Prospective validation of the Urgent Surgery Elderly Mortality risk score (USEM)

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ARTICLE INFO

ABSTRACT

Introduction: We aimed to test the predictive ability and to compare the predictive ability of the USEM to SRS, SORT and ASA in a prospective sample.
Patients and methods: A Prospective cohort of >65-year-old patients undergoing urgent abdominal surgery in a Hospital. Models calibration and discrimination were evaluated using the receiver operating characteristics curves and the Hosmer-Lemeshow test.
Results: A total of 500 patients with a median age of 78 years were included. The AUROC in the validation cohort was 0.824. The USEM overestimated mortality (Test Hosmer-Lemeshow p < 0.001), after recalibration the USEM provided an accurate prediction of postoperative mortality.
Conclusions: After the recalibration, the USEM had good discriminant power to estimate the risk of mortality in elderly patients after urgent abdominal surgery.

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Introduction

The elderly population is rapidly increasing more than half of urgent surgery in the United States is performed in elderly patients.[1,2] Advanced age increases the risk of mortality and morbidity after urgent surgery, due to the decrease in physiological reserve and associated comorbidities.[3]

Several urgent mortality prediction models have been developed. They can be used in both urgent and elective surgery, but are not designed for elderly patients nor urgent abdominal surgery. From a retrospective study we designed a mortality scoring tool to predict mortality in elderly patients undergoing urgent abdominal surgery, called the Urgent Surgery Elderly Mortality risk score (the USEM).[4] This scoring tool comprising five variables was developed and validated internally to predict 30-days mortality in elderly

patients. The speed and easiness of collecting variables are important features to be considered in choosing the USEM for routine use. The USEM could be used in conjunction with clinical judgment to aid in decision-making and to facilitate informed consent in elderly patients undergoing urgent abdominal surgery.

We aimed to validate externally the USEM in a prospective sample. Therefore, we compare the predictive ability of the USEM against other scoring tools validated previously: the ASA, Surgical Risk Scale (SRS)[5] and Surgical Outcome Risk Score (SORT).[6]

Patients and methods

The study comprised a prospective database, including elderly patients who underwent urgent abdominal surgery in the period 2017—2019 at the Complejo Hospitalario de Navarra, Spain. Patients and surgical interventions related data were retrieved prospectively from the hospital's electronic medical records. All patients without a complete register of risk factors were excluded. The hospital Institutional Review Board approved the study. All study participants provided informed consent.

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<table>
<tr><td colspan="2">Acronyms</td></tr>
<tr><td>ASA</td><td>American Society of Anaesthesiologists</td></tr>
<tr><td>AUROC</td><td>Area under the ROC curve</td></tr>
<tr><td>BUPA</td><td>British United Provident Association</td></tr>
<tr><td>CEPOD</td><td>Confidential Enquiry into Perioperative Deaths</td></tr>
<tr><td>CI</td><td>Confidence interval</td></tr>
<tr><td>SORT</td><td>Surgical Outcome Risk Tool</td></tr>
<tr><td>SRS</td><td>Surgical Risk Scale</td></tr>
<tr><td>USEM</td><td>Urgent Surgery Elderly Mortality risk score</td></tr>
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We identified the variables included in the USEM: age, ASA score, diagnosis, surgical wound classification, open or laparoscopic surgery (as described in the surgical record) and 30-day mortality. We also registered the items included in the SRS and SORT scores. The SRS is a mortality predictor model that includes the surgical severity scoring (British United Provident Association (BUPA) category), ASA grade and the Confidential Enquiry into Perioperative Deaths (CEPOD) grade. The SORT is a risk stratification tool comprised of six preoperative variables: ASA grade, urgency of surgery (expected, urgent, immediate), high-risk surgical specialty (gastrointestinal, thoracic, vascular), surgical severity (from minor to complex major), cancer and age 65 years or over. It is used to predict 30-day mortality after non-cardiac surgery in adults.

