Human Factors Training: Structured Management Airway Response Team (SMART) Approach Aims to Improve Patient Safety

Ravi Dravid[1], Sunita Balla[2], Subrahmanyan Radhakrishna[2], Bhagyashree Netke[3], Priya Gauthama[4], Ajay Swami[1], Trevor Dale[5], Cyprian Mendonca[6]

**Corresponding author:** Dr Sunita Balla sunita45@doctors.org.uk

**Institution:** 1. Woodland Hospital, UK, 2. University Hospitals Coventry & Warwickshire NHS Trust, UK, 3. Royal Wolverhampton NHS Trust, New Cross Hospital, UK, 4. Leicester Royal Infirmary, UK, 5. Atrainability, UK, 6. University Hospitals Coventry & Warwickshire NHS Trust; Warwick Medical School; University of Warwick, UK

**Categories:** Education Management and Leadership, Educational Strategies, Learning Outcomes/Competency, Teaching and Learning, Clinical Skills

Received: 30/07/2019
Published: 18/11/2019

**Abstract**

**Background:** Technical skills and human factors are the pillars of effective team work in every given situation. This is more evident in professions where an error can transform into a catastrophe in seconds and minutes. The aviation industry and medical specialty have been witness to this predicament. Difficult airway is one such realm in anaesthetics where a sound management strategy coupled with excellent team dynamics hold the key to a successful outcome. Hence, we piloted the concept of Structured Management Airway Response Team with ‘predesignated roles’ to improve airway safety.

**Methods:** A training course was developed to teach non technical skills to teams of anaesthetist and anaesthetic assistants. The course was evaluated for its effectiveness at changing delegates’ attitudes to ‘airway safety’. Delegates were asked to complete pre and post course questionnaires designed by panel of airway experts where they were asked to mark their response to eight question on a visual analogue scale of 0-100.

**Results:** The results indicated a positive change as the visual analogue scores were significantly higher in the post-course questionnaire (p = 0.001 for one question and = <0.001 for other seven questions).

**Conclusion:** We infer that teaching Human Factors to teams involving anesthetist and anaesthetic assistants would improve attitudes to airway management and promote patient safety.
Introduction

Airway management is central to safe patient care in the operating theatre (Berkow, 2004; Brambrink and Koerner, 2004). Final consequence of failure in airway management is hypoxia and irreversible brain damage. Guidelines have been developed and appropriate techniques suggested for managing an unanticipated difficult airway (Henderson et al., 2004; Apfelbaum et al., 2013). More recently it has been recognised that human factors is a major contributor to airway related serious adverse events. Human factors includes a range of issues such as system failure, unfamiliarity with equipment or environment and failures on the part of individuals and teams to work towards a common objective. These could happen to the ‘most experienced’ and ‘technically competent’ individuals and teams leading to an adverse outcome (Reason, 1990; Gaba, 1992; Hawkins, 1993; Bromiley, 2008). This has accounted for up to 80% of accidents in anaesthesia (Cooper et al., 1978).

Airway crisis are generally rare but when they occur, can be a nightmare for even the most skilled and experienced anaesthetist (Ruxton, 2010; Bromiley, 2008). These are time critical events where a structured approach involving all team members with effective communication and awareness of roles can make a difference to patient outcome (Manser, 2009; Billyard et al., 2011).

Patient safety is critically dependent on and enhanced by strategies which incorporate error avoidance, trapping error and mitigating the consequences if error eventually does happen (Helmreich, Merritt and Wilhelm, 1999). It is recommended that the error avoidance and management model from high reliability organisations should be adopted in healthcare to improve safety and efficiency (Howard et al., 1992; Donaldson, 2000; Kohn, Corrigan and Donaldson, 2000; Gaba et al., 2014). Effective team working with pre-agreed roles for members, good communication, checklists and standard operating procedures underpin above aims.

