Current practice of rapid sequence induction of anaesthesia in the UK - a national survey

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Abstract

Background: The ‘classical’ technique of rapid sequence induction (RSI) of anaesthesia was described in 1970. With the introduction of new drugs and equipment in recent years, a wide variation in this technique has been used. The role of cricoid pressure is controversial because of the lack of scientific evidence. Moreover, gentle mask ventilation has been recommended in situations such as obesity and critically ill patients, to prevent hypoxaemia during the apnoeic period. In identifying multiple techniques, we conducted a national postal survey to establish the current practice of RSI in the UK.

Methods: A survey consisting of 17 questions was created and posted to 255 National Health Service (NHS) hospitals in the UK. We included two copies of the questionnaire in each envelope; one to be completed by the airway lead (consultant anaesthetist with responsibility of overseeing the standard of airway training and implementing national airway guidelines and recommendations within their institution) and the other by a trainee in the same department. The difference in responses from consultants and trainees were assessed using the $\chi^2$ test and the Fisher’s exact test.

Results: In total we received 272 responses (response rate 53%) of which 266 (58% from consultants and 42% from trainees) were analysed. A majority of the respondents (68%) pre-oxygenated by monitoring end-tidal oxygen concentration and 76% of the respondents use 20–25° head up tilt for all RSIs. Propofol is the most commonly used induction agent (64% of all respondents). Opioid has been used by 80% of respondents and only 18% of respondents use suxamethonium for all patients and others choose rocuronium or suxamethonium based on clinical situation. Although 92% of anaesthetists use cricoid pressure, 83% of them never objectively measure the force used. During the apnoeic period 17% of the respondents use gentle mask ventilation.

Conclusions: Our survey demonstrated a persistent variation in the practice of RSI amongst the anaesthetists in the UK. The ‘classical’ technique of RSI is now seldom used. Therefore there is a clear need for developing consistent guidelines for the practice of RSI.

Key words: anaesthetics; Great Britain; intubation; neuromuscular block; oxygen; propofol; questionnaires
Editor’s key points

- The ‘classical’ technique of rapid-sequence induction of anaesthesia was introduced in 1970’s, and there may be a wide variation of techniques now, as a result of introduction of new drugs, equipment, and concepts.
- A postal survey was made to examine the variation of this technique in the UK.
- The ‘classical’ technique was seldom used, and there was a wide variation in the technique, necessitating up-to-dated guidelines for the practice of rapid-sequence induction of anaesthesia.

Introduction

Rapid sequence induction (RSI) of anaesthesia is such a fundamental skill in anaesthetic practice in the UK, that the Royal College of Anaesthetists (RCoA) has set it as one of the initial assessment competencies for novices. The ‘classical’ approach to RSI, as advocated by Stept and Safar, describes pre-oxygenation, administration of a pre-determined dose of thiopental and suxamethonium, application of cricoid pressure, avoidance of face mask ventilation and intubation with auffed tracheal tube. This ensures an optimal condition for rapid tracheal intubation.

There is controversy regarding the choice of drugs, patient position, ventilation during the apnoeic period and application of cricoid pressure during RSI. In recent years, newer techniques of pre-oxygenation,4,5 patient positioning6 and delivery of oxygen during the apnoeic period7,8 have been described. Rocuronium, at a dose of 1.2 mg kg⁻¹, has been shown to produce rapid onset of muscle paralysis similar to suxamethonium11 and sugammadex rapidly antagonizes even profound levels of rocuronium induced neuromuscular block.12 To prevent hypoxaemia during the apnoeic period, gentle mask ventilation has been used in situations such as the obese, pediatrics and critically ill patients.3 Although the purpose of cricoid pressure is to prevent regurgitation of gastric contents, there are reports of its failure.3,13,14

The national survey11 of anaesthetists in the UK in 2001, exploring the practice of RSI, found that all respondents used pre-oxygenation and applied cricoid pressure. The same survey found that thiopental and suxamethonium were the most widely used drugs and the majority of respondents (75%) also routinely administered an opioid. Another regional survey15 in the UK in 2009, showed that 100% of respondents choose RSI for bowel obstruction, whereas only 83% of them chose RSI for symptomatic hiatus hernia. It also demonstrated a significant difference in the practice between trainees and consultants. A survey amongst the anaesthetists in the USA demonstrated that the majority of residents and attending physicians use mask ventilation during RSI.17 However there are certain aspects of RSI that need to be further explored. These include the use of newer techniques of pre-oxygenation, including patient position and oxygenation during the apnoeic period, whether rocuronium has completely replaced suxamethonium, if cricoid pressure is still routinely used and if the force applied during cricoid pressure is objectively measured. Therefore using a national survey, we aimed to evaluate the current practice of RSI in view of answering the above questions. We also wished to determine whether the practice is consistent between trainees and consultants across the UK.

