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EDITORIAL

The Surgical Outcome Risk Tool: Where Are We 10 Years on?

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Introduction

In 2011, the "Knowing the Risk" (KTR) report was published by the National Confidential Enquiry into Patient Outcome and Death (NCEPOD), reviewing perioperative care and the associated mortality risk of patients undergoing inpatient surgery in the United Kingdom (UK) (Findlay et al, 2011). Anaesthetists prospectively completed forms by hand during surgical procedures performed during a one-week period in March 2010. 19,097 forms were returned from 326 National Health Service (NHS) and independent hospitals. A key recommendation was for a UK-wide system that would allow rapid and easy identification of patients who were at high risk of postoperative mortality and morbidity. The Surgical Outcome Risk Tool (SORT) was developed to meet this need.

The formula for the SORT was outlined in the British Journal of Surgery (Protopapa et al, 2014). The free SORT app with offline capability and web-based tool followed in 2015/6, which launched the SORT as an easy-to-use preoperative risk prediction tool for death within 30 days of surgery for adult inpatients undergoing non-cardiac, non-neurological surgery. At the time of publication, the data from the SORT led to it being heralded as the largest analysis of risk prediction tools in a UK cohort of patients undergoing inpatient surgery in multiple surgical specialties. The publication has reached a milestone of over 300 citations.

Limitations in mortality risk calculators used at the time included not displaying a percentage mortality risk, having too few or too many variables, and not all variables being available prior to surgery. These were addressed in the SORT, and as with all mortality risk tools, we highlighted that it should not be used as a standalone tool but rather in conjunction with clinician judgement and as part of the overall clinical toolkit. Potential uses included the mortality risk calculation being used to aid identification of patients requiring Enhanced Perioperative Care and thus capacity planning, and to form part of the shared decision-making process between healthcare professionals (HCPs) and patients. The results of a survey in 2015 of over 500 participants in the UK indicated that the SORT web-based tool was mostly starting to be used in preoperative assessment clinics, high-risk clinics,

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and the emergency and surgery departments. The SORT app was developed in 2016 and has been incorporated in the suite of clinical resources in many UK hospitals.

The High-Risk Patient: The Status Quo

Clinicians have generally continued to use the same mortality risk tools in the UK. More recently, the National Emergency Laparotomy Audit (NELA) risk tool provides an estimate of mortality following emergency abdominal surgery (Eugene et al, 2023). In an editorial and systematic review, the credibility of SORT as a preoperative risk prediction tool was maintained: independent reviewers found that it demonstrated the best predictive performance of all available options, in combination with high usability in a clinical setting and has been externally validated on multiple occasions, thus strengthening its appeal (Lee and Moonesinghe, 2023; Vernooij et al, 2023; Wong et al, 2020). The use of SORT has been suggested for preoperative risk assessment in guidance from a collaborative of Royal Colleges and the Centre for Perioperative Care and Getting it Right First Time (GIRFT) preassessment guidelines (Centre for Perioperative Care, 2021; McCone, 2023).

Similar to an earlier report in 2011 from the Royal College of Surgeons, the definition of a high-risk patient remains a predicted hospital mortality risk of $\geq$5% (Lees et al, 2018). Patients who have a mortality risk of 1% or more might benefit from Enhanced Perioperative Care (Level 1), and those with a mortality risk $>$5%, Critical Care (Level 2 or 3). Since the SORT was published in 2014, surgical risk factors, including the surgical urgency of a surgical procedure (e.g., immediate) as defined by NCEPOD with input from specialist societies, and surgical severity (e.g., major), are broadly similar today. However, changes in the latter would be expected over time with advances in surgical techniques, increased experience of the surgeon, such as with metabolic and bariatric surgery, endovascular procedures and robotic surgery, and decreased morbidity risk following advances in pharmacotherapy.

High-Risk Comorbidities

In the KTR study, data were collected on comorbidities which the Steering Group considered to be indicative of a high-risk patient in 2010: arrhythmia, cancer, documented cirrhosis, congestive cardiac failure, current smoker, diabetes (insulin), diabetes (non-insulin), ischaemic heart disease, respiratory disease, and having a prior Transient Ischaemic Attack (TIA)/stroke. From this, cancer (active malignancy within the past five years) was a significant independent risk factor in the regression analyses of the SORT, together with the American Society of Anesthesiologists (ASA) Physical Status classification system (ASA-PS) (Saklad, 1941), surgical urgency, thoracic, gastrointestinal or vascular surgery, and the patient's age. The surgical procedure name links to the surgical severity. Wong et al (2020) included additional comorbidities in their demographic descriptives: coronary artery disease, dementia, renal disease, and specifically chronic obstructive pulmonary disease (COPD) and pulmonary fibrosis rather than the more general respiratory disease.