Traditionally, healthcare professionals work in teams but train in ‘silos’. Those who work together should be trained together in teams. These teams should be trained in handling the unexpected acute complications such as difficult airway, in a simulated environment (Gaba, 1992). Based on these principles we developed the Structured Management Airway Response Team (SMART) project in two phases. In phase 1, an airway response team – SMART was conceptualised from staff routinely available in operating theatres to manage an airway crisis. Checklist and standard operating procedures with predefined roles were developed for each team member to improve communication and team working during a simulated airway emergency (Dravid, 2008). Subsequently in Phase 2, SMART anaesthesia course was developed to integrate technical skills (TECHS) and non-technical skills / human behaviours (NTS / HB) with an ethos: "train together those who work together. The SMART protocol teaches how to
avoid errors and manage a crisis. We aimed to evaluate the course for its effectiveness at changing delegates’ attitudes to ‘airway safety’ by comparing the pre course and post course questionnaire.

**Methods**

The training of non technical skills was evaluated during two phases of the course. This research was not submitted for Ethics Board approval because it was quality evaluation project of a training course and participants completed the survey questionnaire on a voluntary basis. The project was assessed using the National Research Ethics Service decision making tool (http://www.hra-decisiontools.org.uk/research/) and did not meet definition for research requiring research ethics committee approval.

**Phase 1:** An airway team was conceptualized consisting of staff routinely available to manage unanticipated difficult airway in an anaesthetic room. A pilot study was conducted with four teams (A, B, C and D). Each team comprised of 1st anaesthetist, anaesthetic assistant, Nurse 1 (scrub nurse in theatre), Nurse 2 (circulating nurse in theatre), a surgeon and a 2nd anaesthetist (who would be available and could be called for help). The aim was to re-create a normal theatre environment. Each team was separately briefed in an identical manner to participate in the management of a standardised difficult airway scenario (Appendix 1). They were also briefed in Difficult Airway Society guidelines for management of an unanticipated difficult intubation. Each team performed the same scenario twice and outcomes were measured by assessors and participants’ self-assessment questionnaires. In the first instance, they were asked to manage the scenario as they would in their routine clinical practice (pre-protocol management). Subsequently they repeated the same scenario following allocation of pre-designated roles to each member (post protocol management). Role allocation was explained to the team members just prior to undertaking the protocol scenario (Appendix 2).

Airmate™ simulator (Laerdal Medical, Kent, UK) was set up in an operating theatre with the anaesthetic machine and all essential airway equipment readily available. All participants were instructed to wear theatre uniform to simulate near realistic environment. At the end of the scenario, all team members were asked to complete a questionnaire. Each participant recorded their own estimate of time with regard to key events during the airway crisis. They also recorded stress and anxiety levels on a visual analogue scale (VAS) of 0-10 (0 being no stress at all and 10 being maximum imaginable stress).

Immediately after all four teams completed the first scenario, they were then identically but separately briefed on the proposed airway response protocol in which each team member was assigned specific roles (Appendix 2). The teams then performed same scenario again, this time with pre-designated roles for the team members (post protocol management). Following completion of scenario, the participants completed the same self-assessment questionnaire again for the second time. All above observations were repeated for the protocol scenario. The teams were kept separate and blinded to other teams’ performance at all times. The independent observers were blinded to the allocation of roles for protocol scenario.

Both scenarios for each team were video recorded. Two consultant anaesthetists with experience in difficult airway management and anaesthetists’ non-technical skills scoring system acted as independent assessors. They scored the actual success or failure of airway management, timings of procedures, and efficiency of the airway team. Technical elements of scenario management i.e. implementation of plan B, C and D as per Difficult Airway Society (DAS) guidelines were rated on a score of 1 to 5; 1 being the skill was poorly performed and 5 being the skill was performed to the best standard. The non-technical skills of Task management, Teamworking, Situation awareness and Decision making were scored using a score of 1 to 4 (1 being the observed skill was poor, 2 marginal, 3=acceptable and 4=Good) as described in ANTS scoring system (Fletcher et al., 2003).
Phase 2: A series of SMART courses were planned and conducted with objectives to teach technical skills included in Difficult Airway Society (DAS) intubation guidelines and their integration with non-technical skills/human behaviours. Twenty-four delegates (12 anaesthetists and 12 anaesthetic assistants) took part in each course. They were allocated into four teams with six delegates in each. Each team consisted of three anaesthetists and three anaesthetic assistants.

