Airway management in anaesthesia care
– professional and patient perspectives

KATI KNUDSEN

Background: Careful airway management, including tracheal intubation, is important when performing anaesthesia in order to achieve safe tracheal intubation. Aim: To study airway management in anaesthesia care from both the professional and patient perspectives. Methods: 11 RNAs performed three airway tests in 87 patients, monitored in a study-specific questionnaire. The tests usefulness for predicting an easy intubation was analysed (Study I). 68 of 74 anaesthesia departments in Sweden answered a self-reported questionnaire about the presence of airway guidelines (Study II). 20 anaesthesiologists were interviewed; a phenomenographic analysis was performed to describe how anaesthesiologists' understand algorithms for management of the difficult airway (Study III). 13 patients were interviewed; content analysis was performed to describe patients' experiences of being awake fiberoptic intubated (Study IV). Results: The Mallampati classification is a good screening test for predicting easy intubation and intubation can be safely performed by RNAs (Study I). The presence of airway guidelines in Swedish anaesthesia departments is poorly implemented (Study II). Algorithms can be understood as law-like rules, a succinct plan to follow in difficult airway situations, an action plan kept in the back of one's mind while creating flexible and versatile personal algorithms, or as consensus guidelines based on expert opinion in order to be followed in clinical practice (Study III). One theme emerged describing experiences of being awake intubated; feelings of being in a vulnerable situation but cared for in safe hands, described in five categories: a need for tailored information, distress and fear of the intubation, acceptance and trust of the staff's competence, professional caring and support, and no hesitation about new awake intubation (Study IV). Conclusions: The Mallampati classification is a good screening test for predicting easy intubation, when the airway assessment is performed in a structured manner by RNAs. The presence of airway guidelines in Swedish anaesthesia departments was poorly implemented and should receive higher priority. Algorithms need to be simple and easy to follow and based on the best available scientific evidence. Tailored information about what to expect, ensuring eye contact, and giving breathing instructions during the procedure may reduce patients' feeling distress.

Keywords: Airway management, algorithm, awake intubation, professional and patient perspective

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To my family Bent & Olivia
List of Papers

This thesis is based on the following papers, which are referred to in the text by their Roman numerals.


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### Abbreviations

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<tr>
<td>ASA</td>
<td>American Society of Anesthesiologists</td>
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<td>RNA</td>
<td>Registered Nurse Anaesthetist</td>
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<tr>
<td>SFAI</td>
<td>Svensk förening för Anestesi och Intensivvård</td>
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<tr>
<td>WHO</td>
<td>World Health Organisation</td>
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<td>Difficult Airway Society</td>
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Preface

During my 20 years of working experience as a registered nurse anaesthetist (RNA) in anaesthesiology, I have observed the different ways a patient’s airway can be assessed before undergoing anaesthesia. I especially remember a situation in which an overweight middle-aged patient went into the operating room for emergency abdominal surgery. My intuition told me that he would probably be difficult to ventilate and intubate due to his beard, obesity, and short neck. Despite being at high risk for difficult intubation I felt that we did not do anything to prepare him or ourselves for a difficult airway, such as shaving his beard in advance or having an alternative plan available on how to secure the airway. At that point I began to think of how we could prepare patients and ourselves when performing endotracheal intubations so we do not jeopardise patient safety. The inability to secure a free airway is not only an emotionally stressful situation for the patients, but challenging for the anaesthesia professional. The present studies will help us gain a deeper understanding and new knowledge about how these situations could be experienced, from both professional and patient perspectives.
Careful airway management, including endotracheal intubation, is important when performing anaesthesia in order to achieve safe endotracheal intubation [1]. Endotracheal intubation is usually performed after the induction of general anaesthesia when the patients are asleep. When a difficult airway is expected, fiberoptic intubation is the recommended option to secure the airway and is performed before the induction of general anaesthesia when the patient is still awake [2]. Depending on whether the intubation is performed in an asleep or awake state, the patient experiences varying degrees of anxiety when undergoing intubation [3]. In general, women are more anxious than men [4], and patients who have experienced awake fiberoptic intubation report more discomfort and suffocation than patients who have undergone traditional endotracheal intubation [5]. To alleviate feelings of anxiety, it is important that patients are well-informed about the procedures, which increases their feelings of calm and security when undergoing anaesthesia. Psychologically preparing the patient for an awake intubation is essential, as this can be highly discomforting for the patient [6].

In Sweden, with a population of more than nine million people, approximately 500 000 general anaesthesia procedures are performed annually [7]. There is wide variation in estimations of the incidence of difficult intubation and depends on differences in study design, assessment tools [8], and how difficult airways are defined [9]. On the basis of a report written by a researcher in the US, difficult face mask ventilation combined with difficult intubation occurs in approximately 1 of every 250 cases annually [10], whereas in a review by Cook & MacDougall-Davis [11], the incidence of difficult intubation was estimated to be approximately 1 in 2000 in the elective setting and approximately 1 in 300 during rapid sequence induction. However, in the literature it is unclear how many of those anaesthetic procedures are performed in the awake state.
Preoperative airway assessment

Preoperative airway assessment is important when planning anaesthesia in order to achieve safe endotracheal intubation [1]. Whether the intubation is performed in an anaesthetised or awake state, the patients should undergo preoperative airway assessment before inducing general anaesthesia. The purpose of this assessment is to psychologically preparing patients for anaesthesia and to make anaesthesia professional aware of those patients who are likely to be easy or difficult to intubate. Studies have shown that preoperative airway assessment before surgery helps identify patients at risk of difficult ventilation and intubation [12, 13], improving patient safety. According to the fourth national audit project in the UK, the majority of airway problems occur during elective surgery in seemingly healthy patients [14]. Individual patient characteristics, such as the presence of a beard, short neck, limited mouth opening, poor dental status, male sex, increased Mallampati classification, and obesity, are associated with intubation difficulties [15, 16].

In 1983, Mallampati [17] developed a simple bedside test for assessing the patient’s airway before inducing anaesthesia. Using this test, adult patients can be divided into four classes according to the individual anatomical structures observed in their mouth while they are sitting in an upright position with the mouth opened wide and the tongue hanging out without phonation. Figure 1 describes Mallampati classification I–IV.

![Mallampati classification I–IV](image)

*Figure 1. Mallampati classification I–IV. Class I: soft palate, uvula, and faucial pillars can be seen. Class II: soft palate, faucial pillars, and portion of the uvula can be seen. Class III: soft palate and base of the uvula can be seen. Class IV: only the hard palate can be seen. "Illustrated by O. Wall, University of Gävle"*

The Mallampati test revealed a significant relationship between the ease of intubation and individual anatomical structures seen in the mouths of adult patients [17]. However, the test has been criticised as not being specific enough when used alone [18] due to variability from one person to another. For example, patients who were expected to have a difficult airway had an
easy intubation, and vice versa, when the test was used alone. Khan et al. [19] compared the Mallampati classification with the upper lip bite test, sternomental distance, thyromental distance, and interincisor distance in 309 patients. Nineteen patients were difficult to intubate and no significant difference was found based on gender. However, significant differences were found between the Mallampati test and laryngeal view [19]. Other studies [20, 21] comparing the Mallampati test and the patient’s position (sitting and supine) have found that the Mallampati test in a supine position is a better predictor of difficult endotracheal intubation than the test in a sitting position. On the other hand, the Mallampati test with the patient in a sitting position is associated with a higher percentage of easy intubations compared to the supine position [20]. Therefore, Bindra et al. [20] recommended performing the Mallampati test in both the supine and sitting positions to obtain a better assessment.

Another commonly used bedside test to predict difficult intubation is measuring the thyromental distance [22], the space from the bony point of the mentum to the thyroid notch. However, this test has been criticised as a bedside test for predicting difficult intubation due to its lack of accuracy [23] depending on how the thyromental distance is measured (i.e., with or without a ruler). In a meta-analysis, Baker et al. [24] showed that the accuracy of the test increased three-fold if the staff used a ruler when measuring the thyromental distance compared to the anaesthetist’s own finger width. Figure 2 describes how the thyromental distance is measured.