The model's discrimination was evaluated using the area under the receiver operator characteristics curve. The model's calibration was evaluated by the calibration curve and the Hosmer- Lemeshow test. The AUROC had a value between 0.5 and 1, where 0.5 is equivalent to guessing, and 1.0 indicates perfect predictive accuracy. Previous work has described and AUROC of less than 0.7 to indicate poor performance, 0.7–0.9 to indicate moderate performance, and over 0.9 to indicate high performance.[7] AUROC comparisons were made using the DeLong test. The Hosmer-Lemeshow test compares observed and predicted event rates across a range of predicted risk. A non-significant test result indicates that a model is well calibrated.

We applied the SRS, SORT and ASA in our sample and tested the predictive ability by the AUROC and calibration plots. Then, we compare the AUROC and calibration plots of the USEM to the SRS, SORT and ASA. All statistical analyses were performed using SPSS v22.0.0.

Results

From January 2017 to January 2019, we registered 500 patients >65 years old undergoing urgent abdominal surgery in a tertiary hospital. We excluded 125 patients, with acute abdominal pain that had received non-surgical treatment. Demographic variables are summarized in Table 1. The mean age was 78.8 years old (range 65–102 years old), the median was 78. Amongst them, 245 were ASA III (49%). A total of 344 (66.8%) procedures were open procedures, and 166 (33%) were laparoscopic procedures.

The overall mortality was 58 (11.6%)

Analysis of the ROC curves indicated that the four analyzed scores showed moderate-to-good discrimination ability (Fig. 1). USEM score showed the best performance, with an area under the curve of 0.82 (0.77–0.87), compared to 0.77 (0.70–0.83) for the SORT, 0.74 (0.67–0.80) for the ASA and 0.70 (0.63–0.78) for the SRS.

SRS score showed the best calibration, with predicted mortality (11.3%) very similar to the observed one (11.0%), as shown in Fig. 2. This good calibration was shown across all risk quantiles (Fig. 2). The SORT and the USEM scores presented poor goodness of fit, p-values of the Hosmer-Lemeshow test were below 0.001 in both cases. SORT underestimated the mortality risk, with a predicted mortality risk of 5.1% and USEM overestimated it, with a predicted value of 18.4%.

Calibration is known to be strongly influenced by the incidence of the outcome in the validation population. To reduce this source of miscalibration, we modify the slope of the curve.[8] After recalibration, SORT and USEM improved the calibration plots (Fig. 3), there was a good agreement between predicted and observed risks for both models, although the risk was slightly overestimated in the USEM model in patients with a high risk of mortality.

Discussion

In the present study, we assessed the predictive performance of urgent prediction models in elderly patients undergoing urgent abdominal surgery. We validate three different scores in a prospective study including elderly patients after urgent abdominal Surgery. We demonstrated that the USEM has a good discriminant ability and after recalibration, it also has a good agreement between predicted and observed risks.

The strengths of this study are the inclusion of elderly patients in urgent abdominal surgery, and to validate three prediction models (ASA, SRS and SORT) in patients > 65 years old in a specific type of surgery, the gastrointestinal surgery. There are many

Table 1
Patient demographics (n = 500).

Age	
Mean	78.8 years old (Range 65–102 years old)
Gender	
Female	223 (44.6%)
Male	277 (55%)
ASA	
ASA I	7 (1.4%)
ASA II	156 (31.2%)
ASA III	245 (49%)
ASA IV	79 (15.8%)
ASA V	1 (0.2%)
Surgical wound classification	
Clean/Clean-contaminated	242 (48.4%)
Contaminated	82 (16.4%)
Dirty or infected	175 (35%)
Surgical procedure	
Open surgery	344 (66.8%)
Laparoscopic procedure	166 (33%)
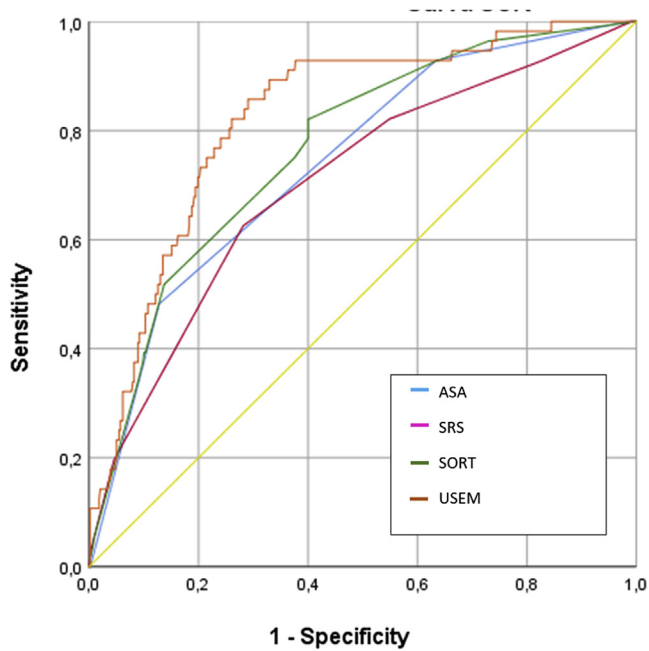
Fig. 1. Characteristic curves for the prediction of mortality by USEM, ASA, SRS and SORT.

