The duration of procedural sedation and the incidence of hypoxaemic events

A retrospective cohort study

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Editor,

Procedural sedation is used for complex procedures lasting from several minutes to many hours. Longer procedure duration is associated with increased risks of adverse (respiratory) events such as perprocedural oxygen desaturation and post-procedural pneumonia.¹⁻⁴ Whether this is the result of a constant incidence rate combined with a longer time-at-risk, where procedural sedation-induced airway compromise and reduced adequacy of spontaneous ventilation may be the primary cause of desaturation (a constant-risk hypothesis), or due to a change in the incidence rate of respiratory adverse events over time caused by pathophysiological processes such as sputum retention and atelectasis (a changing-risk-hypothesis) is unknown. If evidence can be found that supports the changing-risk-hypothesis, this may aid in making an informed decision about the safety of procedural sedation when longer procedure times are expected and duration should arguably be limited to reduce the patient’s risk of hypoxaemic events. We studied the incidence rate of oxygen desaturation during procedural sedation and its relationship with the duration in a large cohort of patients undergoing procedural sedation.

We performed a retrospective analysis of 2937 procedures performed under procedural sedation (depth of sedation Observer’s Assessment of Alertness and Sedation score: 3 to 2) using target-controlled infusions of propofol and remifentanil in the University Medical Center Groningen, The Netherlands. All procedures were carried out by Sedation Practitioners: anaesthetic nurses with an extra year of specialised training in procedural sedation, who worked under indirect supervision of an anaesthesiologist who supervised up to four Sedation Practitioners.²

The current retrospective cohort study does not fall under the scope of the Dutch Medical Research Involving Human Subjects Act. The medical ethical committee waived the need for informed consent (9 March 2020 METCnumber 202000069).

Data were extracted from automated digital patient records. Hypoxaemic events were defined as SpO₂ less than 90% for at least 1 min and were identified using scripts written in R (R Foundation for Statistical Computing, Vienna, Austria; URL: http://www.R-project.org). Artefacts were eliminated by visual inspection of SpO₂ measurement plots and comparison with recorded clinical notes or user interventions. Procedures were divided into 5-min time epochs from the start of sedation. For procedures lasting less than 4 h we analysed all data. Only 84 procedures lasted more than 4 h, and for these we only analysed the data from the first 4 h, to avoid weakening the statistical power.

The incidence rate of hypoxaemic events (IrHE) per time epoch was determined as (number of procedures with hypoxaemic events during a time epoch)/(number of procedures still ongoing during this time epoch). We used a generalised estimation equation (GEE) model (IBM SPSS Statistics, Version 23.0.0.3; IBM, Armonk, New York, USA) to investigate the association between time and IrHE with patient age, ASA physical status (ASA PS), BMI and sex as covariates. P values less than 0.01 were considered to be statistically significant.

A total of 2937 patient records from procedures were available for analysis from cardiac [n = 392 (14.4%)], pulmonary [n = 1080 (39.7%)], radiological [n = 81 (3.0%)] and gastroenterological [n = 1169 (42.9%)] procedures performed in patients of ASA PS 1 (4.5%), 2 (61.2%), 3 (33.7%) and 4 (0.6%) between 1 May 2014 and 1 November 2017. Mean procedure duration was 73 ± 51 [range 10 to 399] min. 1190 (44%) procedures lasted longer than 1 h, 388 (14%) lasted longer than 2 h. 215 procedures were excluded because of missing or artefactual data. During 610 (22.4%) procedures one or more hypoxaemic events occurred. The IrHE peaked to 5.77% (99% CI: 4.62 to 6.93) between 15 and 20 min. After this peak the IrHE reduced to 0.76% (99% CI: 0.02 to 1.49%) at 75 min. A second peak (mainly attributable to the IrHE during cardiac procedures) occurred at 165 min (2.78% (99% CI: 0.0 to 5.66%)). (Fig. 1) The 99% CI for the difference of IrHE between the nadir (75 min) and this second peak was —0.2 to 4.28%. The incidence rate showed a negative trend over time.

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In the GEE-model we found a weak, negative association between the time to the hypoxaemic event and IrHE (i.e. as time progressed the IrHE decreased). Other significant factors were patient age ($P=0.002$) and BMI ($P<0.001$) (Table 1). Sub-analyses of different age groups (18 to 39; 40 or 64 and 65+) and ASA PS-groups did not alter these results significantly: time to hypoxaemic event remained negatively and significantly associated with the IrHE.

We conducted this study to investigate whether earlier findings of a relationship between procedure time and desaturation risk were due to a prolonged time-at-risk (constant-risk-hypothesis) or whether the risk actually changes (i.e. increases) over time (changing-risk-hypothesis). To our surprise we observed that the IrHE neither remained constant nor increased over time. Instead we observed a significant, though limited negative effect of procedure time on the IrHE.