![Image of thyromental distance measurement](image)

**Figure 2.** The thyromental distance is the space between the bony point of the mentum and the thyroid notch, and is measured with the head fully extended and the mouth closed. The measurement should be performed with a ruler. "Illustrated by O. Wall, University of Gävle"

Shiga et al. [25] conducted a meta-analysis that included 50,760 patients from 35 different studies to determine the accuracy of bedside tests for predicting difficult intubation. They found that a combination of the Mallampati test and thyromental distance was the most reliable method for predicting
difficult intubation. On the other hand, Rosenstock et al. [26] conducted a qualitative interview study to explore how anaesthesiologists manage an unanticipated difficult airway, finding that only five of 24 patients were examined using more than two airway tests before endotracheal intubation, as recommended by the American Society of Anesthesiologists (ASA) guidelines [1].

Difficult endotracheal intubation is usually associated with a poor laryngeal view. One of the more widely accepted airway tests for predicting difficult intubation was described by Cormack & Lehane in 1984 [27]. This test consists of four grades describing the best laryngeal view depending on the visualisation of the glottis in the patient’s mouth during direct laryngoscopy. However, this test has the disadvantage that it can only be used after the patient has been anaesthetised. Figure 3 describes how Cormack & Lehane grades I–IV are assessed.

![Cormack & Lehane’s grading system](image)

*Figure 3. Cormack & Lehane’s grading system. Grade I: all of the vocal cords can be seen. Grade II: the anterior glottis is not seen. Grade III: only the epiglottis is seen. Grade IV: none of the above can be seen. Adopted from the SIARTI guidelines for a difficult intubation and difficult airway management.*

Traditionally, endotracheal intubation is performed after successful mask ventilation, when the patient is anaesthetised [28]. When difficult mask ventilation or intubation is expected based on the patient’s preoperative evaluation, intubation should be performed while the patient is still awake [2].

To perform intubation in the awake state, it is important that patients are informed of the procedure in order to increase the patient’s psychological comfort and cooperation during the procedure [6, 29].
Managing a difficult airway

Managing a difficult airway when inducing anaesthesia is one of the most challenging tasks for anaesthesia professionals. Failure to secure the airway, even for a few minutes, may increase the risk of hypoxic brain damage and harm the patients, causing stress for the professionals caring for them [1,14, 30]. When presented with a difficult airway in clinical practice, such as during an emergency, there is no time to think about what has gone wrong. Instead, the airway must be prioritised and a plan B considered for securing the airway [1, 31]. Therefore, in such critical situations, anaesthesia professionals must not only be technically skilled, but also have communicative, cognitive, and behavioural competence in making decisions [32, 33]. Furthermore, when a difficult airway is expected, there is a strong consensus among experts that specific strategies can improve patient outcomes when performing anaesthesia [14].

Airway guidelines and algorithms

In order to promote safer airway procedures, airway guidelines have been published to help anaesthesia professionals manage patient airways when they fail. One of the first published guidelines for the management of a difficult airway was developed by the American Society of Anesthesiologists (ASA) in 1993 [34] and updated in 2003 [35] and 2013 [1]. As a lack of consensus exists in the literature regarding the definition of a difficult airway, the ASA [1] defined a difficult airway as:

“...the clinical situation in which the conventionally trained anesthesiologist experiences difficulty with face mask ventilation of the upper airway, difficulty with tracheal intubation, or both” (page 251, ASA 2013).

Since then, various forms of clinical guidelines and algorithms that describe procedures for managing a difficult airway have been published in Canada [31] and the UK [36], followed by the European [37] and Scandinavian countries [38]. Despite their purpose to enable safer procedures, there is an ongoing debate regarding their relevance and usefulness in clinical practice [39]. Regarding the differences between clinical guidelines and algorithms, guidelines are systematically developed recommendations in the form of standardised guidance that one ought to take into account when making decisions. According to the World Health Organisation (WHO) [40], clinical guidelines are defined as:

“...systematically developed evidence-based statements which should assist the anaesthesia personnel, recipients and other stakeholders to secure optimal treatment for all patients, regardless of by whom or where the patients are treated” (page 2, WHO 2003).
International and national guidelines can be modified and local guidelines can be developed, but they cannot guarantee any specific outcomes and, therefore, following them is not absolutely required. However, clinical guidelines should summarise good practices and side steps from such protocols to benefit the individual patient should be encouraged [41]. The advantage of using guidelines in clinical practice is that they can remind anaesthesia professionals of problems that could occur in daily practice. Deciding to follow clinical guidelines may come down to the fact that these are standard regimens for the average patient and sometimes lack scientific evidence to support their recommendations [42].

In contrast, according to the ASA [1], an algorithm is defined as a form of decision tree that describes step by step how to safely manage difficult airways. The use of cognitive aids such as algorithms improves patient safety only if they are well-designed and accompanied by training [43]. Marshall & Mehra [44], who video-observed anaesthesia providers’ skills during a “can’t intubate can’t ventilate scenario”, found that a cognitive aid presented as algorithms improved the anaesthesia providers’ skills during the simulation.

Despite airway guidelines being developed and recommended to achieve safer airway procedures [1, 45], adherence to clinical guidelines and algorithms is generally described as poor [46] and being influenced by the anaesthesia professionals’ individual experiences, beliefs, and attitudes when making decisions in clinical practice [47]. Even if the purpose of using algorithms is safer practice [1], there is no strong evidence of benefits for any specific guidelines for the management of a difficult airway; there is, however, strong agreement that a pre-planned approach may lead to improved patient outcomes [1, 44].

Airway management from a professional perspective

The anaesthesiologist has the primary responsibility of assessing the patient’s airway prior to anaesthesia and planning for their anaesthetic procedure [37]. In Sweden, RNAs have a graduate diploma in specialist nursing in anaesthesia care, with or without a master’s degree [48]. The RNAs’ clinical work and education differ between European countries and the rest of the world [49]. In Sweden, RNAs are allowed to start, maintain, and end general anaesthesia in healthy patients (i.e., ASA physical status I-II) after prescription by an anaesthesiologist [48]. In contrast, in some states in the US [50], certified RNAs are allowed to independently administer anaesthesia to patients without the supervision of anaesthesiologists and under their own authority [51].

The management of a difficult airway during anaesthesia is a challenging and stressful situation [52] that anaesthesia professionals may sometimes be
involved in during their clinical work. In daily practice, RNAs and anaesthesiologists work closely as a team and have many overlapping skills that provide safer care for the patient during their anaesthesia [53]. In Sweden, anaesthesiologists are usually responsible for several operating rooms at the same time and serve as support for RNAs, who do much of the work around the patients during and after anaesthesia. The RNA is often the first person the patient meets when they arrive in the operating room. When the patient is in a state of unconsciousness or anaesthetised and cannot make their own voice or choices heard, the RNA is professionally responsible for their care, needs, and well-being. The RNAs act as the patients’ advocate to protect them from harm [54], observing and evaluating the patient’s responses to the anaesthesia and ensuring that the patient’s individual needs are met. When a difficult airway is expected or the anaesthesia does not proceed as planned, the RNAs and anaesthesiologists work together in the best interest of the patient [48].

Anaesthesia and intubation from a patient perspective

For both awake and asleep intubation, patients worry about being anaesthetised and intubated [3]. Patients undergoing anaesthesia worry about being anaesthetised and intubated [55, 56] more as the date of the surgery approaches [4]. Those with previous anaesthesia experience are less anxious than those who have never undergone anaesthesia [55, 56]. Patients who perceive stress and worry about the anaesthesia and surgery preoperatively report more postoperative anxiety and discomfort [55]. In addition, patients experience more anxiety regarding general anaesthesia than local anaesthesia [56], and women generally exhibit more anxiety about having anaesthesia than men [4, 55, 56]. Patients who have experienced an awake endotracheal intubation report more feelings of discomfort, sensation of suffocation, and hoarseness than those who undergo a traditional endotracheal intubation [56].