Methods

The initial list of National Health Service (NHS) hospitals in the UK was sourced from the medical education department, University Hospital Coventry, UK. This was cross checked for completeness with the list of hospitals with airway leads obtained from the Health Services Research Centre, Royal College of Anaesthetists. Finally, airway leads (consultant anaesthetist with responsibility of overseeing the standard of airway training and implementing national airway guidelines and recommendations within their institution) were searched on the RCoA online database. The NHS hospitals in the UK with resources for anaesthetizing adult, non-pregnant patients were included in the survey.

A survey questionnaire consisting of a total 17 questions was designed in Microsoft Word with 5 sections: characteristic details, such as grade of the respondent and type of hospital they work at, techniques of pre-oxygenation including patient position, drugs used, details of cricoid pressure and technique of oxygenation during the apnoeic period. The initial draft survey questionnaire was designed based on previously published audit on RSI18 and circulated to anaesthetists in the authors’ (NU and CM) own department and subsequently for all trainees in the West Midlands region. The comments and suggestions received were incorporated and the final questionnaire was designed (Appendix I). The questionnaire requested the respondent to answer the questions with regard to their clinical practice of RSI for a haemodynamically stable adult patient.

The postal survey, addressed to airway leads was sent to 234 hospitals. In each envelope, we included a short covering letter and two questionnaires, one to be completed by the airway lead and the other one by a junior trainee in their department. The initial round of survey questionnaires were posted between 1st October and 15th October 2014. Six weeks later, the non-responders were reminded by email or telephone call. The questionnaires were re-sent to those who stated that they had not received it. During this stage, we posted 21 envelopes addressed to the college tutors in those hospitals assumed to have no nominated airway leads. In total 255 envelopes containing 510 questionnaires were sent in the post.

The responses of returned questionnaires were entered into a Microsoft Excel spreadsheet. The incomplete responses and those received from paediatric and obstetric specialist hospitals were excluded from the analysis. Analysis of the data was carried out using statistical software SPSS (Version 18, SPSS Inc., Chicago, IL). The differences in responses between consultants and trainees were compared using the χ² test or, if very few anaesthetists selected specific responses, the Fisher’s exact test. All comparison tests were performed at 5% significance level.

Results

We received 272 questionnaires with an overall response rate of 53%. Six returned questionnaires could not be analysed (two from specialized obstetric hospitals, one from a specialized paediatric hospital and three incomplete responses). The total 266 questionnaires; 155 (58%) from consultants and 111 (42%) from trainees were included in the analysis.

Pre-oxygenation and position

All respondents, except one trainee and three consultants, performed pre-oxygenation. A majority of the respondents (68%) pre-oxygenated by monitoring end-tidal oxygen concentration (FEO₂), with proportionately higher number of trainees monitoring the FEO₂ (Table 1). Head up position of 20 to 25° was chosen by 203/266 (76%) of respondents as a routine practice during pre-oxygenation and another 11% of the respondents used up to 45°
head up tilt (sitting up position). There was no significant difference between the consultants and trainees in terms of position used during RSI (P=0.629).

**Continuous positive airway pressure (CPAP) during pre-oxygenation**

In total 42% (111/266) of the respondents (65 consultants and 46 trainees) stated that they use CPAP during pre-oxygenation. Of these, 23% use CPAP for all patients whilst 77% use it for obese patients only. In comparison to trainees, proportionately higher numbers of consultants use CPAP for obese patients (P=0.032).

**Drugs used in RSI**

Propofol is the most commonly used agent (Table 2) for induction and significantly higher proportion of consultants use propofol in comparison to trainees (P<0.001).