The format of the course consisted of theory module, which included interactive lectures, discussions and video analysis of non-technical skills with regard to airway management and human behaviours followed by practical sessions (Appendix 3). The non-technical skills taught during the theory module included introduction and background to human factors, human limitations and fallibility, cognition, interpersonal skills of team working and coordination, leadership and management. Cognitive skills teaching included situational awareness, decision-making, pitfalls and strategies to improve decision-making. Techniques of context specific communication skills, issues of managing personal resources such as stress and fatigue, rule violation and reducing hierarchical barriers were also explored. Concepts of briefing (SMART briefing), minibriefing, debriefing and scoring of observable behaviour using a modified nontechnical skill scoring system (NOTECHS) was introduced (Appendix 4).

Technical skills

Practical module/session included technical skills to manage an unanticipated difficult intubation (DAS guidelines), training in SMART briefing, role allocation and mini-briefs and simulated scenarios using medium fidelity simulator followed by debriefing of scenario. All delegates were given opportunity to rehearse these airway skills on manikins. Emphasis was given on preparedness including plan for failure, thinking ahead and avoiding getting into ‘crisis’ with explicit discussion on awakening the patient from general anaesthesia to ensure patient safety. Delegates were encouraged to reflect on allocation of appropriate roles and responsibilities to team members and use an all-inclusive approach.

Simulation Scenario

For each simulation scenario, a team comprising of six delegates (acting as anaesthetist 1, anaesthetist 2, surgeon, anaesthetic assistant, nurse 1 and nurse 2) were presented with a case for airway management on a medium fidelity simulator (SimMan® Laerdal Medical, Kent, UK) and encouraged to practice non-technical skills and human behaviours learnt during the earlier part of the course. Facilitators and a second team (of six delegates) observing the scenario, evaluated the performance by identifying effective and less effective behaviours in all the categories and elements of NTS. The delegates in the participating team were encouraged to reflect and debrief followed by input from the facilitator as well as observer team. They were encouraged to verbalise on positive behaviours they would increasingly use and ineffective/negative behaviours they would reduce in their routine practice. After this debriefing, the teams were swapped with the observer team now performing a different scenario and the other team and facilitators now assessing and marking the behaviours.

Course evaluation

A hypothetical case scenario of an unanticipated difficult tracheal intubation was designed. This was circulated to six senior consultants with an airway interest who were also members of DAS. Comments were requested independently on the aspects of preparation and management of this scenario with specific focus on safety in airway management. Their independent comments were then scored by other members of this group, which were compiled in designing the final questionnaire to evaluate the course.

All participants were asked to complete a structured questionnaire pre and post course (before the start of the course and on completion of the course) on a voluntary basis to help in the evaluation of the course (Supplementary File 1).
There were eight questions pertaining to nontechnical skills. These questions were designed to evaluate the approach to the scenario and routine behaviour of team members towards NTS. The first two questions were related to checking the difficult airway trolley prior to inducing general anaesthesia and personnel involved in checking the difficult airway trolley. The next six questions were related to the use of resources and awareness of appropriate roles of personnel involved in the management of unanticipated failed intubation. They were asked to rate each question using a VAS of 0 to 100 (0 being strongly disagree with the given statement and 100 being strongly agree with the statement). The completed pre-course questionnaire was collected from the delegates before the start of the course. Delegates completed the same scenario questionnaire at the end of the course.

All completed questionnaires were collated and analysed. The normal distribution of values was tested using Shapiro-Wilks test. For each question, the difference between pre and post course score was compared using Wilcoxon signed rank test. Data was analysed using R statistical software version 2.1.1.

Results

Phase 1

One team was withdrawn because consent was withdrawn post pilot. There was inconsistent or no improvement in the observed technical skills in the post protocol management. There was no improvement in the non-technical scores, however the self-rated anxiety levels in all the teams improved in post protocol scenario. (Table 1A, 1B and 1C). Participants favored a team approach with pre-designated roles in the management of airway crisis scenario. Overall both participants and assessors felt that communication, information transfer, documentation and task performance were better in the post protocol management.