According to Burkle et al. [57], it is important to inform patients about their planned anaesthesia so they can weigh their own individual risks and benefits before undergoing anaesthesia. A systematic review [58] showed that preoperative communication and dialogue between patients and healthcare professionals is important for improving the quality of care. It has also been found that if patients discuss their thoughts and feelings with a nurse anaesthetist and if a harmonious atmosphere in the operating room can be created, patients feel secure and cared for [59]. If patients are informed and know what will happen to them, it can reduce their fear of the unknown [60] and calm them preoperatively [61]. Patients have concerns about having anaesthesia and this cannot be overlooked or underestimated. The need for
more individualised information and support are of importance for the patient and may allay anxiety [62].
Rationale for the thesis

In clinical practice, careful airway assessment is important when performing endotracheal intubation and to the quality of care. The aim of preoperative airway assessment is to identify patients who will probably be easy or difficult to intubate in order to improve patient safety [1]. This is important because, in Sweden, RNAs are allowed to induce and maintain general anaesthesia without the direct supervision of an anaesthesiologist, in accordance with specified protocols and agreements [48]. In addition, in clinical practice, it is not always the same anaesthesia professional that preoperatively assesses the patient’s airway and then performs the endotracheal intubation. Therefore, systematic and detailed documentation of the patient’s airway is important for improving patient safety. Several anaesthesia societies, both national and international [1, 36-38, 63], have published guidelines and algorithms to assist anaesthesia professional in managing a difficult airway. Even if the purpose is to provide safer practices, there is wide variability in the adherence to guidelines and algorithms in anaesthesia practice [47]. Thus, the use of guidelines and algorithms is influenced by human factors, such as personality, individual experience, scientific beliefs, and attitudes, when making decisions in clinical practice [47]. In addition, how a difficult airway should be managed depends on the anaesthesia providers’ individual technical and non-technical skills and on the specific situation [64]. Studies have also been published on how to support anaesthesia professionals when assessing the patient’s airway prior to anaesthesia and how to safely perform an endotracheal intubation [13, 65], but no nationwide studies have described the presence of airway management guidelines or variations in the ways anaesthesiologists understand the phenomenon ‘airway algorithm’ when acting in and handling critical airway situations. When a difficult intubation is expected, the recommended option for securing the airway is awake fiberoptic intubation [2, 28], but little is known in the available literature on how patients experience this procedure. To the best of my knowledge, no study has explored patients’ experiences of being awake intubated. Preoperative experiences, such as anxiety and worries about anaesthesia and surgery, have been explored [55, 56]. From the patients’ perspective, feedback about their experiences with awake fiberoptic intubation is useful information that may contribute to changes in caring for patients, thereby improving the quality of care.
Aims

The overall aim of the present thesis was to study airway management in anaesthesia care from both professional and patient perspectives.

Study I

The specific aim was to investigate whether the Mallampati classification, thyromental, and Cormack & Lehane grades are useful tests for predicting an easy intubation.

Study II

The specific aim was to explore the presence of airway guidelines in Swedish anaesthesia departments.

Study III

The specific aim was to deepen our knowledge about how anaesthesiologists comprehend algorithms for the management of difficult airways.

Study IV

The specific aim was to describe patient experiences of being awake fiberoptic intubated.
Methods

Design

An overview of the included studies is presented in Table 1. Studies I and II were quantitative, whereas studies III and IV were qualitative.

Table 1. Description of the design, sample, data collection, and data analyses used in study I - IV.

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Sample</th>
<th>Data collection</th>
<th>Data analysis</th>
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<tr>
<td>I</td>
<td>Descriptive, comparative</td>
<td>All RNAs, n=11, at 1 day surgery department performed airway assessment in 87 patients</td>
<td>A study-specific questionnaire was used to collect data before, during, and after anaesthesia, in spring 2006</td>
<td>Sensitivity and specificity, positive predictive value (PPV), and negative predictive value (NPV), receiver operating characteristic (ROC) curve analysis</td>
</tr>
<tr>
<td>II</td>
<td>Descriptive, comparative</td>
<td>68 of 74 anaesthesia departments in Sweden were included</td>
<td>A structured self-reported questionnaire was sent out by postal mail in March 2011</td>
<td>Pearson chi² tests Fishers’ exact test</td>
</tr>
<tr>
<td>III</td>
<td>Descriptive</td>
<td>Strategic sampling procedure, n= 20 anaesthesiologists</td>
<td>Individual face-to-face interviews were conducted between December 2014 and February 2015</td>
<td>Phenomenographic analysis</td>
</tr>
<tr>
<td>IV</td>
<td>Descriptive</td>
<td>Consecutive sampling procedure, n= 13 patients</td>
<td>Individual face-to-face interviews were conducted to collect data between autumn 2013 and spring 2015</td>
<td>Qualitative, content analysis</td>
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Sample and setting

Study I
All RNAs in one department were recruited over a 4-month period in 2006. The airways of 100 patients were assessed by RNAs who were directly involved in the patients’ routine care. Inclusion criteria were adult patients > 17 years of age who were scheduled to undergo general anaesthesia requiring endotracheal intubation and were ASA physical status I or II. Patients undergoing emergency anaesthesia and patients who were pregnant or had a body mass index > 35 kg/m² were excluded from the study. This hospital provides anaesthesia services for both inpatient and outpatient surgery and was organised as part of a larger county hospital in the County Council of Gävleborg, which had 275 000 inhabitants at the time of the study. The day surgery department served approximately 3300 patients annually and was chosen as the research setting because the RNAs routinely conduct pre-operative airway evaluations and intubate all patients as part of their routine work.

Study II
A structured self-reported questionnaire concerning the presence of guidelines for airway management was sent out in March 2011 to directors or assistant directors of Swedish anaesthesia departments (n = 74). The anaesthesia departments were identified by the Swedish Association of Local Authorities and Regions [66].

Study III
A strategic sampling procedure was used to maximise the variation in which anaesthesiologists understand algorithms. According to Bowden & Green [67], 20-30 interview participants is enough to ensure sufficient variation. Twenty anaesthesiologists from one university and three county hospitals in Sweden were invited to participate in the study. The study was conducted between December 2014 and February 2015. The inclusion criteria were a minimum 2 years of working clinical experience in anaesthesiology. Anaesthesiologists not involved in direct patient care were excluded.

Study IV
A consecutive sampling procedure was used and participants recruited from one university hospital and three county hospitals in the middle part of Sweden. The study was conducted between autumn 2013 and spring 2015. Inclu-
sion criteria were patients > 18 years of age admitted to the anaesthesia department for planned or unplanned awake fiberoptic intubation who were able to speak and understand the Swedish language. Patients planned to undergo regional anaesthesia or who had undergone planned or unplanned awake fiberoptic intubation in the past were excluded from the study.

Procedures

Study I

Information and educational instruction regarding the study aim and procedures were provided by Kati Knudsen (KK) 2 weeks before the study started. All patients underwent airway evaluation at the time of the preoperative visit, and after the anaesthesia were finished. The airway was evaluated by the same RNA who then performed the anaesthesia to reduce assessment error. The patients’ airways were evaluated during the daytime, Monday through Friday. All patients received general anaesthesia according to the hospital’s local standard and were intubated with a 7-mm (for women) or 8-mm (for men) endotracheal tube using a Macintosh laryngoscope.

Study II

The directors received written information about the purpose of the study and were asked to fill out the questionnaire and return in a prepaid and addressed envelope. Informed consent was given by returning the questionnaire. Reminders were sent out twice. Those who did not respond within 3 months of the second reminder were reminded a third time by telephone.

Study III

The head of each anaesthesia department was contacted via e-mail and asked to distribute written invitation letters about the study purpose and procedures to all anaesthesiologists who worked in their departments. Two weeks later, during a workplace meeting, the anaesthesiologists were verbally informed about the study by KK in person and an appointment for the interview set up. Anaesthesiologists who volunteered for the study provided written informed consent before the interview started. All interviews were conducted by KK in the daytime in a quiet room over the course of 1 week at each workplace.

Study IV

Before the study started, patients received written and verbal information about the study purpose and procedure from the anaesthesiologists during
their preoperative meeting. A consecutive sampling procedure was used and individual face-to-face interviews performed. Each participant was interviewed twice. The first interview was conducted at a place chosen by the patient, such as the hospital or their own home. The second, follow-up interview was conducted over the telephone 4 weeks after the first interview in order to give the patient an opportunity to clarify and verify what had been said. Written informed consent was obtained before the interviews started.

