Unexpected Difficult Intubation in Cesarean Section

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Conflicts of Interest

• The lecturer is involved in the development, design and clinical testing of devices related to airway management, which are produced by Acutronic Medical Systems, Switzerland (e.g. the SensaScope®).

• When in this presentation a product is mentioned with which a conflict of interests is possible, this symbol is included:
A Difficult Airway

...is if an adequately trained anesthesiologist cannot apply sufficient face mask ventilation or perform a successful tracheal intubation or both, according to the mentioned definitions.
Difficult intubation in obstetric anaesthesia 1:300 (Lyons, Br J Anaesth 1985) vs 1:2300 in non-obstetric anaesthesia (King, Br J Anaesth 1990)

Difficult intubation in obstetric anaesthesia 7.9% (Rocke, Anesthesiology 1992) vs 2.5% in non-obstetric anaesthesia (Rose, Can J Anaesth 1994)
Recent data

Methods: Airway experience was analyzed among patients who had pregnancy-related surgery under general anesthesia from January 2001 through February 2006.

Results: In a total of 30,766 operations, **2,158** (7%) were performed with general anesthesia. Among these, **1,026** (47.5%) were for emergency cesarean delivery (CD), **610** (28.3%) for nonemergency CD, and **522** (24.2%) for non-CD procedures. A total of **12** patients (0.56%) were identified as having an unanticipated difficult airway.
Recent data

Methods: Data were collected by writing a custom report from the Meditech electronic patient record system, containing details of all deliveries, operations, anaesthetics and associated complications from January 1st 2000 until December 31st 2007.

Results: …there were 55,057 deliveries of which 12,806 occurred via Caesarean section (23.2%). A total of 3,430 obstetric general anaesthetics were administered. Of these, 86.3% were given for Caesarean section… General anaesthesia was used, on average, for 8.7% of elective and 30.4% of emergency Caesarean sections. Only 23 patients were recorded as having a difficult intubation (1:156). Of these, 15 occurred in emergency Caesarean sections (65%). Two of the patients had severe pre-eclampsia. Airway difficulties were anticipated in 9 patients.
Higher incidence in obstetrics

- Obesity, large breasts
- Oedema of connective tissue (lingual oedema)
- Increased mucosal tissue vulnerability
- Lower tolerance for hypoxaemia
- Full stomach, elevated intraabdominal pressure
- Tendency for low anaesthetic dosage
- Psychological factors (tendency for low anaesthetic dosage, stressful and impatient ambiance in OR)
**Imbalance of O₂ availability**

- Thoracic compliance: -45%
- Expiratory residual volume: -20%
- Functional residual capacity (FRC): -20%

**Increased metabolism**

- More consumption
- +20% VO₂

**less O₂ supply**
Morbidity and mortality

Desaturation, hypoxaemia
Injury (teeth, mucosa [18%])
Edema [50%]
Airway obstruction, laryngeal spasm
Aspiration
Pneumothorax, mediastinal emphysema

*Shorten GD (1992) Curr Op Anaesth 5, 772*

7% of anesthesia associated death cases
41% of anesthesia associated death cases in obstetrics

*Caplan RA (1980) Anesthesiology 72, 828*
Some Improvement

Death/brain damage associated with DA decreased in 1993-1999 (35%) as compared with 1985-1992 (62%; $P < 0.05$; odds ratio, 0.26; 95% confidence interval, 0.11-0.63; $P = 0.003$).


After the introduction and use of these monitors (pulse oximetry and capnography), there was a significant reduction in the proportion of respiratory damaging events responsible for death or permanent brain damage.

What else to do?
Eventually this here...?
Eventually this here...?
DIFFICULT AIRWAY ALGORITHM

1. Assess the likelihood and clinical impact of basic management problems:
   A. Difficult Ventilation
   B. Difficult Intubation
   C. Difficulty with Patient Cooperation or Consent
   D. Difficult Tracheostomy

2. Actively pursue opportunities to deliver supplemental oxygen throughout the process of difficult airway management.

3. Consider the relative merits and feasibility of basic management choices:
   A. Awake Intubation
   B. Non-Invasive Technique for Initial Approach to Intubation
   C. Preservation of Spontaneous Ventilation

4. Develop primary and alternative strategies:

   **AWAKE INTUBATION**
   - Airway Approach by Non-Invasive intubation or Airway Access
t
   - Initial Intubation Attempts
     - Initial Intubation Attempts SUCCESSFUL
     - Initial Intubation Attempts UNSUCCESSFUL

   **FACE MASK VENTILATION ADEQUATE**
   - Ventilation Adequate, Intubation Unsuccessful
     - Alternative Approaches to Intubation
     - Successful Intubation
     - Multiple Attempts