Table 1A Summary of technical and non technical elements in pre-protocol versus post protocol management of airway scenarios (Phase 1)

<table>
<thead>
<tr>
<th>Team</th>
<th>Improved time to DAS plan B</th>
<th>Improved time to recognise failed oxygenation</th>
<th>Improved time to DAS plan C</th>
<th>Improved time to DAS plan D</th>
<th>Overall anxiety levels improved</th>
<th>Non technical scores improved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team A</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Team B</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Team C</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

One team withdrew the consent, hence three teams.

Table 1B Comparison of anaesthetists’ non-technical skills scores in pre-protocol versus post protocol management of airway scenarios (Phase 1)

<table>
<thead>
<tr>
<th>Skill description</th>
<th>Team A</th>
<th>Team B</th>
<th>Team C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-protocol</td>
<td>Post-protocol</td>
<td>Pre-protocol</td>
</tr>
<tr>
<td>Task Management</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Team working</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Situation awareness</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>
Values expressed as mean. Each non-technical skill was scored between 1 to 4; 1 = the observed skill was poor, 2 = the observed skill was marginal, 3 = the observed skill was acceptable and 4 = the observed skill was good.

### Table 1C Comparison of Anxiety scores of team members in pre-protocol versus post protocol management of airway scenarios (Phase 1)

<table>
<thead>
<tr>
<th>Anxiety score of team members (0-10)</th>
<th>Pre-protocol scenario</th>
<th>Team protocol scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead anaesthetist</td>
<td>6.3</td>
<td>4.3</td>
</tr>
<tr>
<td>Second anaesthetist</td>
<td>5.7</td>
<td>4.3</td>
</tr>
<tr>
<td>Surgeon</td>
<td>2.7</td>
<td>2.7</td>
</tr>
<tr>
<td>Nurse 1</td>
<td>5</td>
<td>7.5</td>
</tr>
<tr>
<td>Nurse 2</td>
<td>4</td>
<td>2.3</td>
</tr>
<tr>
<td>ODP</td>
<td>6.7</td>
<td>5.7</td>
</tr>
</tbody>
</table>

Values are expressed as mean score. Delegates recorded stress and anxiety levels on a visual analogue scale (VAS) of 0-10 (0 being no stress at all and 10 being maximum imaginable stress).

### Phase 2

A total of 165 delegates attended seven consecutive SMART courses [Appendix 4], held over two years. In total 141 questionnaires from those delegates (Table 2) who completed both pre-course and post course questionnaire were included for analysis of the data.

### Table 2 Demographic data of all delegates who completed the both pre and post course evaluation forms in Phase 2

<table>
<thead>
<tr>
<th></th>
<th>NCCG</th>
<th>Consultant</th>
<th>Trainee</th>
<th>AA</th>
<th>Nurse</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course 1</td>
<td>1</td>
<td>7</td>
<td>5</td>
<td>8</td>
<td>2</td>
<td>21</td>
</tr>
<tr>
<td>Course 2</td>
<td>2</td>
<td>8</td>
<td>3</td>
<td>8</td>
<td>3</td>
<td>23</td>
</tr>
<tr>
<td>Course 3</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>8</td>
<td>2</td>
<td>23</td>
</tr>
<tr>
<td>Course 4</td>
<td>0</td>
<td>7</td>
<td>5</td>
<td>9</td>
<td>2</td>
<td>21</td>
</tr>
<tr>
<td>Course 5</td>
<td>0</td>
<td>4</td>
<td>9</td>
<td>9</td>
<td>2</td>
<td>18</td>
</tr>
<tr>
<td>Course 6</td>
<td>0</td>
<td>8</td>
<td>5</td>
<td>9</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Course 7</td>
<td>0</td>
<td>6</td>
<td>6</td>
<td>11</td>
<td>0</td>
<td>18</td>
</tr>
<tr>
<td>Total</td>
<td>7</td>
<td>45</td>
<td>38</td>
<td>62</td>
<td>13</td>
<td>141</td>
</tr>
</tbody>
</table>

Values are expressed as numbers.

