Anaesthetists stress is induced by patient ASA grade and may impair non-technical skills during intubation

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Background: The aims of this study were to determine if patient ASA grade was associated with increased stress in anaesthetists with a subsequent effect on non-technical skills.

Methods: Stress was measured using a validated objective (heart rate variability or heart rate) and subjective tool. We studied eight consultant anaesthetists at baseline (rest) and during 16 episodes of intubation with an ASA 1 or 2 patient vs. an ASA 3 or 4 patient. The primary outcome for the study was objective and subjective stress between both patient groups. Secondary outcomes were non-technical skill ratings and the association between stress measurements.

Results: ASA 3 or 4 patients were associated with increases in objective stress when compared to baseline (mean 4.6 vs. 6.7; \( P = 0.004 \)). However, ASA 1 or 2 patients were not associated with increases in stress when compared to baseline (mean 4.6 vs. 4.7; \( P = 1 \)). There was no significant difference in subjective stress between the groups (\( P = 0.18 \)). Objective stress negatively affected situational awareness (\( P = 0.03 \)) and decision-making (\( P = 0.03 \)); however, these did not decline to a clinically significant threshold. Heart rate variability \((r = 0.60; \ P = 0.002)\) better correlated with subjective stress when compared to heart rate \((r = 0.30; \ P = 0.15)\). Agreement between raters for Anaesthetic Non-Technical Skills (ANTS) scores was acceptable (ICC = 0.51; \( P = 0.003 \)).

Conclusion: This study suggests that higher patient ASA grade can increase stress in anaesthetists, which may impair non-technical skills.

Editorial comment: what this article tells us
The ability to maintain high quality in their non-technical skills and performance in difficult circumstances is an asset for anaesthesiologists. This study shows that higher patient ASA physical status by itself can provoke a degree of stress and some degradation in non-technical performance in experienced practitioners.

Stress is a physiological and psychological response to external stimuli. A degree of stress can optimise performance although when this reaches a certain threshold, performance deteriorates.\(^1\) During the conduct of anaesthesia, there are many potential sources of mental stress. The majority of anaesthetists recognise that stress can negatively affect performance;\(^2\) while...
calmness under pressure is seen as a key quality of a model anaesthetist. However, there has been a paucity of research into stress in anaesthetists during routine clinical practice.

The American Society of Anesthesiologists (ASA) grade can be used to risk-stratify patients in the perioperative period, with higher ASA grades associated with increases in mortality. With an ageing population and a rise in co-morbid conditions, there is an increase in the proportion of patients of higher ASA grades undergoing surgery. More complex patients may induce more stress in the anaesthetist, which has possible implications for the specialty such as increases in cardiovascular disease, depression, burnout, substance abuse and suicide. Using heart rate, previous studies have demonstrated only minor manifestations of acute stress in anaesthetic practice. However, heart rate variability may offer a more sensitive marker of stress.

The effects of stress on clinical practice are diverse and may affect both technical and non-technical skills. Non-technical skills are a range of cognitive and social skills that do not include technical performance, which contribute to safe practice and task performance. The recognition of the importance of non-technical skills led to the development of the anaesthetist’s non-technical skills taxonomy (ANTS). Since its development, several studies have been published which utilise the ANTS score, however, these studies are often performed in simulation scenarios and therefore have limited validity when compared to routine clinical practice. Stress is known to affect non-technical skills, although no study has evaluated the direct effect of stress on non-technical skills in routine anaesthetic clinical practice.

The aims of our study were to observe if the physical status of the patient could influence the stress experienced by the anaesthetist during intubation. Secondly, to assess the influence of stress on anaesthetist’s non-technical skills. Finally, we aimed to compare heart rate and heart rate variability as measures of stress in anaesthetists. We hypothesised that higher ASA grades would increase stress in anaesthetists and this in turn would negatively affect non-technical skills.

