lowest heart rate, and lowest mean arterial pressure, using "instantaneous" measures, or the true lowest heart rate and lowest mean arterial pressure in the record. These "instantaneous" values for the SAS are the least useful option for predicting outcomes when compared with alternatives such as moving median values over 5- and 10-min windows.[3] In essence, the choice of instantaneous values biases the assessment to no benefit of the SAS.

Second, would the authors consider adding a calculation of risk reclassification to better test the clinical utility of the SAS? The authors reported the c-statistic and Brier score to evaluate the utility of the SAS. Although statistically robust, neither of these measures provides clinical insight. Moreover, the c-statistic is known to change minimally even when important improvements are made with risk prediction.[4] For this reason, the use of a reclassification measure may be applied to provide a more clinically meaningful assessment of change in risk prediction.[5] Reclassification approaches can be problematic, but the concept of categorizing patients into high- and low-risk groups is clinically intuitive and actionable, because we treat high-risk patients differently such as with admission to the intensive care unit.

The potential for real-time risk revision is not known, and with these suggestions, the authors may be able to more robustly test its potential.

Competing Interests

Although the author is a current awardee of the Anesthesia Patient Safety Foundation and Anesthesia Quality Institute, this letter was written on separate time. "No Funding Received" is the most accurate description of the funding details. The author receives no funding from industry or honoraria and has no conflicts of interest to disclose.

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In Reply:

We thank Dr. Hyder for his interest in our recent article published in Anesthesiology, "Preoperative Surgical Risk Predictions Are Not Meaningfully Improved by Including the Surgical Apgar Score: An Analysis of the Risk Quantification Index and Present-On-Admission Risk Models."[1]

As suggested by Dr. Hyder, we performed additional analyses using an alternative sampling interval for vital signs and added a calculation of risk reclassification to better test the clinical utility of the Surgical Apgar Score (SAS) when combined with preoperative risk stratification models.

A sampling method for slowest heart rate (HR) and lowest mean arterial pressure (MAP) was established before initiating data analyses. The method was based on "windows" or intervals of data and was established as follows: 10-min nonoverlapping windows, with windows beginning at the time of incision (0 to 10 min, 11 to 20 min, 21 to 30 min, *etc.*). Within each window, a median value was determined. Median values for HR and MAP were the basis for the original SAS investigations, and median values were chosen for this investigation. Estimated blood loss as recorded by the in-room anesthesia provider was calculated for the entire case.[2]

We also added a calculation of risk reclassification to better test the clinical utility of the SAS. The use of a reclassification measure may be applied to provide a more clinically meaningful assessment of change in risk prediction. A concept of categorizing patients into high- and low-risk groups is clinically intuitive and actionable, as we treat high-risk patients differently, such as with admission to the intensive care unit. Traditionally, risk prediction models have been evaluated using the area under the receiver operating characteristic curve, along with model calibration, Brier score, information criteria, *etc.*, but this can be an insensitive measure for model comparison in a healthcare setting, providing little direct clinical relevance. Since its description in 2006, much interest has been generated in reclassification, which assesses the ability of new models to more accurately classify individuals into higher or lower risk strata. This has led to new methods of evaluating and comparing risk prediction models, including the reclassification calibration test and the net reclassification index (NRI). Pencina *et al.*[3] developed the NRI and the integrated discrimination improvement (fig. 1).

After performing analyses using alternative sampling for vital signs and calculating risk reclassification, the Risk Quantification Index and present-on-admission preoperative risk models were not meaningfully improved by adding intraoperative risk using the SAS, as determined by the NRI value of 0.02 ($P = 0.10$). These analyses supported the original findings: adding the SAS did not substantively improve predictions. In addition to the estimated blood loss, lowest HR, and lowest MAP, other dynamic clinical parameters from the patient's intraoperative course may need to be combined with procedural risk estimate models to improve risk stratification.

Cases(1)/Controls(0)= 1

	Established risk factors + new risk factors			
	1:<0.1	2:0.1-0.2	3:0.2-0.3	4:>=0.2
	N	N	N	N
Established risk factors				
1:<0.1	621	43	1	.
2:0.1-0.2	39	228	69	3
3:0.2-0.3	.	59	140	66
4:>=0.2	.	3	52	177

Cases(1)/Controls(0)= 0

	Established risk factors + new risk factors			
	1:<0.1	2:0.1-0.2	3:0.2-0.3	4:>=0.2
	N	N	N	N
Established risk factors				
1:<0.1	68147	363	2	.
2:0.1-0.2	417	1280	214	8
3:0.2-0.3	2	221	365	142
4:>=0.2	.	7	135	268

Fig. 1. Reclassification tables. If the larger model (which includes the Surgical Apgar Score) on average assigns a higher risk class to cases and a lower risk class to noncases than the small model (no Surgical Apgar Score), then net reclassification index is positive.

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Competing Interests

The authors declare no competing interests.

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Arterial Pressure and Cardiopulmonary Bypass

To the Editor:

I was pleased to see our work cited in the recent Review Article, "Cardiac Output and Cerebral Blood Flow: The Integrated Regulation of Brain Perfusion in Adult Humans."[1,2] Nevertheless, some conclusions made by the authors may have been misleading. They state that during cardiopulmonary bypass, alpha-stat management of carbon dioxide resulted in cerebral blood flow correlated with arterial blood pressure, whereas pH-stat management resulted in cerebral blood flow correlated with pump flow. Yet, clinical and laboratory evidence indicates that this explanation may be deficient. When Rogers *et al.*[3] directly addressed this issue in a study of cardiac patients randomly assigned to either alpha-stat or pH-stat management, both groups showed cerebral blood flow dependent on arterial blood pressure and not dependent on cardiopulmonary bypass flow rate. Furthermore, Hindman *et al.*[4] demonstrated that in pH-stat–managed rabbits, during constant-flow cardiopulmonary bypass, increases in arterial blood pressure resulted in large increases in cerebral blood flow. Meng *et al.*[2] also state that during cardiopulmonary bypass, organ perfusion is propelled by centrifugal pump. However, in several studies they cite, cardiopulmonary bypass was by roller pump.[5–7]

Competing Interests

The author declares no competing interests.

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