

Non-Invasive Arterial Blood Pressure Nomograms for Children Undergoing Total Intravenous Anesthesia – Results from a Large Retrospective Cohort Study

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Background: Vital signs monitoring is an integral aspect of anesthetic care. Reference values for non-invasive blood pressure (NIBP) are available for healthy, non-anesthetized children [1], and for children undergoing inhalational anesthesia (IHA) [2]. However, there are currently no reference values for children undergoing total intravenous anesthesia (TIVA), a technique known to reduce some undesired side effects of general anesthesia [3]. This study aims to create age-specific NIBP reference values for children undergoing general anesthesia, and subsequently stratify NIBP values for three different anesthetic regimes: a) TIVA, b) IHA, and c) mostly intravenous anesthesia (MIVA), consisting of an inhalational induction followed by intravenous maintenance of anesthesia.

Methods: With Research Ethics Board approval and waiver of informed consent, NIBP data were extracted from a de-identified vital signs database: we used NIBP measurements from children <19 years undergoing general anesthesia for procedures in the main operating rooms performed between Jan 2013 - Dec 2016, excluding cardiac surgery and cases shorter than 13 minutes in duration. Data cleaning and sampling followed the methods established in our previous work (6-month pilot data) [4]: we randomly sampled 20 NIBP values per case. The phase of the anesthetic (induction or maintenance) was identified using operating room booking times for surgical procedure start. We defined anesthetic types based on these minimum alveolar concentration (MAC) thresholds: a) TIVA, cumulative MAC of 0; b) IHA, MAC ≥ 0.55 for >70% of case of the maintenance phase; c) MIVA, a maximum of MAC >2 in the induction phase and MAC <0.55 for the first 70% of the maintenance phase. Finally, we performed subgroup analyses based on the phase of the anesthetic and by patient's sex.

Results: Out of a potential 36,347 cases included in the operating room booking system, we were able to match 24,457 cases meeting our inclusion criteria, for which vital signs data were available. Of these, 20,613 (84%) cases had valid NIBP data and could be assigned to one anesthetic type: TIVA 11,819 [57%], IHA 4,752 [23%], and MIVA 4,042 [20%]. We observed that, in younger patients, the mean NIBP values were significantly higher when TIVA was used compared to IHA ($p < 0.001$); a difference in mean NIBP of 5 mmHg was observed for patients below one year of age (Figure 1). For the NIBP nomogram split by anesthetic phase (Figure 2) and the NIBP nomogram split by sex (Figure 3), the differences were clinically insignificant between groups.

Conclusions: The results from the full dataset support the findings of our pilot study [4]. We believe that these data are now sufficiently representative to guide the selection of alarm limits based on age and anesthetic type, and to motivate further prospective studies into the effects of different anesthesia regimes on vital signs, and ultimately outcomes, in children.

References: [1] *Pediatrics*. 2011;127(4):e978-88. [2] *Anesthesiology*. 2016;125(5):904-913. [3] *Paediatr Anaesth*. 2009;19(5):521-34. [4] *Anesth Analg*. 2019;128(4S):63-4

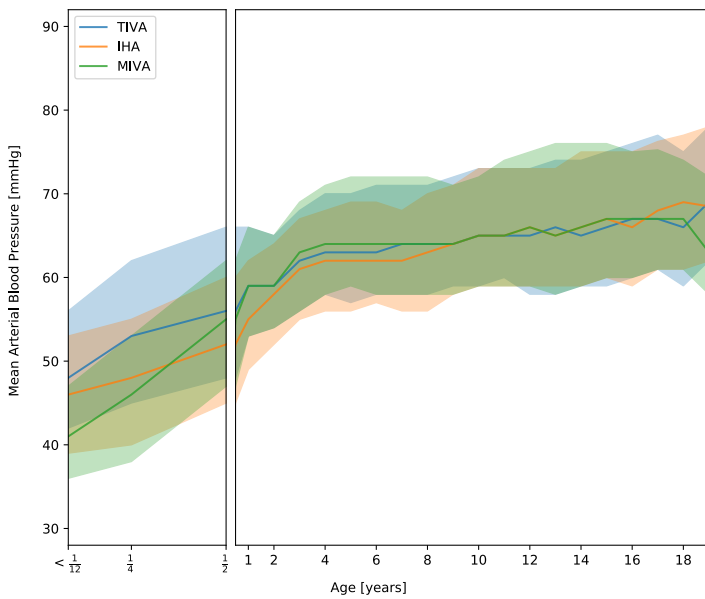


Figure 1: Nomograms for non-invasive mean arterial blood pressure split by anesthetic type: total intravenous anesthesia (TIVA, blue), inhalational anesthesia (IHA, orange), and mostly intravenous anesthesia (MIVA, green). Data shown include the median (solid line) and interquartile range (IQR) as shaded areas.