### Methods

We gained ethical approval from the University of Nottingham Ethics Committee prior to study commencement. Written, informed consent was obtained from each participant and verbal consent was obtained from the patient. Inclusion criteria included anaesthetic consultants from one hospital within the UK. Exclusion criteria included the consumption of caffeine (any caffeinated drink or supplement on the day of data collection), concurrent use of cardiovascular medication or any rigorous physical activity prior to recordings (within 1 h). We observed consultant anaesthetists at our institution undertaking one episode of tracheal intubation with an ASA 1 or 2 patient and a further episode with an ASA 3 or 4 patient, as graded by the anaesthetist being studied. The primary outcome for the study was objective and subjective stress between both patient groups. Secondary outcomes were non-technical skill ratings and the association between stress measurements.

To measure objective stress, we used heart rate variability. Heart rate variability can be used to measure overall sympathetic tone and therefore act as an indirect measure of mental stress during procedures based on R-R variability from ECG recordings. We used the previously validated Polar RS800CX (Polar Electro 2011, Warwick, UK) heart rate monitor. The equipment included a lightweight heart rate monitor, which contains electrodes and is worn by the anaesthetist across the chest. In addition, a remote watch was worn by the researcher, to which the monitor transmits its data. Both items of equipment are minimally invasive and based on previous experience do not interfere with clinical activities. Data can then be analysed offline using computer software (Polar ProTrainer Version 5 Polar Electro, Warwick, UK).

We used frequency domain analysis using fast Fourier transformation to calculate power spectral density. This calculates three distinct components for heart rate variability, very low frequency (< 0.04 Hz), low frequency (LF) (0.04–0.15 Hz) and high frequency (HF) (0.15–0.4 Hz). As LF components are thought to reflect sympathetic nervous activity and HF parasympathetic activity, the LF/HF ratio can be used as a sensitive measure of overall sympa-
thetic activity and therefore increased mental stress. Normal values of LF/HF ratios of 1.5–2 have been suggested. Heart rate variability and heart rate recordings were collected on each participant at rest (baseline) on the same working day and then during tracheal intubation in both groups of patients.

We concurrently measured subjective stress. We used the short version of the State Trait Anxiety Inventory (STAI), a valid and reliable tool, which has been used in previous clinical studies measuring stress in healthcare professionals. Scores range from 6 (lowest) to 24 (highest). A combined objective and subjective approach to measuring stress has been recommended previously. STAI was administered both at rest on the same working day (baseline) and as soon as possible (within 2 min) after tracheal intubation in both groups of patients.

In order to measure the effect of stress on non-technical skills, we selected those procedures that were objectively stressful (increased the LF/HF ratio) and analysed these as low stress vs. high stress procedures. We used the anaesthetist non-technical skills score (ANTS), a previously validated and reliable tool. We presented scores at the category level and included half marks to convert the score to a seven-point Likert scale as described previously. If behaviours were not observed, these were regarded as missing values for data analysis. Training to use the tool included attending a 1-day training course at the Royal College of Anaesthetists and dissemination of course materials including the handbook.

Two raters (members of the research team unknown to the participants) assessed non-technical skills independently and blinded to the other raters score. These scores were used in the calculation of agreement statistics. Following the procedure, non-technical skills were discussed and if scores were different, agreement was reached by consensus and used for the final scores. Raters used data sheets to make notes of observed non-technical skills during intubation, which were used for later discussion. This method was chosen due to the logistical difficulties in video recording patient episodes. When recording non-technical skills, raters were blinded to the stress status of the participant. We regarded median ANTS scores < 3 as clinically significant, as this is the level at which performance is a cause for concern.