A minority (18%) of the respondents use suxamethonium only for all patients and 16% use rocuronium only for all patients. A majority of anaesthetists (150/266, 56%) would usually use suxamethonium but in selected patients they use rocuronium. The reasons stated for choosing rocuronium included elective cases with aspiration risk, anticipated difficult airway and presence of contraindications for suxamethonium. Similarly 92% (20%) of the respondents usually use rocuronium but in some selected patients they would choose suxamethonium.

Proportionately higher numbers of consultants choose to administer opioid as compared with trainees, fentanyl being most commonly chosen opioid (Table 3).

**Cricoid pressure**

A total of 244 (92%) anaesthetists who responded to our survey stated that they always apply cricoid pressure during RSI. The other 8% would apply cricoid pressure only in selected patients such as those with bowel obstruction. A higher proportion of trainees always apply cricoid pressure as compared with consultants (99 and 87% respectively, P<0.001). Most anaesthetists (84%) allow ODPs ([Operating Department Practitioners who assist the anaesthetists (anaesthetic assistants)] to identify cricoid cartilage by manual palpation, whereas 16% identify it themselves and hand-over to ODPs. Only one consultant anaesthetist said that he uses ultrasound to identify the cricoid cartilage.

A vast majority of respondents 220/266 (83%) never objectively measure cricoid force applied. Only 52% of respondents check that their assistants are trained, as compared with trainees (60 and 40% respectively). There is a wide variation in the timing when cricoid pressure is applied (Table 4).

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**Table 1** Methods of pre-oxygenation during Rapid Sequence Induction of anaesthesia. Values are actual numbers (%). There is more than one capacity breathing; CPAP, continuous positive airway pressure. An individual anaesthetist can have more than one response

<table>
<thead>
<tr>
<th>Method</th>
<th>All respondents (n=266)</th>
<th>Consultants (n=155)</th>
<th>Trainees (n=111)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Until FEO2 ≥0.9</td>
<td>180 (68)</td>
<td>97 (63)</td>
<td>83 (75)</td>
<td>0.036</td>
</tr>
<tr>
<td>3 min TV breathing</td>
<td>178 (67)</td>
<td>101 (65)</td>
<td>77 (69)</td>
<td>0.472</td>
</tr>
<tr>
<td>1 min VC breathing</td>
<td>63 (24)</td>
<td>40 (26)</td>
<td>23 (21)</td>
<td>0.336</td>
</tr>
<tr>
<td>Other methods FEO2 ≥0.8 or 2 min VC breathing</td>
<td>25 (9)</td>
<td>16 (10)</td>
<td>9 (8)</td>
<td>0.542</td>
</tr>
</tbody>
</table>

**Table 2** Induction agents used in Rapid Sequence Induction of anaesthesia. Values are number (%). Respondents could choose more than one induction agent

<table>
<thead>
<tr>
<th>Induction agent</th>
<th>All respondents (n=266)</th>
<th>Consultants (n=155)</th>
<th>Trainees (n=111)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propofol</td>
<td>170 (64)</td>
<td>113 (73)</td>
<td>57 (51)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Thiopental</td>
<td>135 (51)</td>
<td>66 (43)</td>
<td>69 (62)</td>
<td>0.002</td>
</tr>
<tr>
<td>Etomidate</td>
<td>10 (4)</td>
<td>7 (4.5)</td>
<td>3 (3)</td>
<td>0.529</td>
</tr>
<tr>
<td>Ketamine</td>
<td>2 (1)</td>
<td>2 (1)</td>
<td>0 (0)</td>
<td>0.512</td>
</tr>
</tbody>
</table>

**Table 3** Use of opioids in Rapid Sequence Induction of anaesthesia. Values are number (%). There is more than one reply for each question hence total add up to >100%