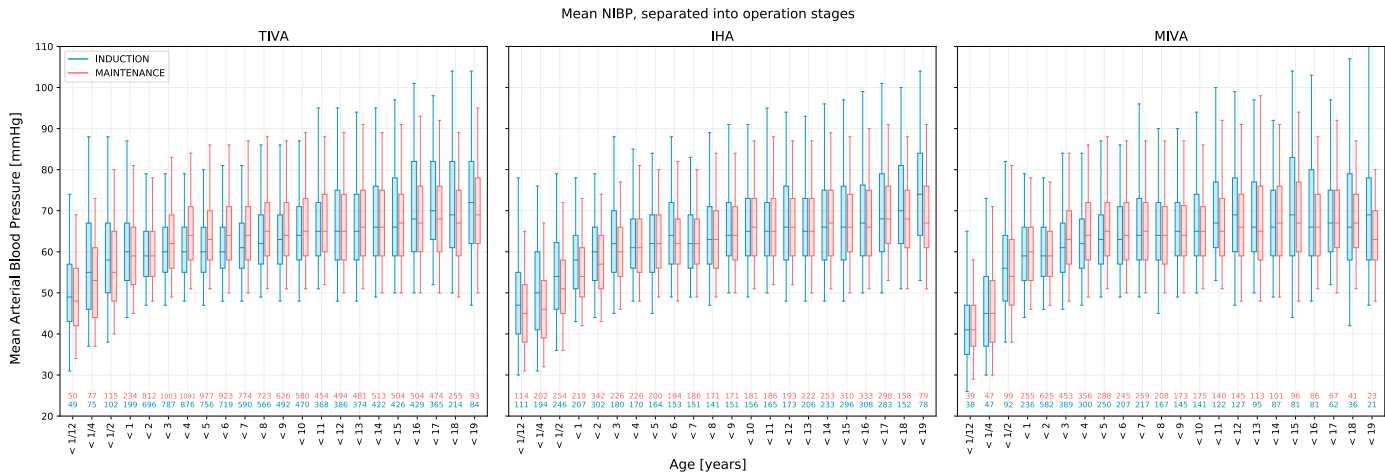


Figure 2: Nomograms for non-invasive blood pressure (NIBP) split by age and anesthetic phase: induction (blue), and maintenance (red). Data are grouped by anesthetic type: total intravenous anesthesia (TIVA), inhalational anesthesia (IHA), and mostly intravenous anesthesia (MIVA). Boxplot shows median and interquartile range (IQR); whiskers reach to last datum within 1.5 IQR. The number of cases for each box is shown along the X-axis.

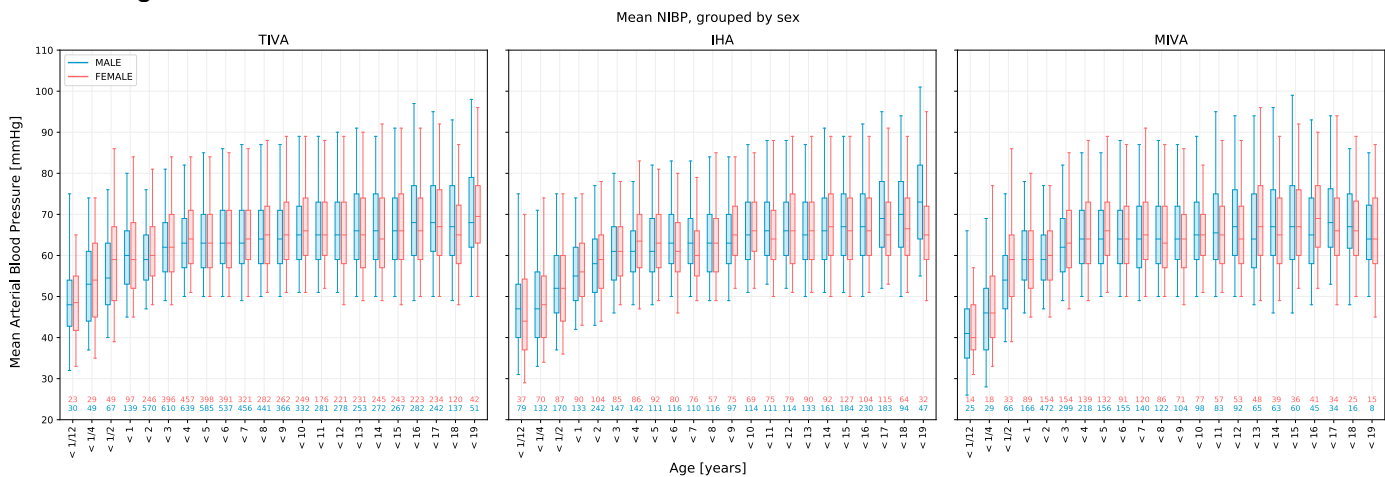


Figure 3: Nomograms for NIBP split by age and sex: male (blue) and female (red). Data are grouped by anesthetic type: total intravenous anesthesia (TIVA), inhalational anesthesia (IHA), and mostly intravenous anesthesia (MIVA). Boxplot shows median and interquartile range (IQR); whiskers reach to last datum within 1.5 IQR. The number of cases for each box is shown along the X-axis.