Sample size calculations determined a sample size of 8 (with 16 recordings) to detect a mean difference in the LF/HF ratio of 2 between the groups with a standard deviation of 1.5 using an \( \alpha = 0.05, 1-\beta = 0.85 \) and a correlation coefficient of 0.5. Descriptive data are presented as mean ± standard deviation, median [interquartile range] or number (percentage) as appropriate. Objective stress was analysed using repeated measures ANOVA with Bonferroni correction for multiple comparisons and Greenhouse–Geisser adjustment for non-sphericity. Subjective stress was analysed using Friedman’s ANOVA. ANTS category scores were analysed with Wilcoxon signed-rank test. Patient baseline characteristics were analysed using the independent samples t-test, Mann–Whitney U-test or Fisher’s exact test. We tested the association between stress variables using Spearman’s rank correlation coefficient. Inter-rater reliability for the ANTS scores were analysed using the intraclass correlation coefficient (ICC). All analyses were conducted on SPSS V21. We regarded results \( P \leq 0.05 \) as statistically significant.

Results

We recruited eight consultant anaesthetists and observed 16 episodes of tracheal intubation. All participants used direct laryngoscopy. One participant was excluded due to use of a videolaryngoscope and participated again at a later date. There were six male and two female participants with a mean age of 42 ± 4.7. The mean years of total anaesthetic experience was 14 ± 5.6. Excluding ASA grade, there were no statistically significant differences between the patients in ASA group 1 or 2 as compared to patients in ASA group 3 or 4 (Table 1). There was a significant correlation between LF/HF ratio and STAI (\( r = 0.60; P = 0.002 \)) (Fig. 1). However, there was no significant correlation between heart rate and STAI (\( r = 0.30; P = 0.15 \)) or heart rate and LF/HF ratio (\( r = 0.31; P = 0.15 \)).

There was a significant increase in objective stress between the baseline, ASA 1 or 2 and ASA 3 or 4 groups (mean LF/HF ratio 4.6, 4.7 and 6.7 respectively; \( P = 0.03 \)) (Fig. 2).
intergroup comparisons, a significant increase occurred in the ASA 3 or 4 group when compared to baseline \((P = 0.004)\). However, ASA 1 or 2 patients were not associated with significant increases in stress when compared to base-

| Table 1 Baseline characteristics of both groups of patients. | ASA 1 or 2 \((n = 8)\) | ASA 3 or 4 \((n = 8)\) |
|---|---|---|
| Patient age | 56 [48.75–58.75] | 57 [55.25–77.5] |
| Patient sex (F) | 4 (50%) | 5 (63%) |
| ASA grade | 2 [1.25–2] | 3 |
| Duration of intubation (seconds) | 21.5 [14.75–26.25] | 21 [15–50.75] |
| Mallampati grade | 1.5 [1–2.75] | 2 [2–2.75] |
| Cormack-Lehane grade | 1.5 [1–2] | 1.5 [1–2.38] |
| Bougie used | 1 (13%) | 1 (13%) |
| Frequency working with ODP | Not at all: 0 (0%) | Not at all: 0 (0%) |
| | On a few occasions: 3 (37.5%) | On a few occasions: 4 (50%) |
| | Monthly: 2 (25%) | Monthly: 2 (25%) |
| | Daily to weekly: 3 (37.5%) | Daily to weekly: 2 (25%) |

Mallampati and Cormack-Lehane grade as assessed by the anaesthetist studied. Values are median [interquartile range] or number (percentage). ODP, operating department practitioner: a non-medically qualified practitioner in the UK who assists the anaesthetist during intubation.

line \((P = 1)\). Although subjective stress was higher in the ASA 3 or 4 group, there was no statistically significant difference when compared to baseline and ASA 1 or 2 patients \((P = 0.03)\). Significant increases in the LF/HF ratio between baseline and ASA 3 or 4 patients \((P = 0.004)\). The central line indicates median, box and whiskers indicates interquartile and total range.

In terms of non-technical skills, the inter-rater reliability for the two raters on the ANTS score at the category level was acceptable \((ICC = 0.51; 95\%\ CI 0.19–0.70; P = 0.003)\). When analysing the effect of stress on non-technical skills, 14 episodes of tracheal intubation were analysed, as one reading was not associated with an increase in the LF/HF ratio. An increase in objective stress was associated with lower scores for situational awareness and decision-making (Table 2). However, these did not decline to a clinically significant level.