Data collection
Study I

A study-specific questionnaire was developed by KK based on clinical experience assessing and performing endotracheal intubations independently, as well as on a brief review of existing airway tests in the literature [34, 63]. The questions were then evaluated and revised by a health care worker as an expert in the field to ensure face validity. The next step was to discuss the specific questions within the research group experienced in quantitative methods in order to improve their clarity and establish content validity. The questionnaire was developed in three parts: before, during, and after anaesthesia. Part one consisted of Mallampati classification scores I–IV (See Figure 1) and the thyromental distance. The thyromental distance (i.e., the distance between the bony point of the mentum to the thyroid notch with the head fully extended) was measured with a 25-cm ruler while the patient’s mouth was closed (See Figure 2). Part two consisted of Cormack & Lehane grades I–IV (See Figure 3) and documentation of the number of intubation attempts according to the ASA recommendations [34]. These airway tests have been used and validated in multiple studies as “golden standards” for predicting a difficult intubation [68, 69]. Part three consisted of the RNA’s judgement of the intubation conditions being experienced as easy or difficult. These were documented and categorised using a four-grade scale as follows: quite easy, easy, somewhat difficult, or difficult. In addition, sex, age, weight, and height were documented, as well as data regarding the RNA’s years of experience.

The following scores were considered to be predictors of easy endotracheal intubation: Mallampati classification I–II, thyromental distance $\geq 10$ cm, Cormack & Lehane grade I–II, and less than two intubation attempts. Mallampati classification III–IV and Cormack & Lehane grade III–IV were categorised as difficult intubations, as well as a thyromental distance $\leq 10$ cm and two or more intubation attempts. RNA scores of “quite easy” and “easy” were considered easy intubations, whereas “somewhat difficult” and “difficult” were considered difficult intubations.
Study II

The questions in study II concerned the presence of airway management guidelines in anaesthesia departments in Sweden. The eight questions concerned whether the department had 1) an airway algorithm, 2) written patient information in the case of a difficult airway, 3) guidelines for difficult airways, 4) guidelines for preoperative airway assessment, 5) guidelines for rapid sequence intubation, 6) guidelines for criteria on when to perform an awake intubation, 7) instructions for awake fiberoptic intubation, and 8) a prescription for when an RNA or anaesthesiologist should perform an endotracheal intubation. In addition, two background questions were included about hospital type and the number of general anaesthesia procedures performed per year.

All responses to the questions were dichotomised (yes or no), and if the respondent answered “yes” to any question they were asked to attach and return copies of their current guidelines. Guidelines for regional anaesthesia or other commonly used guidelines, such as preoperative fasting, were excluded. The director was also asked to attach the department’s anaesthetic record form in order to review whether a fill-out “box” of airway elements was pre-printed as a checklist. The questionnaires were returned by postal mail in pre-addressed return envelopes.

Studies III and IV

As interviews are a common method of collecting data in qualitative research, semi-structured individual face-to-face interviews were conducted in both studies III and IV [70]. Interview guides were developed. To test the interview guides and interview technique, pilot interviews were conducted with some adjustments to the questions and not included in the studies. In study III, the interview guide focused on variations in the ways how anaesthesiologists understand algorithms for the management of difficult airways. The anaesthesiologists were asked three main questions (Table 2) to maximise the focus on airway algorithms. All interviews were conducted by KK.
Table 2. Interview guide for questions used in Study III on anaesthesiologists views on algorithms, including probing questions.

1. Can you give a concrete example of an event when you observed a difficult airway?
2. What do you think about algorithms, which might also be referred to as guidelines, protocols, or decision aids?
3. Can you describe a situation where you felt that you were successful or not successful in managing a difficult airway?

Probing questions were:
“Did you use an algorithm that helped you manage the situation?”
“What do you mean”?
“Can you give more examples”?
“What did you think would happen”?
“Is there anything else you would like to add”?

In study IV, the questions concerned how patients experienced awake fiberoptic intubation using open-ended questions (Table 3). The data were considered saturated after nine of the 13 interviews [71].

Table 3. Interview guide for questions used in Study IV on how patients experience being awake intubated, including probing questions.

1. What is your experience with general anaesthesia in the past?
2. What information was given to you before your awake fiberoptic intubation was performed?
3. What is your experience of being awake fiberoptic intubated?
4. Did any anaesthesia staff, postoperatively in the recovery room, ask about your experiences with the anaesthesia?
5. What is your view of undergoing awake fiberoptic intubation again in the future?

Probing questions were:
“Please could you tell me more”
“How did you mean”
“How did you feel about that”

Data analysis
All quantitative data were analysed by PASW Statistics version 19.0 and 20.0 for Windows (SPSS Inc. an IBM Company, Chicago, IL USA) [72].

Study I
Data collected before, during and after anaesthesia were analysed. Cross tabulation was used to determine correlations between the Mallampati classification and Cormack & Lehane grade. Results were also calculated on the
basis of sensitivity and specificity for the Mallampati classification, thyro- 
romental distance, and Cormack & Lehane grade used to predict the ease of 
intubation. Sensitivity was defined in terms of the percentage of correctly - 
predicted easy intubations as a proportion of all intubations that were truly 
easy: [true easy intubations/(true easy intubations + false difficult intuba-
tions)]. Specificity was defined in terms of the percentage of correctly pre-
dicted difficult intubations as a proportion of all intubations that were truly 
difficult: [true difficult intubations/(false easy intubations + true difficult 
intubations)]. In addition, the positive predictive value (PPV) and negative 
predictive value (NPV) were calculated if the test was clinically useful. The 
PPV was defined in terms of the percentage of correctly predicted easy intu-
bations as a proportion of all predicted easy intubations: [true easy/(true easy + 
false easy)]. The NPV was defined in terms of the percentage of correctly 
identified difficult intubations as a proportion of all predicted difficult intu-
bations: [true difficult/false difficult + true difficult]. The thyromental dis-
tance was measured and the results divided into two levels: >10 cm or < 10 
cm. A receiver operating characteristic (ROC) curve [72] was applied to de-
termine the optimal cut-off level. Each cut-off value was plotted against 
sensitivity on the vertical axis and 1-specificity on the horizontal axis. The 
optimal cut-off value was the value in the upper leftmost position. In addi-
tion, continuous variables were described using means and standard devia-
tions (SDs), and categorical variables as frequencies and percentages [72].

Study II
Descriptive statistics were used to describe each hospital type (university, 
county, and private). For comparisons between hospital type and the avail-
ability of written airway guidelines, cross tabulation was used and analysed 
by Pearson's chi-square tests. Data are expressed as mean and SD, number, 
or percentage. A p-value < 0.05 was considered significant [72].

Study III
The interviews were transcribed verbatim by a professional transcript com-
pany. The audio-recorded interviews were listened to by KK and checked 
against the transcribed text. Qualitative phenomenographic analysis was 
performed in five steps [73]:
1. The printouts were read and re-read several times to achieve overall com-
prehension of the interview.
2. In each interview, the parts of the texts where the anaesthesiologists de-
scribed experiences using algorithms in difficult airway situations or re-
flected on such experiences were marked.
3. The marked parts of the text with descriptions of ‘what’ and ‘how’ the anaesthesiologist thought about algorithms were summarised into one preliminary ‘way of understanding’ for each interview.
4. The resulting 20 ‘ways of understanding’ were compared and, based on similarities and differences, grouped into different categories.
5. Each category was discussed regarding its accuracy, going back to the interview texts and revising the category description. In the final analysis, four categories of understanding were revealed.

Three of the researchers conducted the analysis and reassessed the categories to enhance the rigour of the analysis [72]. After steps 1-4, the categories of descriptions that emerged were discussed with all fellow researchers until a consensus was reached [73]. The research team has experience in interviewing and qualitative methods, and one researcher had experience specifically in the phenomenographic method. All researchers except one had experience from working in anaesthesiology.

