial ischemia has been reported to be 52% after CABG. In our study 6/47 (12.76%) of the patients had a cardiac reason for reintubation, where myocardial ischemia or acute infarction were the common reasons, that led to low output syndrome and heart failure among CABG patients, while pulmonary hypertension was the important reason in the valve

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replacement surgical patients.

It is well known that patients, who undergo myocardial revascularization procedures, are particularly prone to stroke, encephalopathy and other neurologic dysfunction, because they are relatively old and have atherosclerotic disease. They are also subject to cerebral embolization and cerebral hyperthermia after the discontinuation of cardiopulmonary bypass\textsuperscript{14,15}. We found impaired conscious level (10.6%) to be the third important reason for reintubation in our study. Two of those patients ultimately developed stroke and died later on.

**CONCLUSION**

Endotracheal reintubation is not uncommon among critically ill patients after open heart surgeries. The incidence was higher in patients undergone valve replacement surgery in comparison to CABG surgery. Impending respiratory failure, cardiovascular (hemodynamic) instability and impaired conscious level were the most important indications for reintubation.

**REFERENCES**