### Discussion

Our results suggest that only ASA 3 or 4 patients are associated with increases in objective stress in anaesthetists during tracheal intubation. In addition, increases in stress are associated with lower scores for situational awareness and decision-making, although this did not decline to a clinically significant threshold. Furthermore, analysis of objective
and subjective stress measurements suggests that heart rate variability is a more sensitive tool to detect stress than heart rate.

There has been little research conducted evaluating acute stress in the anaesthetist around the perioperative period. Our findings demonstrate an association between patient ASA grade and increases in stress. The most recent study that evaluated acute stress in anaesthetists found only a small, clinically insignificant increase in heart rate in anaesthetists.10 Similar to our results, the ASA grade of the patient was positively correlated with increases in heart rate ($r = 0.43; P = 0.04$).

In addition, our study found an association between increases in stress and impairment of situational awareness and decision-making. A similar study design to ours has been utilised in simulation scenarios exposing participants to both low stress and high stress environments.14 Although the high stress scenario induced increases in cortisol and STAI scores, the reduction in ANTS score during the high stress environment was not statistically significant ($P = 0.13$). This contrasts with our findings, which may be related to the environment in which the research was conducted. Indeed, literature from previous studies indicate that stress can negatively affect both situational awareness24 and decision-making.14,25–27

Finally, we demonstrated that only heart rate variability was significantly correlated with subjective stress when compared to heart rate. Many previous clinical studies measuring stress have been conducted, most within a surgical cohort, an example being the Imperial Stress Assessment Tool (ISAT).22 However, this tool utilises heart rate as a continuous objective measure. Previous research has suggested heart rate may lack sensitivity when compared to heart rate variability.11 Our results are in agreement with this and therefore the LF/HF ratio may be a more sensitive tool to use in future clinical research studies.

There are several limitations with this study. Firstly, the relatively small sample size limits conclusions. In addition, our sample included only experienced anaesthetists, which may have limited applicability to trainee anaesthetists. We also encountered significant logistical difficulties while attempting to study participants in clinical practice such as identifying appropriate theatre lists, cancellations of cases and concerns from participants over disruptions to clinical practice, which may limit future studies in this area. Also, the association between ASA grade and stress may be prone to confounding variables such as differences in patient monitoring, additional procedures required and the expected complexity of the surgery. As we were only able to study routine clinical practice, it is unclear whether crisis situations will have a more clinically significant effect on non-technical skills. Logistically, these are difficult to capture in clinical practice due their rarity and are perhaps

and subjective stress measurements suggests that heart rate variability is a more sensitive tool to detect stress than heart rate.
more appropriately studied in simulation scenarios.\textsuperscript{18}

Finally, with regard to the ANTS score, the level of training for our raters was limited and this score has not been previously validated in the clinical arena. However, our inter-rater reliability values were acceptable and similar to values published previously.\textsuperscript{14,17,23} In addition, there was still disagreement within some elements of ANTS scores, with some behaviours being missed by one of the raters, which were only resolved later on discussion. This may especially be the case for cognitive processes such as situational awareness and decision-making.

Despite the limitations of this study, we believe we can make some recommendations for future studies and clinical practice. Firstly, future studies measuring stress in anaesthetists should use both subjective and objective measures of stress, with heart rate variability being a more sensitive measure than heart rate. Secondly, video recording patient episodes could be utilised in order to resolve the difficulties in observing real-time non-technical skills. Ultimately, larger studies in a wider sample of anaesthetists are required, evaluating the effects of stress on non-technical skills.

In conclusion, only ASA 3 or 4 patients were associated with significant increases in objective stress levels in consultant anaesthetists during intubation. In addition, heart rate variability appears a more sensitive tool to assess objective stress when compared to heart rate. Moreover, increases in stress resulted in statistically, but not clinically significant decreases in situational awareness and decision-making. This is to the best of our knowledge, the first study to assess the influence of stress on non-technical skills in routine anaesthetic practice.

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