Study IV

The interviews were audio-recorded and transcribed verbatim by the first author. Inductive qualitative content analysis was performed in several steps as described by Graneheim & Lundman [74]. The goal of content analysis is to gain an understanding of the phenomenon being studied [75]. This study aimed to describe patients’ experiences with awake intubation. To get a sense of the whole text, the analysis began by reading the interviews repeatedly. Meaning units from the interviews that corresponded with the aim of the study were identified and marked with a number. The numbered meaning units were then condensed and shortened into codes, which were compared regarding differences and similarities for sorting into subcategories and categories in dialogue with the co-authors (manifest content analysis). After all data were categorised, one theme was formulated. Verbatim quotations were given to illustrate each category and to ensure credibility and transferability [74]. During the analysis procedure, the categories were discussed and re-evaluated in order for the researcher to confirm the outcome. The research team had a pre-understanding of the phenomena being studied from work in anaesthesiology and/or intensive care, which was actively reflected upon during the analysis to minimise interpretive bias.
Ethical considerations

Formal approval from ethics committee was not required, according to Swedish national legislation and directives [76, 77] at the time study I was conducted, as no intervention was performed and no personal data were obtained. To protect the interest of the people involved in the study I, the anaesthesia department involved reviewed the research protocol and approved the study without any changes. Throughout the research, ethical issues were considered carefully and in accordance with the Declaration of Helsinki [78].

Ethical consideration is important when conducting research involving vulnerable participants [79], such as when there is a risk that a participant may be affected by physical or mental discomfort or harm related to the research procedures. The potential risks and benefits associated with the research study were taken into account. As the study procedure included standardised care and were part of their routine airway assessments, and no additional or new intervention was implemented, there were no foreseeable risks involved in the study. In study I, the primary focus was on how RNAs can independently perform the airway assessment and intubation in patients. To protect the patients’ rights, all were orally informed that the focus was on the involved RNAs. The patients were also informed that their participation did not change their usual care and that the obtained data would be coded in a way that they would not be identified. Study II was a national survey of the presence of written airway guidelines and did not involve sensitive personal material or data. Therefore, this research is not subject to Swedish law and no ethical approval was sought.

The Regional Ethical Review Board in Uppsala, Sweden, approved studies III-IV (Diary no. 2012/546 and 2014/491, respectively). All participants received both oral and written information about the studies’ purpose and procedures before the studies began. To protect the participants’ confidentiality, they were informed that the obtained data were coded in a manner that was not linked to the particular participants’ name or hospital. To protect all of the involved participants, they were also informed that their participation was strictly voluntary and that they could withdraw at any time, without explanation, and that this withdrawal would not affect their employment or care. The participants involved in studies III and IV were also informed that the interviews should be audio-recorded, transcribed, coded, and stored so that no one could be identified, neither in person nor in the workplace. Written informed consent was obtained before the studies started. The partici-
pants were also informed that the collected data would be kept in a way that access was limited to the research team only. Participants were also given contact information for the researcher, should they have further questions or want to discuss their concerns related to their involvement in the studies.
Results

Study I
A total of 11 RNAs performed airway assessments on 87 patients (68 women, 19 men). Most of the RNAs had worked for more than 10 years (n=61 patients, 71%); 25% of patients were seen by RNAs who had worked 3-6 years (n=22) and 5% (n=4) by those who had worked less than 3 years. The mean patient age was 42 (± 11) years, mean weight 71 (± 14) kg, and mean height 168 (± 9) cm. Thirteen patients were excluded due to incomplete documentation of the data.

Preoperatively, 54 (62%) patients were classified as easy to intubate according to the Mallampati classification and 55 (63%) patients with a thyromental distance ≥ 10 cm. After induction of anaesthesia, 72 (83%) patients were graded as easy to intubate using the Cormack & Lehane grade (Table 3). The Mallampati classification had the highest specificity (91%) in predicting easy intubation, followed by the Cormack & Lehane grade (82%). The thyromental distance had the poorest specificity (36%) and sensitivity (65%) compared to the other tests.

Table 3. Distribution of the number of patients by thyromental distance, Mallampati classification, Cormack & Lehane grade, and categorisation of intubation conditions

<table>
<thead>
<tr>
<th>Intubation assessment</th>
<th>Thyromental distance (cm)</th>
<th>Mallampati classification</th>
<th>Cormack &amp; Lehane classification</th>
<th>Outcome of intubation conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy intubation</td>
<td>≥10 cm</td>
<td>Class I n=24</td>
<td>Grade I n=55</td>
<td>Easy intubation n=19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Class II n=30</td>
<td>Grade II n=17</td>
<td>Quite easy intubation n=57</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>n=54</td>
<td>n=72</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Class III n=24</td>
<td>Grade III n=14</td>
<td>Somewhat difficult intubation n=7</td>
</tr>
<tr>
<td>Difficult intubation</td>
<td>&lt;10 cm</td>
<td>Class IV n=9</td>
<td>Grade IV n=1</td>
<td>Difficult intubation n=4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>n=33</td>
<td>n=15</td>
</tr>
</tbody>
</table>

33
Sixty-two percent of the patients (54/33) were easy to intubate according to the Mallampati classification (i.e., required less than two intubation attempts). Seventeen percent (15/72) of the patients were difficult to intubate according to the Cormack & Lehane grade and required two or more intubation attempts. The agreement between the number of intubation attempts and the RNA scoring of intubation conditions was 86%. The agreement between the RNAs’ subjective assessments and the Mallampati classification was 72%.

Study II

Of the 74 directors, 68 returned the questionnaire, a response rate of 92%. These completed questionnaires were received from 53 county hospitals, 9 university hospitals, and 6 private hospitals. The highest number of general anaesthesia procedures per year was performed by the university hospitals (mean 14 389 ± 7674), followed by county hospitals (mean 5646 ± 4143), and the private hospitals had the fewest anaesthesia procedures per year (mean 4063 ± 1837). No significant difference was found between the hospitals regarding the percentage of written guidelines for airway management, except for guidelines on difficult airways (p = 0.049). Eight of the nine university hospitals reported having guidelines for difficult airways, compared to only 25 of the 53 county hospitals and 2 of the 6 private hospitals.

A total of 214 guidelines were reported by the anaesthesia departments, 67% of which (n=132) were not verified by an attachment. Of the attached guidelines, 21% (n=46) were followed as recommendations of the SFAI [63] and 17% (n=36) of the attached guidelines were developed by the local anaesthesia department. Twenty-nine of the 68 departments (43%) had guidelines for preoperative airway assessment. Forty-six departments (68%) had a pre-planned intubation plan, in the form of an airway algorithm, in the case of failed intubation. Thirty-five departments (52%) had guidelines for a difficult airway, and 35 departments (52%) had an anaesthesia problem card that they gave to the patient in the case of a difficult airway. Guidelines for how to perform awake fiberoptic intubation were available in 14 (21%) of the departments, whereas criteria for when to perform an awake intubation were available in 18 (26%) of the departments. In total, 21 (31%) of the departments attached guidelines for emergency rapid sequence intubation. A prescription for when the RNA could carry out the endotracheal intubation was reported by 16 (24%) of the departments.

Fifty-one (75%) departments sent their anaesthesia record form for reviewing pre-printed airway tests. In 35 (69%) of these records, tooth status was the most common pre-printed preoperative airway test, followed by the thyromental distance (25%); sternomental distance (8%) was the least common pre-printed airway test. In 23 (45%) departments, the Cormack & Le-
hane grade and evaluation of the extubation conditions were the most common pre-printed airway test after the anaesthesia was finished, whereas the number of intubation attempts was pre-printed in only 6 (12%) of the attached anaesthesia records.

Study III

Twenty anaesthesiologists volunteered to participate in the study (5 women, 15 men). Their age ranged from 29 to 68 years (median 39 years), and their clinical experience as anaesthesiologists ranged from 2 to 39 years (median 3.5 years).

Four categories of how an algorithm could be understood were identified: 1) a normative plan for procedures to be followed in difficult airway situations, i.e., law-like rules that must be followed; 2) a succinct plan to follow in difficult airway situations; i.e., a decisional or cognitive aid; 3) an action plan adaptable to the needs of the individual patient and the clinical situation, to be kept in mind when creating a personal algorithm based on experience; 4) a set of guidelines collected by a consensus of experts for procedures in managing the difficult airway based on scientific evidence and expert opinions.

