The Efficacy of the NSQIP Surgical Risk Calculator in Head and Neck Surgery

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Introduction

- Preoperative surgical risk stratification is critical in head and neck surgery, where malignancy, significant patient comorbidities, and complex reconstructions suggest significant perioperative and postoperative risk.
- One publicly available tool is the American College of Surgeons National Surgery Quality Improvement Program's (ACS NSQIP) Surgical Risk Calculator (SRC), which uses a Current Procedural Terminology (CPT) code and 21 preoperative factors to predict a patient's risk for each of 13 postoperative complications.[1]
- The SRC is validated broadly for use in surgery, including otolaryngology.[2]
- While data from over 1.4 million operations were used in the development of the SRC, only 2% of these were otolaryngologic procedures.[3]
- This project is the first meta-analysis to pool data from multiple cohort studies to better assess the efficacy of the SRC in head and neck oncologic surgery.
- The authors hypothesized that the SRC would not show adequate predictive value in this field given the unique pathophysiology and treatment risks for head and neck cancer.

Results

[Table 1] Description of Studies Meeting the Inclusion Criteria

First Author	Year Published	Study Design	LOE	Operations	All patients underwent free flap transfer	Location of Hospital System	Number of Patients
Arce	2016	R-COH	4	Head and neck reconstruction with fibula free flap transfer	Yes	USA	153
Kao	2018	R-COH	4	Glossectomy	No	Australia	120
Ma	2019	R-COH	4	Head and neck reconstruction using free flap transfer	Yes	USA	561
Prasad	2016	R-COH	4	Laryngectomy or head and neck free flap transfer	No	USA	98
Schneider	2016	R-COH	4	Laryngectomy	No	USA	49
Subramaniam	2017	R-COH	4	Thyroidectomy, parotidectomy, radical oral cavity resection, total laryngectomy, skull base resection, maxillectomy	No	India	150
Tierney	2020	R-COH	4	ALT flap, FFF, and RFFF reconstructions	Yes	USA	336
Vosler	2018	R-COH	4	Thyroidectomy, laryngectomy, hemiglossectomy, glossectomy, laryngopharyngectomy, composite resection	No	Canada	107
Yung	2022	R-COH	4	Microvascular head and neck reconstruction using free flap transfer	Yes	Australia	200

Abbreviations: R-COH, retrospective cohort study; LOE, level of evidence; ALT, anterolateral thigh; FFF, fibular free flap; RFFF, radial forearm free flap.

[Table 2] Comparison of Pool Size, Predicted and Observed Complication Rates, AUCs, Brier Scores, and Interstudy Heterogeneity (I²) for Each Outcome

Complication	Studies Included	Total Patients	Predicted	Observed	Number of Studies Reporting AUC	Pooled AUC	Number of Patients Included in Brier Score Calculation	Pooled Brier Score	I^2
Mortality	3	821	1.55%	0.37%	--	--	739	0.215	--
Any Complication	5	1171	21.78%	35.87%	4	0.560 [0.478,0.642]	988	0.144	78.2% [41.3,91.9]
Serious Complication	4	1021	17%	28.7%	3	0.568 [0.527,0.609]	988	0.167	1.9% [1,3.13]
Unplanned Reoperation	8	1654	11.18%	16.87%	5	0.523 [0.512,0.533]	1569	0.104	0.0% [0,79.2]
SSI	6	1211	5.5%	11.64%	4	0.597 [0.494,0.700]	1233	0.098	82.8% [56%,93.3%]
Pneumonia	9	1774	3.05%	4.9%	4	.778 [0.612,0.945]	1569	0.031	83.4% [57.8,93.5]
Cardiac Complication	6	1307	1.34%	2.75%	2	.603 [0.452,0.753]	1075	0.023	--
VTE	7	1454	1.6%	3.65%	2	0.544 [0.452,0.639]	1320	0.032	--
UTI	5	1171	1.64%	2.5%	2	0.782 [0.672,0.893]	988	0.015	--
Discharge to nursing facility	4	1204	11.95%	19.35%	3	0.682 [0.634,0.730]	1324	0.148	16.8% [0%,91.3%]

AUC threshold for acceptability >0.7, threshold for excellence >0.8; Brier score threshold for accuracy <0.01

Abbreviations: SRC, surgical risk calculator; AUC, area under the curve; SSI, surgical site infection; VTE, venous thromboembolism; UTI, urinary tract infection.