Is It Time to Re-Evaluate the Comorbidity and Other Criteria for a High-Risk Patient?

This begs the question of whether it might be timely to review the factors that impact a patient's surgical risk. Although advanced age is likely to remain an independent surgical risk factor, there are older, fit, and healthy adults who run marathons. It seems likely that frailty is important when assessing risk (Panayi et al, 2019). Frailty data were not available when the SORT was devised, but there might be a benefit in evaluating future use in a mortality risk tool (Becerra-Bolaños et al, 2024; Parmar et al, 2021). The age categories used in SORT were $<$65, 65–79, and $\geq$80, and there might be some value in re-evaluating these to further discriminate between risk in the upper age groups.

Obesity is another health condition to which HCPs have needed to be attuned over the last 10 years. It is increasingly recognised as a chronic disease, is amongst the leading risk factors for type 2 diabetes and is likely to remain a challenge for many individuals exposed to the obesogenic environment and food poverty. The SORT factors this in to some extent by incorporating the ASA-PS, as they classified body mass index (BMI) $>$30 as ASA 2 and BMI $>$40 as ASA 3. However, it might be challenging to determine whether extremes of BMI were independent perioperative mortality risk factors for inclusion in a risk prediction tool. For example, although BMI has been used as a surrogate marker of obesity, alternative anthropometric measurements are preferable indicators of obesity, excess adiposity, and distribution of adiposity (Rubino et al, 2025). Furthermore, BMI data for surgical patients are not always available in the UK, as evident in the KTR data from which the SORT was derived, and Wong et al (2020) study ten years later.

Anaemia, significant chronic kidney disease and functional capacity could also be considered (Mathew et al, 2008; Shander et al, 2023; Takahashi et al, 2025). However, although presurgical management of obesity and other risk factors might be desirable where practicable, incorporating them into a risk prediction tool such as SORT might diminish the usability of the tool. Measurements might not always be available preoperatively, nor practical to obtain. Furthermore, it is important to be cognisant of any potential negative bias that might arise during the risk decision-making process, with unintended consequences of widening healthcare inequalities. For example, if ethnicity, socioeconomic status/deprivation and what is termed "severe obesity" were included in a risk tool. It might be preferable to adopt a pragmatic approach by incorporating them in the overall clinical assessment, where relevant. Therefore, if a further version of SORT was to be produced, frailty might be a variable that would be practicable to include if it were found to be an independent predictor of outcome, together with analyses to further discriminate between risk in the upper age groups.

Conclusion

The SORT has far exceeded the expectations we set ten years ago. It has been widely adopted by HCPs in the UK, potentially aiding capacity planning for Enhanced Perioperative Care beds and forming part of shared decision-making. Fu-

ture external validation and recalibration of the tool would be beneficial to keep pace with the mortality risk attached to surgical and patient-related factors, as well as being mindful of advancements in technology and pharmacotherapy. The digitalisation of healthcare systems offers an opportunity to automate and increase the use of risk scoring tools to support shared decision-making during preoperative assessment. Using machine learning to improve and guide risk assessments looks promising, although we should be mindful of limitations and that further testing is required. It would be prudent in any such work to maintain a combined approach by incorporating human/clinician judgement, as is already the case with SORT.

Key Points

- The Surgical Outcome Risk Tool (SORT) was developed in 2014 and contains six variables which are available preoperatively to estimate a percentage risk of death within 30 days of surgery for adult inpatients undergoing non-cardiac, non-neurological surgery.
- A free app with offline capability and a web-based tool followed in 2015/6.
- SORT remains a simple quantitative risk assessment tool that can be used in conjunction with clinical judgement to facilitate patient-centred preoperative assessment and shared decision-making.
- The SORT was originally internally validated and has since been externally validated on multiple occasions.
- Future external validation and recalibration of SORT would be beneficial to keep pace with the morbidity and mortality risk attached to surgical and patient-related factors as well as advancements in technology and pharmacotherapy.

Availability of Data and Materials

Not applicable.

Author Contributions

KP, JS and SRM designed the work. KP contributed to the first draft and subsequent redrafting of the manuscript. All authors contributed to important editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

Not applicable.

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Conflict of Interest

KP is an employee at NCEPOD. JS is an employee of East Suffolk and North Essex NHS Foundation Trust. SRM is National Clinical Director for Perioperative and Critical Care and National Director of Patient Safety at NHS England. All authors declare no conflict of interest.

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