In the first category, the algorithm could be understood as a normative plan for procedures to be followed in difficult airway situations. For example, when an incident happens, one must be able to defend one’s choices of action. If one has diverted from the algorithm based on personal knowledge and experience, the reasons for this diversion must be clearly declared to avoid future critique. In the second category, an airway algorithm could be understood as a plan to follow in a difficult airway situation. For example, plans B and C are ready as back-ups in stressful situations and to avoid forgetting any important steps in the procedure. In the third category, the algorithm could be seen as an action plan adaptable to the needs of the individual patient and the clinical situation that can be kept in mind when creating a personal algorithm based on experience. In the last category, algorithms derived from scientific knowledge provide guidance, ideas, and recommendations for how to act.

Study IV

A total of 15 patients were invited to participate in the study, two of whom declined (1 man, 1 woman) without any specific reason. Ten of the patients had previous experience with general anaesthesia and three of the patients were receiving anaesthesia for the first time. Of the 13 included patients (7 men, 6 women), eight were interviewed preoperatively and five postopera-
atively. The reasons for awake fiberoptic intubation were rheumatoid arthritis (n=2), thyroidectomy (n=2), pharyngeal abscess (n=2), oropharynx cancer (n=1), mandibular surgery (n=2), neck immobility (n=3), and acute throat bleeding (n=1).

From the patient interviews, one main theme emerged: feelings of being in a vulnerable situation but cared for in safe hands. This theme was revealed in the following five categories with 15 subcategories: 1) a need for tailored information, 2) distress and fear of the intubation, 3) acceptance and trust of the staff’s competence, 4) professional caring and support, 5) no hesitation about new awake intubation. Patients described different concerns about how they wished to be involved and how much information was needed before the intubation was performed. A lack of information about what to expect was noted. Knowing that they should undergo awake fiberoptic intubation was emotionally stressful due to the fear of throwing up during the procedure, provocation of the gag reflex by the tube, and fear of the local anaesthetics. For some of the patients, their fears became reality during the procedure when the local anaesthetic solution was sprayed into the throat and the injection into the cricothyroid membrane evoked feelings of discomfort, coughing, and suffocation. The patients expressed that this was the most unpleasant experience during the whole procedure. The fiberoptic intubation was extremely painful for some patients when the tube was inserted, despite local anaesthetics. On the other hand, patients who had experienced upper intestinal gastroscopy procedures in the past stated that an awake intubation was nearly the same phenomenon and nothing to fear. Patients described feeling more involved when the anaesthetists made eye contact with them and saw how they reacted during the procedure.

Some patients revealed that they felt overwhelmed by the information they were given and wanted less specific information about the equipment used. Instead, they wanted more information about how they would be cared for in the operating room, including breathing instructions and eye contact. Undergoing awake intubation was an acceptable experience for most patients, though some found it to be painful and terrifying because they felt they could not breathe or communicate during the procedure itself.
Discussion

Summary of findings
The aim of this thesis was to study airway management in anaesthesia care from both professional and patient perspectives. Study I pointed out that the Mallampati classification is a good screening test for predicting easy intubation and that intubation can be safely performed by RNAs. Despite the recommendations of locally adopted airway guidelines, study II affirmed that the presence of airway guidelines in Swedish anaesthesia departments is poorly implemented. According to the findings from study III, algorithms can be understood in four different ways: as law-like rules, as a succinct plan to follow in difficult airway situations, as an action plan kept in the back of one’s mind while creating flexible and versatile personal algorithms, or as consensus guidelines based on expert opinion in order to be followed in clinical practice. Study IV revealed one main theme; feelings of being in a vulnerable situation but cared for in safe hands, which is described in five categories as follows: a need for tailored information, distress and fear of the intubation, acceptance and trust of the staff’s competence, professional caring and support, and no hesitation about new awake intubation.

Airway management and guidelines from a professional perspective
Study I pointed out that the Mallampati classification is a good screening test to predict an easy intubation. Of the 87 included patients, most patient were easy to intubate according to the Mallampati classification I-II, and required less than two intubations attempts and by definition classified as easy intubation by the ASA [1].

According to the ASA [1], all patients scheduled for general anaesthesia and tracheal intubation should be considered for preoperative airway assessment. However, these assessments have been reported to often be incompletely documented or lacking [14]. The results from study II agree with this, as the presence of guidelines for airway management in our departments could be improved. For instance, surprisingly few departments reported have guidelines for preoperative airway assessment. Adequate airway assessments and detailed documentation of patient airways are important,
especially when the endotracheal intubation is not always carried out by the same anaesthesia professional that performed the preoperative airway assessment. From a professional safety perspective, it is important to perform a preoperative airway assessment in advance, when the patient is still awake, to give the anaesthetists enough time to be prepared for alternative airway approaches. Research has shown that a previous history of difficult endotracheal intubation is a strong risk factor for intubation problems in the future [80].

In study II, few departments reported they have prescriptions for when RNAs can carry out endotracheal intubation, despite RNAs being allowed to maintain and intubate patient airways independently. In Sweden, they are allowed to induce and perform general anaesthesia independently in healthy adult patients with ASA physical status I and II according to specified protocols and agreements [48]. Standardised, structured documentation of the patients’ airway assessment, as recommended by the ASA [1], may make the anaesthesia professionals aware and prepared for using the right competence at the right time to ensure patient safety, that adequate airway devices are readily available, and that there is supervision from a more experienced anaesthesiologist who is able to assist the RNA and secure the airway if needed. Based on the preoperative airway evaluation, a test that can predict easy intubation beforehand, such as the Mallampati classification, is a valuable tool in clinical practice. This test facilitates the decision about who should carry out the intubation, the RNA or the anaesthesiologist, when there is still time to plan for an alternative airway approach.

Airway guidelines and algorithms for managing patients’ airways within anaesthesia care have been recommended by several anaesthesia societies and by the Swedish National Board of Health and Welfare [1, 36-38, 80]. Despite these recommendations, study II demonstrated that the presence of airway management guidelines is generally poorly implemented in Swedish anaesthesia departments. One reason for a lack of local adopted airway guidelines in Swedish anaesthesia departments could be a lack of time and, perhaps, knowledge about how to create evidence-based guidelines. A lack of knowledge and practical skills in handling a difficult airway and adherence to guidelines have also been found in Danish [81], German [82], and Canadian anaesthesia departments [83]. The ASA recommends practice guidelines being adopted and modified according to the department's own needs and constraints. As airway guidelines are not an absolute requirement, the development of such guidelines may not be a priority for departments. The results from study III are consistent with previous studies, which affirm that human factors, such as the professional's knowledge and beliefs, influence compliance with or deviation from the guidelines [47].

Some researchers have argued that algorithms are a useful cognitive aid to achieve safer airway procedures [44]. However, the results from study III argue that, before airway algorithms can be used, it must be ensured that
they are easy to follow, without too many steps, because in a stressful situation too many steps would be difficult to memorise. As stated by Smith & Alderson [41], guidelines should be as short and concise as possible; if they are too descriptive they appear to limit professionals’ judgement. The authors further advocated that guidelines need to be based on the best available scientific evidence and a broad consensus to improve patient outcomes. Study III showed that algorithms for the management of difficult airways can be understood in four ways: as law-like rules, as a succinct plan to follow in difficult airway situations, as an action plan kept in the back of one’s mind while creating flexible and versatile personal algorithms, or as consensus guidelines based on expert opinion. One barrier against using guidelines such as algorithms is that they do not take the individual anatomical characteristics of a patient (e.g., a tonsil tumour) or a specific situation into account. For instance, it was explained that algorithms are developed for the “average” patient and are not applicable to all kinds of patients and situations:

“An algorithm is a useful tool, but you need to tailor it for each individual patient... a useful support, like a crutch... but patients are also different; they have various conditions and anatomy, and one must take these factors into account... “(Study III)

Thus, algorithms may be more useful in clinical practice if they could be designed in a more efficient and practical manner. In addition, algorithms need to be based on a simple principle and easy to follow in order to be implemented. A systematic review by Ebben et al. [84] highlighted that there is a gap between guidelines and clinical practice. One reason for this gap is that guidelines contain too many recommendations to adhere to when making choices. They emphasised that if guidelines could be translated into more efficient, practical and feasible algorithms, it would be easier to adhere to them. Goldhaber-Fiebert & Howard [85] recently reported that cognitive aids, such as algorithms, cannot be implemented powerfully if they are not developed from evidence-based practice. A study on the use of evidence-based guidelines for mechanical ventilation in a Swedish intensive care setting reported similar findings [86]. However, anaesthesia professionals’ manage difficult airways on their own during critical situations based on their own knowledge and beliefs [47]. According to Polanyi [87], knowledge can be divided into two different categories, namely tacit knowledge and explicit knowledge, and can be used to explain how individuals handle specific situations. He described tacit knowledge as an individual’s intuitively acquired knowledge that is developed through experiences and difficult to verbalise, whereas explicit knowledge is knowledge acquired by reading the medical literature and sharing specific information. However, he argued that individuals need both tacit and explicit knowledge when acting in and han-
dling specific situations. In other words, knowing how to adopt and use, for example, guidelines and algorithms in clinical practice requires both tacit knowledge and the support of explicit knowledge.

