In conclusion, it is apparent that Dr. Gupta fails to clearly distinguish the drastically different risks of pulmonary aspiration in two distinct clinical settings: patients after partial *versus* total laryngectomy and similarly in patients with pharyngocutaneous *versus* tracheoesophageal fistulas.

We greatly appreciate the opportunity to respond to this letter.

Competing Interests

The authors declare no competing interests.

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DOI: 10.1097/ALN.0000000000003032

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(Accepted for publication October 3, 2019.)

Improving Pediatric Risk Stratification: Comment

To the Editor:

It was with great interest that we read your recent article, "Pediatric Risk Stratification Is Improved by Integrating Both Patient Comorbidities and Intrinsic Surgical Risk,"[1] as this model could be useful in prognostication of negative outcomes after surgery, quality improvement, and risk adjustment. This methodologically rigorous analysis empirically derived procedural risk groupings, and added these groupings into a predictive model for 30-day postoperative mortality after common pediatric surgical procedures utilizing The American College of Surgeons National Surgical Quality Improvement Program Pediatric Surgical Risk Calculator dataset. The model also contained five patient variables (American Society of Anesthesiologists Physical Status, weight less than 5 kg, sepsis, preoperative mechanical ventilation, and preoperative vasopressors) to adjust for patient comorbidity. The inclusion of procedural risk groupings improved model discrimination significantly, and groupings were said to represent the "intrinsic surgical risk" of the procedures analyzed.

However, the procedural groupings presented in the appendix aggregate dissimilar procedures into the same risk category, and also separate similar surgical procedures with disparate indications into different risk categories. For example:

- Surgeries to repair craniosynostosis and spinal fusion, which involve large fluid shifts, transfusion of blood products—and in the case of craniosynostosis surgery, a craniotomy—are grouped in the lowest risk category together with digit reconstruction, repair of syndactyly, upper endoscopy, and bilateral myringotomy tubes.
- Tracheostomy is in the highest risk category, while tracheoplasty and pharyngoplasty, procedures that involve similar surgical and anesthetic risks, are in the lowest risk category.
- Burr hole is grouped in the highest risk category, while craniotomy for tumor resection, which is more likely to involve blood loss and fluid shifts, is categorized as high-middle risk.
- Laparoscopic ileostomy, jejunostomy, and colectomy are grouped with the lowest risk procedures, while appendectomy is categorized as low-medium risk; laparoscopic colectomy for congenital megacolon or cecostomy, proctectomy, or small intestine resection are categorized as high-medium risk.
- Pancreatectomy is in the highest category risk. Ventriculoperitoneal shunt and peritoneal dialysis catheter, which typically incur much shorter operative times and do not commonly involve major blood loss or fluid shifts, are also in this highest risk category.

Is it possible that these procedural groupings reflect not only "intrinsic surgical risk" but also insufficiently adjusted-for patient risk factors and surgical circumstances? For instance, laparoscopic appendectomy may incur higher mortality risk than laparoscopic ileostomy because of unadjusted-for acute illness (*i.e.*, the patient is acutely ill, but not septic or on vasopressors), and insufficient time for surgical optimization. Do burr hole, ventriculoperitoneal shunt, and peritoneal dialysis catheter placement confer higher risk of death than a craniotomy because they are more likely to be performed under emergent circumstances such as acutely elevated intracranial pressure, need for intrathecal chemotherapy, or urgent need for dialysis, which the model does not adjust for? Is it possible that surgery for craniosynostosis and spinal fusion, or tracheoplasty and pharyngoplasty, fall into the lowest risk category because most patients present for these elective procedures fully optimized, and are therefore at low risk of death despite the high likelihood of major blood loss and fluid shifts (in the case of craniosynostosis surgery and spinal fusion), or airway loss (in the case of tracheoplasty or pharyngoplasty)?

While sample size and event rate limitations likely limited the authors' ability to adjust for additional patient risk factors (and indeed, in any model it is impossible to do so completely), we have concerns that the identified procedural risk groupings reflect *patient risk factors* and *surgical circumstances* in addition to—and in some cases more so than—*intrinsic surgical risk,* which may limit its utility for risk adjustment in other settings. Given the constraints of the data we have currently,

would it be better to think of intrinsic surgical risk as a function of surgical duration, operative site, and the likelihood of major fluid shifts rather than as empirically derived groupings that are likely to reflect unadjusted-for confounding?

Competing Interests

The authors declare no competing interests.

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DOI: 10.1097/ALN.0000000000003034

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(Accepted for publication October 3, 2019.)

Improving Pediatric Risk Stratification: Reply

In Reply:

Dr. Brown *et al.* have made important comments and raised good questions about the definition of intrinsic surgical risk and categorization of the different surgical procedures. We would like to take the opportunity to answer the questions and clarify intrinsic surgical risk stratification.

This study is an initial step toward risk stratification in patients under noncardiac surgeries, focusing on mortality.[1] We would like to emphasize that the intrinsic surgical risk is the risk of 30-day mortality. It does not reflect the risk of morbidity including blood loss, possible postoperative mechanical ventilation, or unanticipated escalation of care and intensive care unit admission. For example, while patients undergoing craniosynostosis surgery may be considered at high risk for morbidity, the risk of mortality is low to nonexistent. In fact, a recent multicenter study by the pediatric craniofacial collaborative group reported a 15% complication rate.[2] Despite this relatively high complication rate, there was no in-hospital mortality for patients undergoing cranial vault reconstruction surgery. This supports our categorization of craniosynostosis surgery as a procedure with a low intrinsic surgical risk of mortality.

The authors also raise a concern regarding the broad grouping of different procedures into the same risk category and the separation of similar procedures. When surgical procedures are identified by specialty, the relationship between mortality and a specific procedure is not possible. In fact, a recent study in adults examining intrinsic surgical risk of cardiac adverse events after surgery classified surgeries into three categories independent of anatomical location or surgical specialty.[3] As an example, the study demonstrated wide variation in the intrinsic risk of individual procedures included under thoracic surgery as a specialty with a median odds ratio of cardiac risk of 1.40 and an interquartile range 0.88 to 2.17. This wide variation justifies the categorization of individual procedures based on individual common procedural terminology codes rather than anatomic location or surgical specialty.

The authors raised the question as to whether the risk quartiles are reflective of the emergent circumstances of the procedure. Intrinsic to some procedures, such as burr hole and laparoscopic appendectomy, are their emergent nature. The intrinsic surgical risk includes characteristics that are intrinsic to the need for a particular surgical procedure obviating the need for further adjustment. Nonetheless, to address the authors' query, we calculated the odds ratios of the risk quartiles adjusting for case type (emergency or elective) using the 2012 to 2016 Pediatric databases of the American College of Surgeons National Surgical Quality Improvement Program, which was used to develop our model. Compared to risk quartile 2, risk quartile 3 has an adjusted odds ratio of 4.72 (95% CI, 3.14 to 7.10; $P < 0.001$), and risk quartile 4 has an adjusted odds ratio of 7.98 (95% CI, 5.27 to 12.07; $P < 0.001$). Independent of case type being an elective or emergency procedure, the intrinsic surgical risk quartiles continue to hold and are significantly associated with an increased risk of 30-day mortality.

Competing Interests

The authors declare no competing interests.

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DOI: 10.1097/ALN.0000000000003035

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(Accepted for publication October 3, 2019.)