Fig. 2. Calibration plots. Observed versus predicted mortality at varying levels of risk.
A- USEM calibration plot
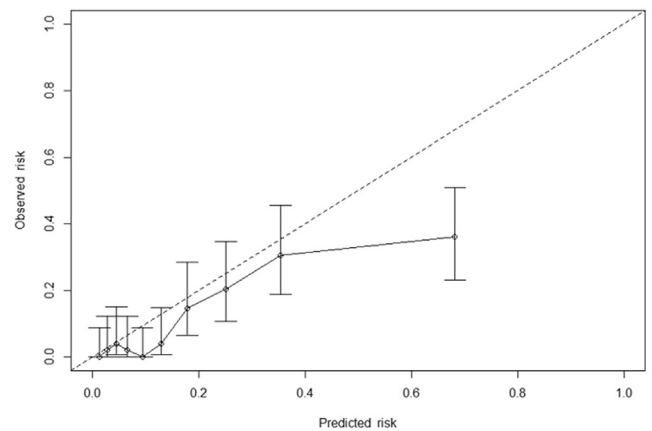B- SRS calibration plot
C- SORT calibration plot.

prediction models but there currently exists no mortality risk prediction tool specifically for high-risk, often in extremis elderly patients undergoing urgent abdominal surgery.

Nevertheless, some limitations need to be addressed. First of all, this is a single-center study and is the same center in which we developed the USEM. Second, the USEM captures data only up to postoperative day 30, whereas the 3 or 6 months endpoint outcome of these elderly patients remains unknown.[9] Thirdly, if we were evaluating mortality in an elderly patient it would be necessary to take into account some characteristics unique to the geriatric population: functional status and frailty. We are working on a prospective study that includes frailty and functional status. In the last years, studies in various surgical populations have identified frailty as an independent risk factor for mortality. The question of the best clinical tool for assessment of frailty remains unanswered, the majority of available tools have not been designed to be applied in a clinical context: Fried scale, Rockwood, Frailty score from the Canadian Study of Health and Ageing (CSHA).

A recent systematic review summarizes recent literature in the most common risk-assessment in surgery to predict mortality in elderly patients.[10] They include a large number of different tools; they included some frailty risk assessment: the CSHA Clinical Frailty Scale (CFS) and the Edmonton Frail Scale (EFS). They evaluated the AUROC to predict mortality of the CFS was 0.71 (moderate performance) in cardiac surgery, and the AUROC for the EFS was 0.69 (poor performance). This frailty risk assessment was validated in elderly patients, not in urgent abdominal surgery and had a poor predictive ability compare with the USEM.