AA: Anaesthetic assistant (operating department practitioner)

N: number of delegates completed the questionnaire

NCCG: non-consultant career grade anaesthetist (SAS / Staff anaesthetist)
Table 3 Improvement in the VAS scores for eight questions in post course questionnaire when compared to pre-course questionnaire

<table>
<thead>
<tr>
<th>Question</th>
<th>Pre-course Median [IQR]</th>
<th>Post Course Score Median [IQR]</th>
<th>Mean improvement [Range]</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Checking the airway trolley 1</td>
<td>32.5 [15-65]</td>
<td>75.0 [43-90]</td>
<td>23.6 [-53,86]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>2. Checking the airway trolley 2</td>
<td>75.0 [45-88]</td>
<td>90.0 [83-93]</td>
<td>18.7 [-35, 80]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>3. Help from theatre staff</td>
<td>82.5 [70-91]</td>
<td>90.0 [85-95]</td>
<td>11.4 [-77, 81]</td>
<td>0.001</td>
</tr>
<tr>
<td>4. Help from surgical colleague</td>
<td>52.0 [30-75]</td>
<td>88.0 [77-95]</td>
<td>28.9 [-76, 82]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>5. Role of ODP- situation awareness</td>
<td>66.5 [35-85]</td>
<td>88.0 [74-95]</td>
<td>21.1 [-69, 92]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>6. Role of ODP-decision making</td>
<td>61.5 [42-80]</td>
<td>88.0 [77-94]</td>
<td>21.5 [-65, 98]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>7. Role of scrub- nurse-situation awareness</td>
<td>56.0 [30-81]</td>
<td>90.0 [82-95]</td>
<td>31.7 [-23, 93]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>8. Role of surgeon- decision making</td>
<td>48.0 [25-72]</td>
<td>85.0 [75-95]</td>
<td>34.1 [-47, 97]</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Values are expressed as median [IQR: Interquartile range]

VAS score for all questions in the post course questionnaire were significantly higher than that of pre-course questionnaire (Table 3 and Figure 1)

**Figure 1:** Visual analogue scores for all eight questions. Values are expressed as mean change in percentage.
Discussion

This study has demonstrated that pre-delegation of roles to the team members and training the team in nontechnical skills / human behaviours improves the management of a simulated difficult airway scenario.

In phase 1, both the participants and the assessors felt that communication, information transfer, record keeping, and task performance were better during the post protocol management. None of the participants had any previous exposure to training of non technical skills or role allocation in managing difficult airway.

It is recognised that most training courses focus on managing ‘crises’ which is directed at individuals although it is ‘teams’ that ultimately manage such ‘crises’ (Capella et al.; Frengley et al., 2011). We formatted the course by teaching non-technical skills and human behaviours first, followed by using these skills during the simulation scenario to practice ‘avoiding getting into a crisis’ initially and ‘crisis management’ if the situation worsens. Awareness of nontechnical skills / human behaviours and education in the form of simulated scenarios with team involvement would ensure that teams perform optimally during crisis.

The course evaluation using pre and post course questionnaire demonstrated a significant improvement in the attitudes of team members in managing a failed intubation scenario. Although the mean post course VAS scores were higher for all questions related to the management of standardized difficult airway scenario, highest improvements in the score were observed for the role of scrub nurse and surgeon in the management of airway crisis (question 7 and 8 respectively). This demonstrates that the course contents and the simulated scenario using pre-designed role to surgeon and scrub nurse enabled the delegates to understand the importance of teamwork and their own contribution to a successful management. Question 1 relates to checking the airway trolley prior to commencing the case and question 4 relates to requesting help from surgeon. The majority of the delegates did not expect the anaesthetist to check the trolley and assumed this would be the task of the anaesthetic assistant (ODP). Similarly, majority of delegates did not expect the anaesthetist to request help from surgeon. This course has highlighted the inclusive approach and the role of surgeon in setting up for surgical airway in an unanticipated failed intubation which is potentially progressing to can’t intubate can’t ventilate scenario. Participants were able to dispel the traditional notion of asking the surgeon to ‘go away and wait till called’ and instead allocated appropriate role to him/her during crisis management. They grasped the value of engaging the surgeon in WHO checklist briefing, sharing information and improved communication to enhance situational awareness.

