2021 43rd Annual International Conference of the
IEEE Engineering in Medicine & Biology Society (EMBC)
Oct 31 - Nov 4, 2021. Virtual Conference

Applying Machine Learning to Identify Pediatric Patients at Risk of Critical Perioperative Adverse Events: using the APRICOT Dataset

Geoffrey M. Gray, Hannah Lonsdale, Hannah M. Yates, Luis M. Ahumada, Mohamed A. Rehman, Anna Varughese, James Fackler, Walid Habre, Nicola Disma

***Abstract*— Perioperative adverse events are severe life threatening outcomes from anesthesia. We use the APRICOT dataset to build a machine learning model to identify patients at low risk for these events. Feature ranking also shows factors important to the model.**

***Clinical Relevance*— This produces a machine learning model for characterization of patients at low-risk of perioperative adverse events.**

I. Introduction

The APRICOT (Anesthesia PRactice In Children Observational Trial) study aimed to identify the incidence, nature, and outcome of perioperative adverse events (PAEs) in children undergoing anesthesia, and the associated potential risk factors, using traditional statistical methodology.[1] This was the most extensive study of PAEs and provided important insights into the risk factors.

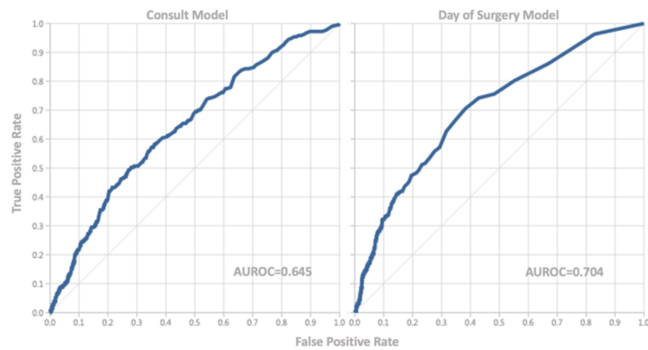
Despite this, integrating lessons learned from this study into clinical practice to assess anesthesia risk is lacking. Our study presents a machine learning precision medicine approach for individualized PAE risk prediction. Additionally, factors influencing risk are extracted from the model to provide better insight into the predictive factors identified as essential by the model.

II. Methods

The APRICOT dataset is a multicenter study comprised of 30 874 children undergoing 31 127 procedures. Two models were built to better integrate into the clinical workflow: one containing information available at booking and the other with information available at day of surgery. The booking model can be used to determine whether a procedure should be performed in a surgery center or an inpatient facility. The day of surgery model can be used to flag patients that need to be monitored more closely. A test-train split of 80:20 was used with 20% of the training set held out for validation. SMOTE was applied to each fold in the test set to increase the majority:minority ratio to 10:1.[2] Multiple machine learning models were tested, with a boosted decision tree chosen for the final model.[3] Missing data was imputed using multiple imputation applying chained equations (MICE).[4]

Results

Model performance metrics are shown in Fig. 1. Small improvements were seen in the Day of Surgery Model compared to the Booking model. Both models show a high negative predictive value, indicating suitability to flag low-risk patients for surgical centers.



Model	Predicted	True (Label)	False (Label)	PPV	NPV
Consult	True	15	141	9.6%	96.2%
	False	202	5127		
Surgical	True	23	128	15.2%	96.4%
	False	194	5140		

Figure 1. ROC curve and confusion matrix for the booking and day of surgery models.

Permutation feature analysis identified the highest contributing features to predicting PAEs.

III. Discussion & Conclusion

Results show that machine learning can serve as a useful tool to support clinical decision-making. Identification of individuals at risk for PAEs will allow providers to tailor approaches based upon individual patient risk. By building models for different stages of the clinical process, the clinical utility was maximized. Risk factors were identified from features important to the model to facilitate clinical use.

References

1. Habre W, Disma N, Virag K, et al. Incidence of severe critical events in paediatric anaesthesia (APRICOT): a prospective multicentre observational study in 261 hospitals in Europe. *Lancet Respiratory Medicine.* 2017;5(5):412-425.
2. Chawla NV, Bowyer KW, Hall LO, Kegelmeyer WP. SMOTE: Synthetic minority over-sampling technique. *Journal of Artificial Intelligence Research.* 2002;16:321-357.
3. Friedman JH. Greedy function approximation: A gradient boosting machine. *Annals of Statistics.* 2001;29(5):1189-1232.
4. White IR, Royston P, Wood AM. Multiple imputation using chained equations: Issues and guidance for practice. *Statistics in Medicine.* 2011;30(4):377-399.

*Research supported by Johns Hopkins All Children's Hospital.
Luis M. Ahumada is with the *Center for Pediatric Data Science and Analytics Methodology, Johns Hopkins All Children's Hospital, St. Petersburg, FL* 33701 USA, phone: 727-767-2349; e-mail: ahumada@jhmi.edu.