   **FACE MASK VENTILATION NOT ADEQUATE**
   - Ventilation Not Adequate, Intubation Unsuccessful
     - LMA Adequate
     - LMA Not Adequate or Not Feasible

   **NON-EMERGENCY PATHWAY**
   - Ventilation Adequate, Intubation Unsuccessful
     - Alternative Approaches to Intubation
     - Successful Intubation
     - Multiple Attempts

   **EMERGENCY PATHWAY**
   - Ventilation Not Adequate, Intubation Unsuccessful
     - Call for Help
     - Emergency Non-Invasive Airway Ventilation
     - Successful Ventilation
     - Failure

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*a* Confirm ventilation, tracheal intubation, or LMA placement with exhaled CO2.

b. Other options include but are not limited to: surgery utilizing larynx or LMA anesthesia, local anesthesia intubation or regional nerve blocks. Pursuit of these options usually implies that mask ventilation will not be problematic. These options may be of limited value if this step in the algorithm has been reached via the Emergency Pathway.

c. Alternative non-invasive approaches to difficult intubation (but are not limited to) use of different laryngoscope guides, LMA as an intubation conduit (with or without antibiotic guidance), fiberoptic intubation, intubating stylet or tube changer, lightwand, miltonge intubation, and blind naso or nasal intubation.

d. Consider repositioning of the patient for awake intubation or canceling surgery.

e. Options for emergency non-invasive airway ventilation include but are not limited to: rigid bronchoscope, esophageal-tracheal combitube ventilation, or transtracheal jet ventilation.
FIGURE 1. Airway management algorithm for the sports medicine physician.
Advanced skills will be discussed in the second article on airway management.
Failed Airway Algorithm

- Failed intubation
  - BVM → SaO₂ > 90%
    - no → Cricothyrotomy
    - yes → Options: Combitube, LMA, Light wand, TTJV, Fiberoptic
      - yes → ETT placed?
        - yes → PostETT mgmt
        - no → SaO₂ > 90%
          - no → Cricothyrotomy
          - yes → Arrange for definitive airway mgmt
  - Call for Help!!!
Distinction first

Elective airway management
Preparation of adequate personnel & equipment
Choice of multiple techniques, e.g. awake fiberoptic intubation

Predicted DA vs. Unpredicted DA

app. 90% vs. app. 10%
Distinction first

Predicted DA vs. Unpredicted DA

Predicted DA:
- Elective airway management
- Preparation of adequate personell & equipment
- Choice of multiple techniques, e.g. awake fiberoptic intubation

app. 90%

Unpredicted DA:
- Adapted algorithms
- Emergency airway equipment available
- Routine preoxygenation
- Relaxation only if mask ventilation possible

app. 10%
But we still have too much of...
But we still have too much of...

Hardware AND Software
Simplification is needed

Hardware AND Software

adequately trained users

Step 1
Step 2
Step 3
Step 4
The difficult intubation drill at the University Hospital Zürich

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Abstract

Recently, an institutional “Difficult Intubation Drill” has been conceived and started at the University Hospital Zürich, which is intended to sustainably improve the handling of difficult airway situations. The drill consists of a weekly course in the airway management SkillsLab of the university to which all staff members of our department are subjected to participate. The hardware of the drill is a standardized difficult intubation cart consisting of 4 airway rescue techniques arranged in successive drawers that represent also the priority and order of use of these 4 devices: 1. SensaScope®, 2. Fastrach®, 3. laryngeal tube, and 4. transtracheal oxygenation and jet ventilation. This actual choice of devices and techniques represent the actual algorithm for the unexpected failed intubation. Repeated assessments of the educational results and clinical outcome of this airway course will possibly contribute to adaptations and modification of the difficult intubation cart and its clinical use.

Keywords: airway management education, difficult airway, failed intubation
Induction of an unsuspected patient

- Pre-oxigenation, opioid, hypnotic
- Fair face mask ventilation
- N.D. neuromuscular relaxation

Intubation attempt... C&L 3 or 4

2. intubation attempt by colleague... no success

Local Algorithm e.g. Zurich DI Drill
Scenarios

- Difficult mask ventilation
- Difficult laryngoscopy
- Unexpected difficulty
- Difficult intubation
- Anticipated difficulty
- Cannot intubate, cannot ventilate
Scenarios

The unexpected difficult intubation in anesthetized and paralyzed patients who cannot be expected to return to wakefulness and spontaneous ventilation in due time and who require a secure airway.
The unexpected difficult intubation in anesthetized and paralyzed patients who cannot be expected to return to wakefulness and spontaneous ventilation in due time and who require a secure airway.

... because the expected difficult intubation is covered by the awake flexible fiberoptic intubation, which is still the gold standard.