Simulator based training of teams who work together in intensive care and major trauma management has shown to improve the performance in terms of teamwork behavior, leadership, team co-ordination and situational awareness when tested on simulator and also subsequent transfer of skills to the workplace (Capella et al., 2010; Frengley et al., 2011). Both during the theory module and practical sessions, the Safety Pyramid model of error avoidance, error trapping and mitigating the consequences were emphasized upon as the cornerstone of patient safety (Manser, 2009). In the context of airway management, this resulted in improved situational awareness and analytical / shared decision-making.

Our model of ‘training forward’, i.e. teaching Human Factors and effective behaviours first is intended to develop ‘good habits’. This is then reinforced in simulator environment with actual theatre staff. All team members except the surgical colleague were doing their usual role in the theatres thus providing more realistic and informed context to the practical training. Our course provided training in integration and effective use of the WHO surgical safety checklist in routine clinical practice to improve communication, preparation and planning. The example of a patient with a potential difficult airway provides an opportunity to practice skills which otherwise would be useful even for a non-airway scenario thereby improving overall safety.

Our study has certain limitations. In phase 1, due to limited number of teams, each scenario was performed only
twice during each course and therefore statistically it is difficult to draw conclusions of efficacy of team approach and effect on outcome. It may be argued that the improvement in management of the scenario a second time could be attributed to a ‘learning effect’. However, a streamlined management, record keeping and alerting the anaesthetist to time and vital parameters by another team member, preparing for a possible can’t intubate, can’t oxygenate situation and surgeon’s involvement can’t be solely explained by this ‘learning effect’. In phase 2, we did not evaluate the performance of these teams at their work place to test the transfer of skills and its actual impact on patient safety due to time and resource constraints. We therefore evaluated our course in its ability in changing attitude / behaviour of participants in improving safety in a simulated setting. The other limitation is that being a questionnaire-based assessment, this evaluation can be biased by delegates’ opinion and hence, our inability to comment if it would translate into improved team performance in their clinical practice and whether this would be sustained. Although we didn't follow up on the delegates, there are anecdotal feedbacks of error avoidance behavior, positive impact on team working, improved communication and safety.

In our routine clinical practice, the anaesthetist and anaesthetic assistants work as teams in managing a difficult airway and are supported when needed by other theatre staff and hence we decided to develop this course for training 'teams'.

In conclusion, structured management airway response team course is shown to bring about a positive change in the non-technical skills of anaesthetists and anaesthetic assistants in improving safety in airway management. Therefore, "train together those who work together" and ‘training forward’ in non-technical skills is an effective method of education which can be adopted nationally to train the teams in airway crisis avoidance and management. This training could help the teams develop generic skills and strategies to avoid getting into crisis and improved management and thus improve safety.

Take Home Messages

- Human Error is a major contributor to adverse outcomes even in the hands of very experienced anaesthetists and teams.
- Human Factors (HFs) training should be provided to theatre teams on the ethos 'train together those who work together'.
- This training enables teams to understand human limitations and fallibility and improve communication and team working and develop knowledge, skills and strategies at 'error avoidance' and crisis management.
- Pre-delegation of roles to the team members and HFs training improves the management of a simulated difficult airway scenario; this can translate into improved airway and patient safety.

Notes On Contributors

Dr Ravi Dravid MD, FFARCSI, FRCA is consultant anaesthetist at Woodland Hospital, Kettering UK. He is one of the first ones in the UK to introduce non-technical skills training at his workshops. He has been associated with the Difficult Airway Society (DAS) from 1996 as Treasurer, Human Factors and Education lead.

Dr Sunita Balla MBBS MD FRCA is ST7 anaesthetic registrar at University Hospitals Coventry and Warwickshire NHS Trust. She has an interest in teaching in airway and as an airway fellow has contributed towards workshops and courses for anaesthetists, Operating Department Practitioners (ODPs) and recovery personnel.