<table>
<thead>
<tr>
<th>Opioid chosen</th>
<th>All respondents (n=266)</th>
<th>Consultants (n=155)</th>
<th>Trainees (n=111)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opioid chosen</td>
<td>214 (80)</td>
<td>132 (85)</td>
<td>82 (74)</td>
<td>0.022</td>
</tr>
<tr>
<td>Fentanyl</td>
<td>160 (75)</td>
<td>103 (78)</td>
<td>57 (69.5)</td>
<td>0.163</td>
</tr>
<tr>
<td>Alfentanil</td>
<td>68 (32)</td>
<td>36 (28)</td>
<td>32 (39.0)</td>
<td>0.073</td>
</tr>
<tr>
<td>Remifentanil</td>
<td>21 (10)</td>
<td>19 (14)</td>
<td>2 (2)</td>
<td>0.004</td>
</tr>
<tr>
<td>Morphine</td>
<td>1 (0.5)</td>
<td>1 (1)</td>
<td>0 (0)</td>
<td></td>
</tr>
</tbody>
</table>

**Table 4** Timing of cricoid pressure in relation to administration of induction agent. Values are number (%). One respondent did not reply to this question

<table>
<thead>
<tr>
<th>Start of cricoid pressure</th>
<th>All respondents (n=265)</th>
<th>Consultants (n=154)</th>
<th>Trainees (n=111)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Just before administering of induction agent</td>
<td>94 (36)</td>
<td>47 (30.5)</td>
<td>47 (42)</td>
</tr>
<tr>
<td>During administration of induction agent</td>
<td>129 (47)</td>
<td>75 (49)</td>
<td>54 (49)</td>
</tr>
<tr>
<td>Immediately after administering induction agent</td>
<td>21 (8)</td>
<td>18 (12)</td>
<td>3 (3)</td>
</tr>
<tr>
<td>After confirming loss of consciousness</td>
<td>20 (8)</td>
<td>13 (8)</td>
<td>7 (6)</td>
</tr>
<tr>
<td>Variable; depends on risk of aspiration</td>
<td>1 (0.4)</td>
<td>1 (0.6)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>
Oxygenation during apnoea

Seventeen percent of respondents use gentle mask ventilation during the apnoeic period and a further 6% of respondents use oxygen insufflation using a nasal catheter.

Discussion

This national survey demonstrates that the current practice of RSI of anaesthesia in the UK differs considerably from the ‘classical’ technique. Only a minority of anaesthetists routinely practice RSI with the drugs and techniques advocated more than 40 years ago. The recently introduced new methods of pre-oxygenation, newer drugs, increasing awareness of maintaining oxygenation during the apnoeic period and the persisting controversy on the use of cricoid pressure may all be contributing factors.

The wide variations in practice of RSI in this survey, follows similar UK studies published in 2001 and 2009. Another recent survey of more than 2900 anaesthetists in Germany also described similar variation in pre-oxygenation, patient positioning and the use of neuromuscular blocking agents. In their survey, one third of the anaesthetists did not use cricoid pressure. A similar survey conducted in the USA demonstrated that the majority of anaesthetists attempt to ventilate the lungs during the apnoeic period as part of modified RSI.

Our survey also identified a significant variation in the practice between trainee and consultant anaesthetists. Trainee anaesthetists particularly novices are more likely to practice the classic RSI technique as described in standard anaesthesia textbooks and RCoA curriculum whereas consultant anaesthetists are likely to modify their practice based on their experience and recently available drugs. A recent European survey evaluated the presence of guidelines in managing RSI and identified a lack of consistent standard in the technique of RSI.

Effective pre-oxygenation is an essential component of RSI. The majority of our respondents said they use either three minute tidal volume breathing or aim for a FEO2 ≥ 0.9. A recent study has shown that eight vital capacity breaths in one min provides a better safety margin with almost double the apnoeic time without hypoxia compared with three min tidal volume breathing.

The application of positive airway pressure increases the duration of apnoeic period without hypoxia in morbidly obese patients and also in non-obese patients. Although 42% of anaesthetists in our survey stated that they use CPAP during RSI, 78% of them use CPAP only for obese patients. This indicates the need to emphasize this simple and effective technique in the airway training.

A 20–25° head up position has been shown to improve pre-oxygenation in both obese and non-obese patients. In our survey, 76% of anaesthetists use this position for all patients and most of the remaining practitioners use it only for obese patients.

There has been a significant change in drugs used for RSI since the previous national survey in 2001. Propofol has been increasingly used for RSI instead of thiopental. This could be because of the comparative efficacy of propofol and also as a result of the familiarity of its use in the elective situations.