A common opinion among anaesthesiologists in study III was that you must have experienced a real situation before you are able to use algorithms, and this requires training and clinical experience. This is consistent with the findings of a systematic review of 13 studies examining the number of endotracheal intubations a novice intubator must perform using direct laryngoscopy to achieve expertise with the procedure [88]. In elective circumstances, a novice intubator needed to perform at least 50 endotracheal intubations on patients before successfully mastering the airway procedures. Dreyfus & Dreyfus [89] described practitioners going through five different levels of experience, from novice to expert, before they master work-related skills. As a novice without previous experience, they make decisions using clear rules and instructions, which they follow strictly until they have gained experience, whereas an expert, who has developed a lot of clinical experience over time, may see situations differently and identify and handle problems more intuitively. Thus, skills such as face-mask ventilation and performing endotracheal intubation are mastered by working bedside on a daily basis (“learning by doing”) and by being exposed to patients with various individual anatomies and situations, especially in time-pressure emergency situations. Perhaps, after a couple years of clinical experience, you can create your own strategies for how to use airway algorithms, modified by your own clinical experiences to fit the patients and situations. Therefore, it seems evident that clinical experience is required, along with theoretical knowledge, to master skills such as handling a difficult airway in critical situations. The professional’s ability to communicate calmly and clearly is also important when acting in and handling critical situations [53]. Hands-on training is needed to improve procedural skills in critical airway situations [90]. Simulator training, together with education and reflection, contributes to improving procedural skills and performance in critical situations [33,44]. However, the simulation training in anaesthesia is still under development and it is not yet known how efficient such approach will be [91]. Part of the problem is that algorithms are developed for the "average" patient and do not account patient individual factors or the skill of the intubator. Simulation training for management of a difficult airway may well improve both knowledge and skills but perhaps not the professionals’ behaviour in critical situation.

The ability to maintain a free airway through face-mask ventilation and intubation is a craft that requires routine practice to master. Once a difficult airway appears, it is an emotionally stressful situation for the professionals [52]. In my experience, difficult intubation is less problematic than difficult mask ventilation because you can still ventilate and oxygenate the patient’s lungs. Problems may occur when it is difficult to ventilate the patient, especially during time-pressure critical situations. Securing the patient's airway is
a team effort [92], and it is hard to work entirely on your own in a critical situation. When facing difficult mask ventilation, one may need to use a two-handed technique to oxygenate the patient’s lungs. However, study III revealed that the ASA algorithm is too descriptive, and it is hard to memorise all the steps and remember them in a critical situation:

“Algorithms are there in the back of your mind... so that you have a plan to follow and know what to do next... but they’ve got to be simple and easy to follow - no more than 3-4 steps - to help avoid becoming blocked in critical situations... once you are in a difficult airway situation, you may not be able to think of every step in the algorithm...” (Study III)

In my opinion, more attention should be given to the development of an algorithm in the form of an illustrated picture showing, step by step, how to handle the situation when the airway fails. In a critical airway situation in which, the airway needs to be managed immediately, it is easier to look at an illustrated algorithm for instructions on what to do next than read a lot of text. The key is to make it easier when acting and handling difficult airways in critical situations. When an airway needs to be managed immediately, patients become extra vulnerable because there is no or little time to adequately prepare them.

Anaesthesia and intubation from a patient perspective

Study IV revealed that careful emotional support before and during the anaesthesia procedure is important when the intubation is performed in the awake state. Patients want tailored information about the procedure without technical details about the equipment used. Support, such as breathing instructions, along with eye contact from the anaesthesia professional, helps patients cope and feel more safe and confident during the procedure. According to Lazarus & Folkman [93], coping is a natural response when individuals face a stressful situation, such as anaesthesia. How patients deal with stress depends on the situation and the patient’s own individual coping strategies. Patients can use several types of coping strategies [94]. Study IV revealed that patients use emotion-focused coping strategies, such as meditating and accepting the situation, when they feel that they have little control over their own situation. Also, patients use problem-focused coping before the procedure. Not knowing what should happen evoked feelings of being in a vulnerable situation. The patients expressed a need for tailored information about what to expect, which helped them master and control the situation. This finding is supported by the study by Mitchell [4], who highlighted that
patients undergoing general anaesthesia are more anxious and want more information than patients scheduled for local anaesthesia.

“\textit{It was just to realise that I must leave myself in other people’s hands. I had full confidence, I meditated and calmed down... There is nothing I can do now, so I have to trust you and your colleagues, those who are going to do this, I must resign myself to it.}” (Study IV)

Even if the study by Mitchell did not focus on awake intubation per se, the patients experienced greater feelings of emotional support when they felt informed. From the patients’ perspective, it is important to be well-informed about what to expect and how the procedures could be experienced, as local anaesthetic is a common part of the anaesthetic procedure. Several patients in study IV described the most unpleasant experience during the whole procedure to be feelings of discomfort after the local anaesthetic solution was sprayed into the throat and the injection was made in the back of the trachea, including pain, coughing, and feelings of suffocation.

“\textit{It felt like I could not swallow, like I would suffocate on the fluid, like as I cough and throw up at the same time...}” (Study IV)

This is a dilemma during an awake intubation, when patients need to be sedated enough to make the procedure more tolerable and alleviate unpleasantness, but still need to be able to follow instructions and commands.

Patients experienced awake fiberoptic intubation as a feeling of being in a vulnerable situation but cared for in safe hands. Several of the patients described awake intubation as a quite acceptable experience, despite the emotional stress, and that they would not hesitate to undergo awake intubation again in the future if needed. Nevertheless, patients are vulnerable during the procedure because it is difficult to vocally communicate due to the local anaesthetic solution and when the tube is inserted. Therefore, it is important for the staff to be aware of how to communicate with the patients via eye contact during the procedures, as described by the patients in study IV. Similar findings have been reported by others [95, 96].

Methodological considerations

In studies I and II, quantitative study designs were chosen because of their usefulness in gaining valuable information about current anaesthesia practice and describing the presence of airway guidelines in our anaesthesia departments. In studies III and IV, qualitative study designs were chosen in order to gain a deeper understanding of how algorithms can be understood and
how patients experience awake fiberoptic intubation. However, there are some methodological strengths and limitations in the presented studies that need to be taken into account [70]. In studies I and II, study-specific questionnaires were used as a data collection method, which must be taken into consideration when assessing the validity and reliability [97]. Before the start of the studies, the questionnaires were pilot tested and reviewed by experienced researchers involved in the study and by RNAs and anaesthesiologists working in the field in order to ensure that the questions were clear and understandable and to establish face and content validity.

In addition, study I included relatively few patients, more women than men, and only healthy adult ASA I-II patients undergoing elective day surgery. Another limitation was that the study was conducted by RNAs who worked at the same anaesthesia clinic. The reliability may have differed if another group of RNAs with different experience or skills from different clinics or if anaesthesiologists had assessed and carried out the intubation. As in all quantitative research, the sample size is important for generalising the findings to a larger population [98]. A sample size calculation was not performed before starting study I. The findings cannot be generalised to other patients or be said to be representative of all anaesthesia departments. However, the result provided information that the Mallampati classification is a useful test for predicting easy intubation when the airway assessment is performed by RNAs in a standardised manner.

The main strength of Study II was that it was a nationwide survey with a high response rate (92%) and included a large number of anaesthesia departments. A limitation of study II was that the questions only addressed specific airway management issues and did not explore how often the departments evaluated their airway management guidelines. The generalisability of the results is questionable, as the data are not necessarily based on which guidelines really exist at these departments. Perhaps they had airway guidelines but use different terms for their documents, such as standards, protocols, checklists, algorithms, clinical pathways, and recommendations for clinical practice [41, 84, 99, 100]. This makes it difficult to draw firm conclusions when interpreting the results.