Dr Subrahmanyan Radhakrishna MBBS, DA, FFARCSI, FRCA, is consultant anaesthetist at University Hospitals Coventry and Warwickshire NHS Trust. He is Trust human factors facilitator. He is past honorary secretary of DAS.
He is a faculty at SMART anaesthesia course and widely lectures on human factors and difficult airway management.

Dr Bhagyashree Netke MBBS, MD, FRCA, is a consultant anaesthetist and clinical governance lead at Royal Wolverhampton Hospital. She has a special interest in patient safety, human factors and advanced airway management. She is a faculty at SMART anaesthesia courses and widely lectures nationally on human factors and patient safety.

Dr Priya Gauthama MBBS, MD, FRCA is a consultant anaesthetist at University Hospitals of Leicester. She is a faculty on the SMART course and uses the concept of tactical decision games in human factors training. She has developed a patient education and staff training app in electroconvulsive therapy.

Dr Ajay Swami MBBS, MD, FCARCSI, is a consultant anaesthetist at Woodland Hospital, Kettering with an interest in airway management, obstetric and regional anaesthesia. He has widely taught on airway and regional anaesthesia workshops both nationally and internationally. He was involved in the initial design of human factors course.

Mr Trevor Dale MRCPs, FRAses is a retired captain of British Airways. Trevor specialises in Human Factors and was part of the team that introduced this subject as a method of reducing 'pilot error'. Trevor worked in several patient safety projects in NHS and widely lectures on human factors.

Dr Cyprian Mendonca MBBS, MD, FRCA, FAcadMEd is a consultant anaesthetist at University Hospitals Coventry and Warwickshire NHS Trust, Honorary Associate Professor, principal clinical teaching fellow at Warwick Medical School and Featherstone Professor of AAGBI (2016-2018). He is the course director for human factors and airway training courses at Coventry.

Acknowledgements

Figure 1. Source: author (Cyprian Mendonca)

Bibliography/References


Appendices

Appendix 1

Scenario for Pilot study:

Airway management based on DAS unanticipated difficult airway guidelines

Mr B, a 45 year old man is scheduled to undergo laparoscopic hemicolecctiony. He weighs 140 kg with a BMI of 42. Clinical examination of airway revealed good mouth opening, Mallampati score of 2, good jaw protrusion, short neck with adequate extension and a thyromental distance 8 cm.

Intravenous access has been secured and he is monitored with ECG, NIBP and a pulse oximeter. Pre-oxygenation will be followed by 200 microgram fentanyl, 300 mg propofol and a 100 mg dose of rocuronium.

Appendix 2

SMART Roles: Role Anaesthetist 1:

Triggers - "Call for Help" (for scrub and floor nurse)

- Triggered automatically if difficult airway trolley is needed
- Shares information with team members

On arrival of second anaesthetist
- Provides structured brief about
- Anticipated / unanticipated DA
- Plan A – failure – no of attempts and devices
- Plan B – reason for failure
- Plan C – success or failure
- Plan D – ready and
- Hands over care if he or she is junior or too stressed to manage further

ODP Role

The anaesthetist caring for the patient will take responsibility for the call or the ODP in consultation with him would trigger call and shout for help.

- ODP may suggest to the anaesthetist to trigger "call for help" if:
  - Unable to intubate after 4 attempts
  - Decreasing saturation < 90%
  - Two persons unable to bag mask ventilate
  - Time contingent call - 5 minutes (Struggling with or without desaturation)
  - Call cardiac arrest if impending or actual cardiac arrest.
- ODP: Remains with anaesthetist to help the anaesthetist and
May have to give advice to other team members for location of required equipment

**Theatre staff 1 Role**

On triggering, both the nurses would immediately come into the intubating area and help.

- Note time of "Call for help". This is time zero (0).
- Ensure proper placement of monitors (Pulse oximeter probe, BP cuff and ECG leads).
- Monitoring vital observations and record keeping – on monitoring record sheet.
- Announce time to the anaesthetist every 2 minutes from time zero (0).
- Announce at any time when O₂ Saturations fall below 90% and its duration.

**Theatre staff 2 Role**

On triggering, both the nurses would immediately come into the intubating area and help.

