Creation of Arterial Blood Pressure Nomograms for Children Undergoing General Anesthesia – Results From a Pilot Feasibility Study

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Background: Intraoperative vital signs monitoring is an integral aspect of anesthetic care. Reference values for non-invasive blood pressure (BP) are available in healthy, non-anesthetized children [1], and in children undergoing inhalational anesthesia (IHA) [2]. However, BP reference values are not currently available for children undergoing total intravenous anesthesia (TIVA), a technique which is known to reduce some undesired side effects of anesthesia [3]. The aim of this study was to identify age-specific mean arterial BP reference values for children undergoing general anesthesia at BC Children's Hospital, and subsequently to compare BP between three different anesthetic regimes: a) TIVA, b) IHA, and c) mostly intravenous anesthesia (MIVA), allowing for an inhalational induction followed by intravenous maintenance of anesthesia.

Methods: With Research Ethics Board approval and waiver of informed consent, non-invasive BP data were extracted from a de-identified vital signs database. For this pilot evaluation, we included data from children <19 years undergoing anesthesia for procedures in the main operating rooms, excluding cardiac surgery, performed between Jan - Sep 2016; we will use Jan 2013 - Dec 2016 for the full cohort. Data artifacts were removed by excluding physiologically impossible values, a moving median filter was applied, and representative values were obtained by randomly sampling 20 BP values per case. The children's ages were obtained by probabilistic matching of cases against an export from the operating room booking system, and were divided into the following groups: <1 month, 1-3, 3-6, and 6-12 months, and continuing in one year increments up to 18 years of age. Anesthetic type was determined using minimum alveolar concentration (MAC) thresholds as follows: a) TIVA: cumulative MAC of 0, b) IHA: MAC ≥0.3 for >70% of case, c) MIVA: MAC >0.2 for first 20% of case and MAC of 0 for the remainder. Data were plotted using MATLAB and compared between anesthetic types using Wilcoxon rank-sum test for each age group (with Bonferroni correction for 3 comparisons).

Results: In this pilot cohort, data were available from 4,850 children, with median (interquartile range [IQR]) age of 6 (3-12) years. Of these, 3,913/4,850 (81%) cases had valid BP data and could be assigned to one anesthetic type: TIVA 2,334 [60%], IHA 847 [21%], and MIVA 732 [19%]. Figure 1 shows the BP nomograms generated. Mean BP values ranged from median (IQR) 46 (41-50) mmHg for TIVA, 44 (37-49) mmHg for IHA and 43 (34-44) mmHg for MIVA in newborns to 72 (64-80) mmHg for TIVA, 71 (64-82) mmHg for IHA and 74 (67-79) mmHg for MIVA in 18 year old's. Children in groups under 5 years of age had significantly higher BP with TIVA than patients with IHA (p<0.001), as did some of the older groups. Data from 25,949 children have been matched for the planned analysis of the full cohort.

Conclusions: Creating BP nomograms has been shown to be feasible with the data available in our databank. As expected, BP increases with age, but interestingly, younger patients with IHA had a lower BP than patients with TIVA. These data have the potential to guide the setting of alarm limits based on age and anesthetic type, and will support future investigations into the effects of anesthetic technique on BP. Results from the full analysis, with additional subgroup analyses are pending.

References: [1] Pediatrics. 2011;127(4):e978-88. [2] Anesthesiology. 2016;125(5):904-913. [3] Paediatr Anaesth. 2009;19(5):521-34.
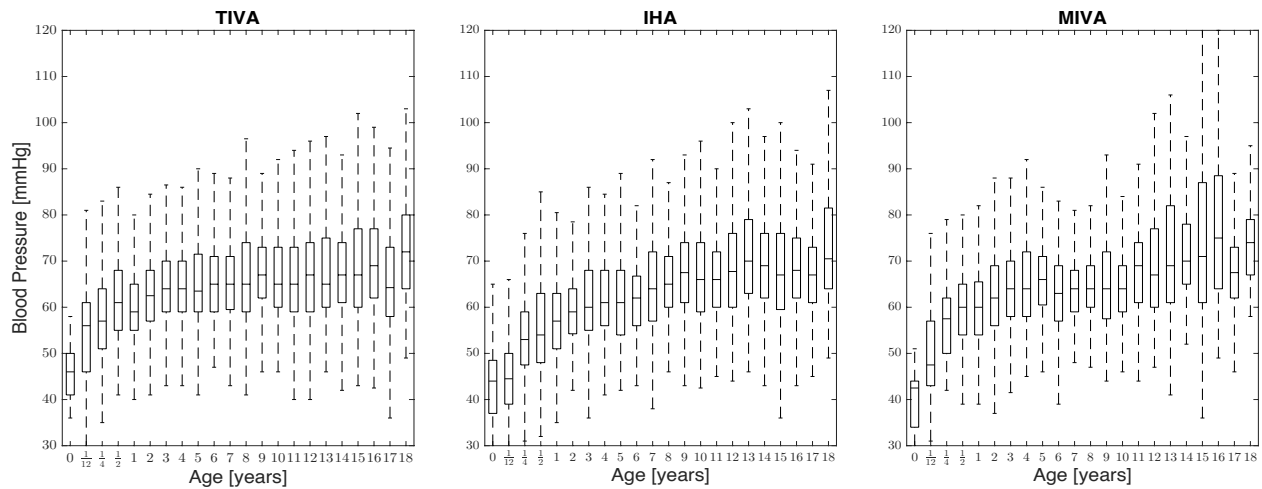

Figure 1: Nomograms for NIBP split by anesthetic type (left TIVA, middle IHA, right MIVA). Boxplot shows median and interquartile range (IQR); whiskers reach to last datum within 1.5 IQR.