Individual interviews are a common data collection method in qualitative research. According to Lincoln & Guba [75], to ensure trustworthiness in qualitative research, the credibility, dependability, confirmability, and transferability need to be taken into considerations. In studies III and IV, semi-structured face-to-face interviews were conducted by KK. An interview guide was developed and used to collect data and strengthen the credibility, minimising research bias (dependability). Pilot interviews were carried out with both anaesthesiologists and patients not included in the studies to test the interview guide and ensure that the questions that were asked closely reflect the aim of the study [67]. As Larsson & Holmström [73] suggested in a phenomenographic study, the data from 20 informants is usually enough to
discover variations in the ways people understand or perceive a specific phenomenon. The phenomenographic approach is based on the theory that people understand a specific phenomenon in a limited number of qualitatively different ways [101]. The data analysis in study III started when all interviews had been conducted. In contrast to study IV, the data analysis was ongoing until saturation was reached and no additional information was obtained [102]. To strengthen the confirmability, the data analyses began by reading the text repeatedly and breaking down the data into smaller units and codes, then grouping the coded material into categories and themes [73, 74]. In both studies, quotes from the interviews were extracted to exemplify the categories and themes that emerged. The research team had a pre-understanding of the phenomenon under study due to extensive experience in anaesthesiology and/or intensive care, which were actively reflected upon during the analysis to minimise interpretive bias [73]. During the whole analysis process, consensus was reached between the researchers concerning the emerging results through discussion to avoid influencing the authors’ pre-understanding of working in the field. The findings have been critically debated and discussed with others with experience in qualitative methods and different pre-understandings of the phenomenon during research seminars. As with all qualitative studies [70], the findings from these two studies cannot be generalised and the transferability of the results is up to the reader to decide. The results from study III are valuable as they can be used to develop a more applicable algorithm to follow in clinical practice. The results from study IV are useful as no available study has explored patient experiences with awake intubation. Such valuable information can improve the quality of care. Whether the results from these studies are transferable to other settings and patients requires further study.
Clinical implications

Preoperative airway assessment is important to identify patients who will be easy or difficult to intubate. Most of the published literature has mainly focused on the prediction of difficult airways [25]. Mallampati classification III-IV is also a predictor of difficult mask ventilation combined with difficult laryngoscopy [103]. Therefore, it is important to use airway tests that can clearly define easy airways to provide guidance for when RNAs can maintain and perform endotracheal intubation independently. In clinical practice, airway tests are more useful if they also predict an easy airway, as endotracheal intubations in Sweden are mostly performed by RNAs without the direct supervision of anaesthesiologists.

In order to promote patient safety in clinical practice, the development of evidence-based guidelines and algorithms for the management of difficult airways should be considered a higher priority. Study III revealed that algorithms are a valuable tool when presented with a difficult airway, but in clinical practice, more attention should be given to developing algorithms that are simple and easier to follow, as presented by the Difficult Airway Society (DAS) [36]. It will be interesting to follow when the DAS guidelines for the management of difficult airways become available in our anaesthesia departments. From the professional perspective, dealing with a difficult airway is one of the most stressful events one will face, especially during an emergency, and the approach takes time to learn and master. Therefore, a well-designed algorithm that is easy to follow is essential. In critical situations, a visual algorithm can be helpful for the practitioner to communicate effectively with the team, especially if one's own experience is governed.

Awake fiberoptic intubation is an alternative procedure for securing the patient’s airway when a difficult airway is expected. From the patients’ perspective, tailored information about what to expect and how awake fiberoptic intubation could be experienced is important to increase their feelings of control and ability to cope during the procedure. To improve the quality of care, it is important to take patients’ needs, feelings, and thoughts into consideration. In addition, patients should be offered written and visual information about how they should be cared for in the operating room to enable patients to feel calm before the procedure is performed.
Conclusions

The overall aim of the present thesis was to study airway management in anaesthesia care from both the professional and patient perspective.

- Airway management is of central importance when performing anaesthesia. The Mallampati classification is a good screening test for predicting easy intubation when the airway assessment is performed in a structured manner by RNAs.

- In anaesthesia care, airway guidelines and algorithms have been developed and recommended to achieve safer airway procedures, but airway guidelines are poorly implemented in Swedish anaesthesia departments.

- Algorithms have been recommended in clinical practice to aid in determining how to act and handle difficult airways. To be used in daily practice, algorithms need to be simple and easy to follow and based on the best available scientific evidence.

- From the patients’ perspective, the most unpleasant part of the procedures is discomfort following the application of local anaesthetic. Tailored information about what to expect, ensuring eye contact, and giving breathing instructions during the procedure may reduce patients’ feeling distress. Most of the patients would not hesitate to undergo awake intubation again if needed, in the future.

Vakenintubation anses vara det säkraste sättet att erhålla fria luftvägar inför generell anestesi och rekommenderas för patienter som identifierats med svår luftväg. En vakenintubation genomförs vanligtvis under lokalaneesi och lätt sedering. Samarbetes och kommunikation mellan patienten och den som genomför vakenintubationen är av betydelse eftersom patientens möjligheter till verbala kommunikation begränsas genom trakealtubens placering. För det flesta patienter är anestesi i samband med operation förkämpade med varierande grad av oro och ångest. Generellt upplever kvinnor mer oro och ångest jämfört med män. Tidigare studier har kunnat påvisa ökad patienttillfredsställelse och minskad ångest och oro i samband med anestesi om patienten är välinformerad.

Det övergripande syftet med avhandlingen var att studera luftvägsbedömning inom anestesisjukvård från både anestesiprofessionens och patientens perspektiv.

Syftet med studie I var att studera om Mallampatis klassifikation, thyromental avstånd och Cormack och Lehanes gradering var användbara luftvägstest för att predicera lätt intubation. Anestesijuksköterskor vid en dagkirurgisk operationsavdelning fick under en fyra månaders period preoperativt luftvägsbedöma 100 patienter inför planerad anestesi. Resultatet visade att
Mallampati klassifikation var ett användbart test för att predicera lätt luftväg om bedömningen genomförs på ett strukturerat sätt samt att intubationen kan genomföras självständigt och på ett patientsäkersätt av anestesijuksköterskan.


Syftet med studie IV var att beskriva patienters upplevelser i samband med en vakenintubation. Under ett besök på den preoperativa mottagningen för sedvanlig anestesibedömning informeras patienten muntligt och skriftligt om studien. Därefter genomfördes individuella intervjuer med 13 patienter. Intervjuerna spelades in och analyserades med hjälp av kvalitativ innehållsanalys. Av resultatet framkom ett huvudtema; känna sig i en utsatt situation men vårdad i säkra händer och följande fem kategorier; behov av skräddarsydd information, oro och rädsla inför intubation, tillit till personalens kompetens, omtänksam och professionell vård och ingen tvekan att genomgå en vakenintubation igen.

Sammanfattningsvis visar avhandlingsarbetet att Mallampati klassifikation var ett användbart test för att predicera lätt luftväg när bedömningen genomfördes på ett strukturerat sätt av anestesijuksköterskan. Vidare visade avhandlingens nationella kliniska riktlinjer för luftvägshantering inför anestesi behöver förbättras för att öka patientsäkerheten. Trots att algoritmer för hur man ska hantera svåra luftvägar har utvecklats och publicerats, både nationell och internationell, framkom att algoritmer för hur man hantera svåra luftvägar är svåra att komma ihåg i en stressig luftvägssituation. Algoritmer bör vara enkla och innehålla få steg för att implementeras i det dagliga kliniska arbetet. Vakenintubation är en rekommenderad metod för att säk-
ra fria luftvägar hos patienter med misstänkt svår luftväg. Från patientens perspektiv, skräddarsydd information, ögonkontakt och andningsinstruktioner under själva förfarandet minskar oro och ångest inför anestesi. Patientens upplevelser av vakenintubation är av klinisk betydelse för hur den preoperativa informationen kan utformas samt hur patientens egen delaktighet kan optimeras i samband med vakenintubation.
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References


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