- Gets the difficult airway trolley / other equipment
- Fast bleeps 2nd anaesthetist and surgical colleague
- Help ODP in getting equipment or any other help as requested including setting up high pressure hose

**Surgical colleague Role**

- Offers to help check IV access and draw up drugs
- States if able to perform a surgical airway and offer help with getting crico-thyroidotomy equipment ready
- Communication if required

**Second anaesthetist Role**

**Offers help to 1st anaesthetist (or takes over)**

Suggest if appropriate and not previously considered:

- Have WE attempted 2 operator mask ventilation?
- Have WE attempted a LMA insertion?
- Do WE need to now attempt a needle crico-thyroidotomy?

Gets crico-thyroidotomy kit and jet equipment ready and announces that "a needle cricothyroid kit is available".

**Appendix 3**

**SMART Course Teaching Objectives**
Concept of Structured Management Airway Response Team

Awareness and understanding of Human Factors

Reinforce Technical skills learning of DAS Airway Guidelines

Integrate NTS with TECHS

Use of NTS techniques in routine clinical practice

**Theory module (interactive teaching)**

Introduction and background to Human Factors

Human limitations and fallibility, Human cognition,

Types of errors including cognitive errors

Rule violations and cognitive aspects

Impact of stress, fatigue

Team working and cooperation

Leadership and management

Cognitive skills:

Situation awareness

Decision-making – Cognition of Decision Making, Pitfalls, strategies to improve decision making

Concepts of (SMART) Briefing and minibriefs and debriefing

**Practical Module (In teams):** TECHS (Technical skills DAS Intubation guidelines skills) and integration with Learned NTS. Reinforcing theory learning and practice in

- (SMART) Briefing and minibriefs - practice
- Simulation scenarios:

Team scenario with ‘observing team’ marking ‘behaviours’ followed by facilitated debriefing

---

**Appendix 4**

Non-technical skills scoring system (NOTECHS)

<table>
<thead>
<tr>
<th>Skill Category</th>
<th>Comments</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Effective</td>
<td>Ineffective</td>
</tr>
<tr>
<td></td>
<td>Behaviour</td>
<td>Behaviours</td>
</tr>
<tr>
<td>Task management</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Motivates and involves Team in two-way process</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plans shared agreed and updated for the team</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prioritises and shares tasks &amp; roles effectively</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balances authority and assertiveness appropriately</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Teamworking</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Creates Environment that encourages input from all</td>
<td></td>
</tr>
<tr>
<td>Encourages and guides all team members</td>
<td></td>
</tr>
<tr>
<td>Two-way communication flow occurs</td>
<td></td>
</tr>
<tr>
<td>Objective and adult conflict resolution</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Situation Awareness</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Notices relevant information regarding patient and procedure</td>
<td></td>
</tr>
<tr>
<td>Understands and shares relevance with team members</td>
<td></td>
</tr>
<tr>
<td>Updates team awareness at appropriate times</td>
<td></td>
</tr>
<tr>
<td>&quot;Foresees&quot; any potential developments and shares with colleagues</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Decision making</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Involves team in consideration of options</td>
<td></td>
</tr>
<tr>
<td>Communicates decision and reasons to entire team</td>
<td></td>
</tr>
<tr>
<td>Reviews new decision in an analytical way</td>
<td></td>
</tr>
<tr>
<td>Considers any revised implications for the team</td>
<td></td>
</tr>
</tbody>
</table>

Communication was applicable to all categories

**Declarations**

*The author has declared that there are no conflicts of interest.*

*This has been published under Creative Commons “CC BY 4.0” ([https://creativecommons.org/licenses/by-sa/4.0/](https://creativecommons.org/licenses/by-sa/4.0/))*

**Ethics Statement**

This research was not submitted for Ethics Board approval because it was quality evaluation project of a training course and participants completed the survey questionnaire on a voluntary basis. The project was assessed using the National Research Ethics Service decision making tool ([http://www.hra-decisiontools.org.uk/research/](http://www.hra-decisiontools.org.uk/research/)) and did not meet definition for research requiring research ethics committee approval.

**External Funding**

This article has not had any External Funding