The indication

The unexpected difficult intubation in anesthetized and paralyzed patients who cannot be expected to return to wakefulness and spontaneous ventilation in due time and who require a secure airway.

otherwise one can apply a more safe de-escalation strategy by enabling the patient to wake up and breathe spontaneously.

The indication

The unexpected difficult intubation in anesthetized and paralyzed patients who cannot be expected to return to wakefulness and spontaneous ventilation in due time and who require a secure airway.

otherwise the much easier and faster insertion of a laryngeal mask airway (or any other suitable supraglottic airway device) would suffice as well.

So, let’s see the indications again...

The unexpected difficult intubation in anesthetized and paralyzed patients who cannot be expected to return to wakefulness and spontaneous ventilation in due time who require a secure airway
4 Categories

1. Simple techniques
2. Minimal invasive techniques
3. Non surgical invasive techniques
4. Surgical techniques
A 4 steps escalation scale

1. Simple techniques
   - head position, BURP, stylets, lightwand,
     different laryngoscope blade, airtrack,
     videoassisted techniques

2. Minimal invasive techniques
   - laryngeal mask, fastrach, combitube, cobra,
     i-gel, easytube, laryngeal tube, assisted
     fiberoptic intubation

3. Non surgical invasive techniques
   - transtracheal oxygenation, jet ventilation,
     retrograde intubation

4. Surgical techniques
   - cricothyrotomy, tracheotomy
A choice of 4 techniques

1. Simple techniques
   - head position, BURP, stylets, lightwand, different laryngoscope blade, airtrack, videoassisted techniques

2. Minimal invasive techniques
   - laryngeal mask, fastrach, combitube, cobra, i-gel, easytube, laryngeal tube, assisted fiberoptic intubation

3. Non surgical invasive techniques
   - transtracheal oxygenation, jet ventilation, retrograde intubation

4. Surgical techniques
   - cricothyrotomy, tracheotomy
A choice of 4 techniques

1. Simple techniques
   - videoassisted techniques

2. Minimal invasive techniques
   - fastrach
   - larygeal tube

3. Non surgical invasive techniques
   - transtracheal oxygenation, jet ventilation

4. Surgical techniques
The choice of techniques

- SensaScope
- Fastrach
- Laryngeal tube
- Transtracheal oxygenation and JV
Voila, the 4 drawers

Believe it or not, this is an algorithm!

And why is this order?
Probability of success

**SensaScope**
Very high (89% for novices, 94% for experienced). Visual technique (WYSWYG) Problematic in C&L 3b, blood, vomiting

**Fastrach**
Very high for LM (90%), moderate for intubation (82%).

**Laryngeal tube**
High (90%), very simple and fast

**Transtracheal oxigenation and JV**
Moderate (highly dependent on experience). Problematic in obesity, scarrs
Desirability of end result

SensaScope
Placement of chosen ETT

Fastrach
Placement of a special ETT. If LMA only, no perfect airway protection

Laryngeal tube
Moderate airway protection, ventilation possible

Transtracheal oxigenation and JV
No airway protection, ventilation difficult but possible
What’s needed

1

2

3

4
What’s needed
What's needed
What's needed
What are the alternatives?

- SensaScope: 7'100 Eur
- Fastrach: 420 Eur
- Laryngeal tube: 30 Eur
- Transtracheal oxygenation: 950 Eur
- Cart: 12'500 Eur
<table>
<thead>
<tr>
<th>Procedure</th>
<th>SensaScope</th>
<th>Flexible FO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laryngeal tube</td>
<td>7'100 Eur</td>
<td>12'000 Eur</td>
</tr>
<tr>
<td>Fastrach</td>
<td>420 Eur</td>
<td>2'500 Eur</td>
</tr>
<tr>
<td>Laryngeal tube</td>
<td>30 Eur</td>
<td>150 Eur</td>
</tr>
<tr>
<td>Combitube</td>
<td>12'000 Eur</td>
<td>19'600 Eur</td>
</tr>
<tr>
<td>Cart</td>
<td>4'000 Eur</td>
<td>4'000 Eur</td>
</tr>
</tbody>
</table>

Total Cost: 12'500 Eur vs 19'600 Eur
## Cheaper?