[Table 3] Subgroup Analysis

Complication	Free Flap Subgroup	Non-Free Flap Subgroup
Mortality	0.204	0.006*
Any Complication	0.130	0.174
Serious Complication	0.152	0.186
Unplanned Reoperation	0.091	0.085
SSI	0.083	0.088
Pneumonia	0.026	0.055
Cardiac Complication	0.012	0.031
VTE	0.035	0.018
UTI	0.012	0.027
Discharging to Nursing Facility	0.157	0.145

Brier score meets the <0.01 threshold for strong predictive ability

Comparison of Brier scores between patients undergoing head and neck surgery with free flap reconstruction ("free flap subgroup") and those undergoing head and neck surgery without free flap reconstruction ("non-free flap subgroup").

Methods

- A systematic review of 5 online databases (PubMed, SCOPUS, EMBASE, COCHRANE, Google Scholar) was conducted using the PRISMA method.
- Studies comparing the SRC's predictions to observed outcomes following head and neck oncologic surgeries were included.
- Pooled AUCs were calculated for each post-operative complication using a DerSimonian-Laird random effects model.[4]
- Pooled Brier scores were calculated as a weighted sum of Brier scores from individual studies.
- A subgroup analysis was performed in which Brier scores were calculated separately for the cohorts of patients undergoing free flap and non-free flap surgeries.
- AUC values ≥0.7 were predefined to be "acceptable" while AUCs ≥0.8 were "excellent." A Brier score of ≤0.01 was predefined to describe an accurate model based on previously published literature.[5]

Discussion

- This analysis found the SRC underpredicts the risks of all postoperative complications except mortality, with no "excellent" AUCs and no complication reaching the Brier score threshold for predictive accuracy.
- These findings suggest the NSQIP SRC is not appropriate for use in head and neck surgery. Possible explanations include:
  - The SRC was developed for general surgery and retains features less relevant to otolaryngology such as AKI, bacteremia, and emergent presentation. Meanwhile, features such as tumor stage, prior radiation, free flap reconstruction, and operative time are not included, despite evidence these increase the risk of pre-operative complications.[6]
  - Tracheostomy placement or dependence is not assessed.
  - While head and neck surgeries may impact multiple physiologic pathways (respiration, phonation, deglutination, etc.), the SRC allows for only a single CPT code.
- Although prior studies suggest the SRC may be specifically inaccurate for free flap reconstructions,[7-8] our subgroup analysis found elevated Brier scores suggesting poor accuracy for both free flap and non-free flap surgeries.
- Many of the limitations to the SRC described above apply to head and neck patients who do not undergo free flap reconstruction, and our findings do not suggest the SRC can be effectively applied to this subgroup.

Limitations

- There was significant interstudy heterogeneity, reflected by high I² values. However, 7 of the 9 studies concurred with our pooled result. In addition, the high degree of variation may itself be reason to avoid relying on the SRC, as results may be inconsistent between institutions and procedures.
- A second limitation is the lack of a strong alternative to the SRC. Despite its flaws the SRC remains an easily accessible tool for quantifying risk, and some physicians may feel a model with a degree of error still provides some value. However, the SRC is not only imprecise but consistently underestimates risk, and therefore even qualified use may misrepresent the serious risks associated with head and neck surgery.
- A head and neck specific risk stratification tool that includes important field-specific features such as TNM staging and adjuvant therapies may better characterize and communicate the risks that patients face.

Conclusion

- Despite prior literature validating the NSQIP SRC for use in broad surgical populations, this meta-analysis found the SRC consistently underrepresents risks for postoperative head and neck patients.
- These inconsistencies are seen for surgeries with and without free flap reconstructions.
- Our findings do not support the use of the SRC in this field, and further research is needed to validate an alternative model.

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