Recently, Ahmed et al., demonstrated that the 5-item modified frailty index was valid and easy to use to predict mortality in colorectal surgery, the AUROC for the model was 0.889.[11] It has not been validated in urgent abdominal surgery, so we still need to test frailty risk assessment in urgent abdominal surgery to use them as predictive mortality tools.
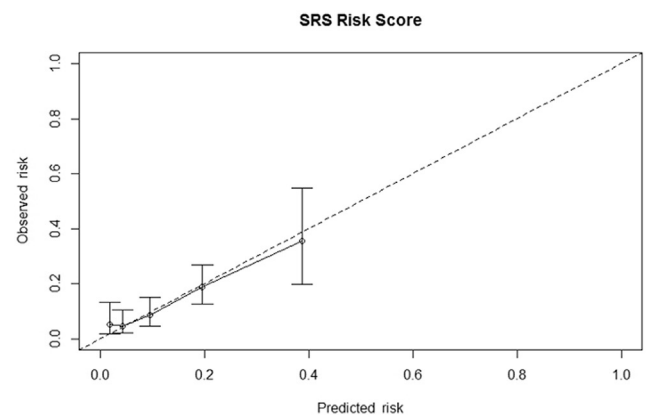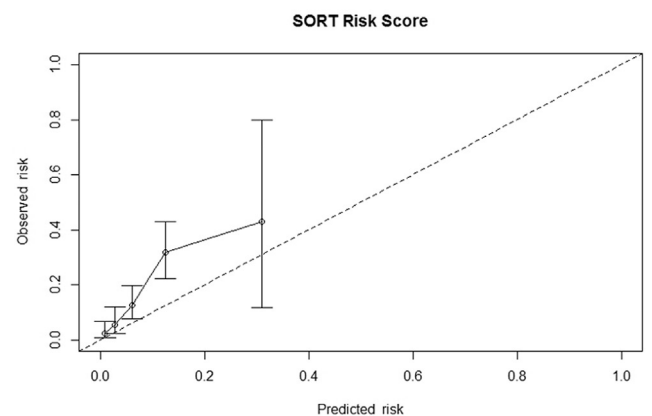
We demonstrate that the USEM score could be used in conjunction with clinical judgment to aid in decision-making and facilitate informed consent in elderly patients undergoing urgent abdominal surgery. No doubt revealing information about the
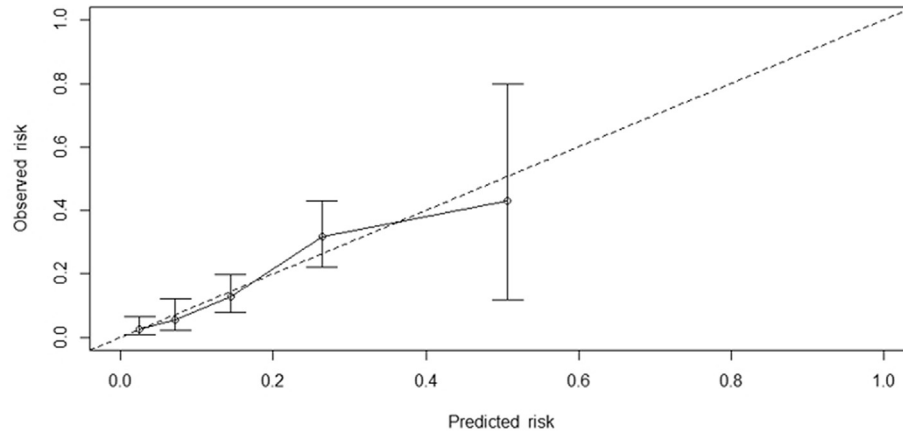
A-USEM
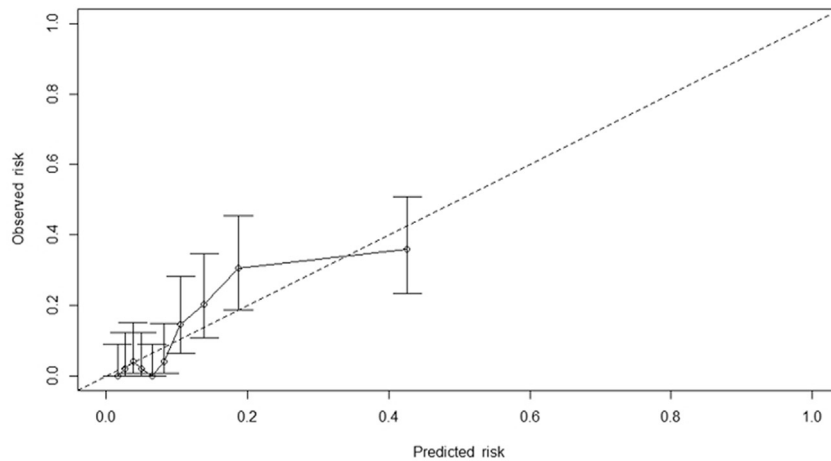
B-SORT