<table>
<thead>
<tr>
<th>Device</th>
<th>SensaScope</th>
<th>AirTraq (Ø CCD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laryngeal tube</td>
<td>7’100 Eur</td>
<td>90 Eur</td>
</tr>
<tr>
<td>Fastrach</td>
<td>420 Eur</td>
<td>LMA</td>
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<tr>
<td>Laryngeal tube</td>
<td>30 Eur</td>
<td>20 Eur</td>
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<tr>
<td>Transtracheal oxygenation</td>
<td>950 Eur</td>
<td>Quicktrach</td>
</tr>
<tr>
<td>Cart</td>
<td>4’000 Eur</td>
<td>Simple Cart</td>
</tr>
<tr>
<td></td>
<td>12’500 Eur</td>
<td>1’720 Eur</td>
</tr>
</tbody>
</table>
1 DIC in SkillsLab, 7 DIC in the OR
Cyclic Teaching and Training
Cyclic Teaching and Training
Principles

• Doctrine is consistent with internal policy
• Everywhere same doctrine, same standards
• Continuous evaluation of alternatives, additions
• Modifications possible (but at once everywhere)
• 1 piece of equipment per drawer
• Continuous cyclic training of all users
• Participation for all users mandatory
• Appointment of candidates outsourced to secretariat
• Controll of efficiency...
  A) for training effect
  B) for outcome
Drawer 1  **SensaScope**

- Familiar handling (+ laryngoscopy, steering like FFO)
- Very high success rate (>90%)
- Visual technique (WYSWYG)
- Placement of chosen ETT.

Ease of use, high success rate
Visualisation of entire pathway
Results from the Training Course

March 2009 to August 2011
Learning curve for SensaScope
March 2009 to August 2011

Overall success rate (o.K. < 60 s)
184 candidates succeeded in 660 of 736 = 90%

Mean 31 ± 16 s
Learning curves for SensaScope
March 2009 to August 2011

Effect of experience with the SS...

171 novices success rate 611 of 684 = 89%
13 experienced success rate 49 of 52 = 94%

\[ \Delta = 5\% \]

\[ \Delta T = 13\text{ s} \]
Learning curves for SensaScope
March 2009 to August 2011

Effect of experience with the FO...

77 novices success rate 264 of 308 = 86%
107 experienced success rate 396 of 428 = 93%

Δ = 7%

ΔT = 12 s
Drawer 2 Fastrach ILMA

Liu EH et al. Anesthesiology 2008; 108: 621-6
Learning curve for ILMA

Overall success rate (o.K. < 60 s)

184 candidates succeeded in 605 of 736 = 82%

Mean 39 ± 17 s
Learning curve for ILMA

Effect of experience with the ILMA...

- 171 novices success rate 559 of 684 = 82%
- 13 experienced success rate 46 of 52 = 89%

$\Delta = 7\%$

$\Delta T = 0.5\ s$
Drawer 3  Laryngeal Tube

Hüter L et al. Resuscitation 2009; 80: 930-4
Learning curve for Laryngeal Tube

Overall success rate (o.K. < 60 s)
184 candidates succeeded in 692 of 736 = 94%

![Graph showing the learning curve for Laryngeal Tube. The x-axis represents the consecutive trial (1st, 2nd, 3rd, 4th) and the y-axis represents time (s). The graph shows a downward trend in time with consecutive trials, indicating improved performance. The mean time is marked as 12 s.](image-url)
Learning curve for Laryngeal Tube

179 novices success rate 674 of 716 = 94%
5 experienced success rate 18 of 20 = 90%

Δ = - 4%

Effect of experience with the LT...

179 Novices mean 13 ± 11 s
5 Experienced mean 8.5 ± 2 s

ΔT = 4.5 s
Drawer 4  Transtracheal Jet Ventilation

Green L.  Eur J Anaesthesiol 2009; 26: 480-3
Learning curve for TTJV

Overall success rate (o.K. < 60 s)

22 candidates succeeded in 87 of 88 = 99%

Mean 13 ± 6 s
Learning curve for TTJV

18 novices success rate 71 of 72 = 98.6%
4 experienced success rate 16 of 16 = 100%

Δ = 1.4%

Effect of experience with the TTJV...

18 Novices mean 13 ± 7 s
4 Experienced mean 14 ± 5 s

ΔT = 1 s
Epilogue

- Number of candidates app. 200
- 184 participants in 2 years and 5 months
- Fluctuation rate app. 15% per year
- Duration of 1 complete cycle app. 15 months

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- Outcome-Effect?
  - app. 18‘000 Intubations per year
  - 5% difficult = 900 per year
  - 10% unpredicted difficult = 90 per year
Take home messages

• DA situations are the main cause for anesthesia related morbidity and mortality

• The most relevant scenario is the unexpected DA in anesthetized patients who cannot wake up immediately and who should be intubated

• Set up a simple local algorithm based on few and well trained elements (one-dimensional, multiple back up type algorithm)

• The emphasis is not on WHICH instruments should be used, but how to combine a few of them in the frame of a concise and standardized local airway management protocol

• Set up a continuous cyclic training course that simulates the relevant scenario(s) with the chosen algorithm

• Keep the instruments from the algorithm available for everyone, everywhere, anytime

• Standardize your approach and permit evolution