The intubating conditions produced by 1.2 mg kg\(^{-1}\) of rocuronium are comparable with that of suxamethonium. Sugammadex at a dose of 16 mg kg\(^{-1}\) antagonizes the neuromuscular block of rocuronium more predictably than the spontaneous recovery from suxamethonium. This higher predictability of reversal of neuromuscular block could be the reason for increasing use of rocuronium. Consultant anaesthetists are more likely to choose rocuronium as compared with trainees. They indicated rocuronium would be chosen in elective patients with aspiration risk and in anticipated difficult airways and situations where suxamethonium is contraindicated.

Although opioids are not part of the ‘classical’ RSI, 85% of consultants and 74% of trainees indicated that they use this class of drug in addition to an induction agent and neuromuscular blocking agent. Fentanyl was the most commonly used opioid during an RSI, followed by alfentanil. Interestingly, around 14% (19/132) of those consultants who use opioids mentioned that they use remifentanil. In certain situations such as open globe injury of eye, remifentanil may offer the benefit of haemodynamic stability. Hanna and colleagues studied the effect of propofol and remifentanil on intra-ocular pressure during RSI and concluded that remifentanil controls the haemodynamic response to laryngoscopy and intubation and prevents an increase in intra-ocular pressure.

In total 92% (244/265) of the respondents answered that they always use cricoid pressure in RSI. Fifty-five years since Sellick described cricoid pressure there is still no consensus of its benefits amongst the anaesthetists worldwide. A randomized controlled trial performed in 2007 did not find any evidence to support the reduced incidence of aspiration with cricoid pressure. Consistent with the previous study in the USA, the majority of anaesthetists we surveyed would apply cricoid force immediately before or during administration of induction agent.

Although there have been descriptions of methods to measure cricoid force in experimental settings, they are not used in routine clinical practice. Objective measurement of cricoid force is practically difficult and it is not surprising that 83% of respondents do not measure it routinely. Fifty-two percent of anaesthetists check that their assistants are trained in applying cricoid pressure. Most anaesthetists work with assistants already known to them routinely and therefore may be fully aware of their competency. Checking of competency to apply cricoid pressure is required when an RSI is performed outside a theatre environment, or when a new colleague is assisting with RSI. A significantly higher number of consultants check the competency of their assistants as compared with trainees (60% and 40% respectively); this could be because of the relatively junior trainees working in well-established teams.

Oxygen insufflation using a nasal catheter or the trans-nasal humidified rapid-insufflation ventilatory exchange technique has been shown to be effective in prolonging the time to desaturation during the apnoeic period. Despite its intuitive nature and the now available evidence, only 6% of the surveyed anaesthetists in the UK use a form of nasal oxygen insufflation, to prevent potential desaturations and hypoxaemia during RSI.

Our study has certain limitations. In view of achieving a better response rate, we conducted a postal survey and not an electronic one. Despite telephone and email reminders, the response rate of our survey was 53%. Our questionnaire was limited to the various components of RSI. We did not enquire about the current practice of using gastric tubes before RSI. In recent years, there has been an increasing use of videolaryngoscopes, which may also contribute to the modification of RSI technique. The indirect view obtained on the monitor screen can give feedback to the anaesthetic assistant on the effect of their cricoid pressure. We did not question participants regarding their use of videolaryngoscopes in RSI. Furthermore, we did not ask about the management strategies and rescue techniques for failed intubation during RSI, which might have included the release of cricoid pressure and use of supraglottic airway devices.
In conclusion, our survey demonstrated a persistent variation in the practice of RSI amongst the anaesthetists. Increasing use of propofol has replaced thiopental and introduction of sugammadex might have contributed to the reduced use of suxamethonium. These findings have specific implications on teaching the technique of RSI to trainee anaesthetists. Therefore a systematic review of existing evidence for RSI is useful in developing standardized technique of RSI. This should be incorporated into the revised curriculum of trainees to ensure a safe clinical practice.

Authors' contributions
Study design/planning: A.S., N.U., J.W., C.M.
Study conduct: A.S., N.U., J.W.
Data analysis: P.K.
Writing paper: A.S., N.U., J.W., P.K.
Revising paper: all authors

Declaration of interest
None declared.

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Handling editor: T. Asai