Fig. 3. Calibration plots after recalibration of the USEM and SORT
A: USEM calibration plot
B: SORT calibration plot.

probability of death at 30 days postoperative, can potentially avoid futile surgical interventions at the end of life when used appropriately in preoperative discussions.[12]

Conclusions

The USEM is a preoperative scoring tool, comprising five variables, created to be used in elderly patients in urgent abdominal surgery. The USEM is simple to calculate and provides the surgeon with a new tool to calculate the probability of mortality in elderly patients after urgent abdominal surgery. We demonstrate the predictive value of the USEM in a prospective sample. After the recalibration, the USEM had good discriminant power to improve the certainty of mortality in elderly patients after urgent abdominal surgery.

Declaration of competing interest

There were no sources of funding or conflict of interest for this article.

References

1. Torrance ADW, Powell SL, Griffiths EA. Emergency surgery in the elderly: challenges and solutions. *Open Access Emerg Med OAEM*. 2015;7:55–68.
2. Partridge JSL, Harari D, Dhesi JK. Frailty in the older surgical patient: a review. *Age Ageing*. 2012 Mar;41(2):142–147.
3. Gazala S, Tul Y, Wagg A, Widder SL, Khadaroo RG. Acute Care and Emergency Surgery (ACES) Group. Quality of life and long-term outcomes of octo- and nonagenarians following acute care surgery: a cross sectional study. *World J Emerg Surg WJES*. 2013 Jul 1;8(1):23.
4. Eguaras Córdoba I, Herrera Cabezón J, Sánchez Acedo P, Galbete Jiménez A, Guillén Grima F. The Urgent Surgery Elderly Mortality risk score: a simple mortality score. *Rev Espanola Enfermedades Dig Organo Of Soc Espanola Patol Dig*. 2019 Jul 18:111.
5. Sutton R, Bann S, Brooks M, Sarin S. The Surgical Risk Scale as an improved tool for risk-adjusted analysis in comparative surgical audit. *Br J Surg*. 2002 Jun;89(6):763–768.
6. Protopapa KL, Simpson JC, Smith NCE, Moonesinghe SR. Development and validation of the surgical outcome risk tool (SORT). *Br J Surg*. 2014 Dec;101(13): 1774–1783.
7. Moonesinghe SR, Mythen MG, Das P, Rowan KM, Grocott MPW. Risk stratification tools for predicting morbidity and mortality in adult patients undergoing major surgery: qualitative systematic review. *Anesthesiology*. 2013 Oct;119(4):959–981.
8. van der Leeuw J, van Dieren S, Beulens JWJ, et al. The validation of cardiovascular risk scores for patients with type 2 diabetes mellitus. *Heart Br Card Soc*. 2015 Feb;101(3):222–229.

9. Cardona M, Lewis ET, Kristensen MR, et al. Predictive validity of the CriSTAL tool for short-term mortality in older people presenting at Emergency Departments: a prospective study. *Eur Geriatr Med*. 2018;9(6):891—901.
10. Eamer G, Al-Amoodi MJH, Holroyd-Leduc J, Rolfson DB, Warkentin LM, Khadaroo RG. Review of risk assessment tools to predict morbidity and mortality in elderly surgical patients. *Am J Surg*. 2018 Sep;216(3):585—594.
11. Al-Khamis A, Warner C, Park J, et al. Modified frailty index predicts early outcomes after colorectal surgery: an ACS-NSQIP study. *Colorectal Dis Off J Assoc Coloproctol G B Irel*. 2019 Oct;21(10):1192—1205.
12. Cardona M, Lewis ET, Turner RM, et al. Efficacy of a tool to predict short-term mortality in older people presenting at emergency departments: protocol for a multi-centre cohort study. *Arch Gerontol Geriatr*. 2018 Jun;76:169—174.