Our study as some limitations. First, its retrospective nature prevents us from extending the analyses into the post-procedural period as these data are not available. Second, the sedation regimen used (target-controlled infusions propofol-remifentanil) may influence the results: use of sedative drugs with different (slower) pharmacokinetic and pharmacodynamic profiles may have an impact on the described relationship.

For the constant-risk hypothesis procedural sedation-induced airway compromise and reduced adequacy of spontaneous ventilation may be the primary cause of oxygen desaturation over time. For the changing-risk hypothesis pathophysiological processes during procedural sedation, such as sputum retention and atelectasis may conceivably worsen as procedure time increases, causing the incidence rate of oxygen desaturation to increase over time. The results from the current study do not support the changing-risk hypothesis and suggest that the role of those pathophysiological processes is limited at best.

Higher BMI was positively associated with an increased IrHE. High BMI has previously been linked to increased risk of respiratory adverse events and it is generally recognised as a risk factor for complications during and after procedural sedation.\textsuperscript{2,5–7}

In conclusion, our findings indicate that the risk of hypoxaemic events per unit of time during procedural sedation does not increase as time progresses. Limiting procedure time of procedural sedation will benefit patient safety but not because the incidence rate of hypoxaemic events increases over time.

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\textbf{References}

Assessment of inter-rater agreement of the American Society of Anesthesiologists physical status classification system in a women’s tertiary hospital

An observational study

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Editor,

Studies suggest that the American Society of Anesthesiologists (ASA) classification system lacks inter-rater agreement, and may be influenced by patient case-mix and rater expertise. Consistent ASA classification is important for the accurate prediction and communication of perioperative risks. With the establishment of outpatient pre-anesthesia evaluation, disagreement in ASA classification between preprocedural and day-of-surgery anaesthesiologists cancelling surgery for further medical optimisation. As part of a larger study to design a clinical decision support system for automated ASA classification, we sought to measure inter-rater agreement in ASA scores assigned by anaesthesia providers to cases commonly encountered in a Singapore tertiary women’s hospital. We also examined the relationship between ASA agreement and clinical experience.

Ethical approval for this study (2017/3002) was provided by the SingHealth Centralised Institutional Review Board D of the Singapore Health Services Private Limited, Singapore (Chairperson Dr Steve Yang) on 10 January 2019. After written informed consent, current anaesthesia providers of the department (comprising two anaesthesia nurse practitioners, 14 residents, six resident physicians and 15 consultants) accessed a web-based questionnaire from 2 January to 28 February 2021 to provide ASA ratings for eight hypothetical cases. The cases were built on the ASA classification system and approved examples and the correct ASA score for each case was determined by consensus among expert members of the study team. Respondents were advised to refrain from accessing the ASA guidelines while taking the survey. Data related to job grade and clinical experience was also collected. Data were analysed using IBM SPSS Statistics for Windows (IBM Corp., Armonk, New York, USA). Median [IQR] ASA scores were calculated for each case example. Agreement in ASA scores were further analysed by grade and clinical experience using the χ² test or Fisher’s exact test when appropriate, with the level of significance set at 0.05. Agreement between rater versus reference score was measured by calculating the percentage agreement and Cohen’s kappa using the quadratic weights (Kq). Inter-rater agreement between multiple raters was measured using the Fleiss kappa. We adopted the method of Landis and Koch for interpretation of Kappa values. The 95% confidence intervals and SD were calculated for the Kq and percentage agreement.

We received 100% response, with no missing data. Table 1 shows the job grade and clinical experience among respondents. The distribution of ASA scores and median [IQR] for each case example is presented in Table 2. Except for cases 3 and 8, the correct ASA score garnered the highest proportion of respondents. Case 3 describes haemorrhagic shock in a Jehovah’s witness parturient scheduled for emergency operative delivery and case 8 relates to a breast cancer patient with a myocardial infarct 2 months earlier, and a current ejection fraction of 40%. The classification of

Table 1 Demographic characteristics of anaesthesia providers

<table>
<thead>
<tr>
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<th>n = 37</th>
</tr>
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<tbody>
<tr>
<td>Sex</td>
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</tr>
<tr>
<td>Female</td>
<td>20 (54.1)</td>
</tr>
<tr>
<td>Male</td>
<td>17 (45.9)</td>
</tr>
<tr>
<td>Job grade</td>
<td></td>
</tr>
<tr>
<td>Consultants</td>
<td>15 (43.2)</td>
</tr>
<tr>
<td>Nonconsultants</td>
<td>22 (56.8)</td>
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<tr>
<td>Years of anaesthesia experience</td>
<td></td>
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<tr>
<td>&lt;5</td>
<td>9 (24.3)</td>
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<tr>
<td>≥5</td>
<td>28 (75.7)</td>
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Data are n (%).

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