

Delayed Inhalation Induction? Comparing the Rate of Rise of Inspired Sevoflurane in an Older (Narkomed 2B) and a New Generation (Dräger Apollo®) Anesthesia Machine.

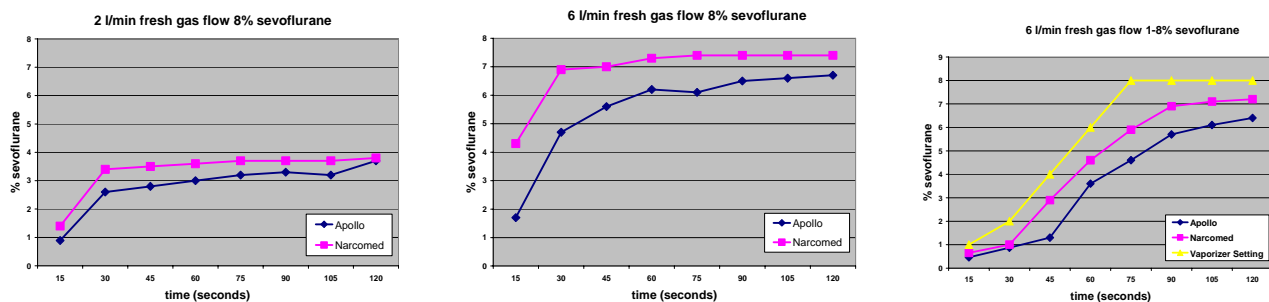
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Introduction: With the transition from Dräger Narkomed 2B to Dräger Apollo® anesthesia machines, some anesthesiologists commented that the speed of inhalation inductions with sevoflurane is slower in the Apollo® machines. The ventilators in the Narkomed 2B and the Apollo® machines are bellows driven and piston driven, respectively. Upon review of the machines' specifications and circuit pathways, a difference in the fresh gas flow (FGF) entry point was noted, being further from the inspiratory limb in the Apollo machine^{2,3}. We therefore hypothesize that the rate of rise of inspired sevoflurane is slower using the Apollo during inhaled induction of anesthesia.

Material and Methods: A spontaneously breathing child was simulated with an IngMar Medical lung model, PMG 3000, with spontaneous breathing accessory, SB 2000(IngMar Medical, Pittsburgh, PA). The lung was set at a rate of 25/min and a tidal volume of 200 ml. Three induction series were simulated. In the first and second series, oxygen FGF was started at either 2L/min or 6L/min and the sevoflurane vaporizer was set at 8% for each machine. In the third series, 6L/min of FGF was initiated and the agent was sequentially increased every 15 seconds from 1% to 2, 4, 6, and 8%. In each series a Dräger Narkomed 2B was compared to a Dräger Apollo® (Dräger Medical, Inc, Telford, PA). Each machine equipped with a disposable pediatric circuit and a 1 L anesthesia bag and was set to a spontaneous breathing mode with the adjustable pressure limiting, APL, valve fully open. Sevoflurane inspiratory concentrations were determined with the same Capnomac Ultima gas analyzer (Datex, Helsinki, Finland). Measurements of the highest inspired sevoflurane concentration during 15 second intervals for two minutes were recorded.

Results: Results are presented in figures 1-3.



Discussion: Concentrations of inhaled sevoflurane were consistently higher with the Narkomed 2B than with the Apollo® anesthesia machine. This is explained by the difference in FGF entry points, resulting in delay and dilution in the Apollo®, where fresh gas must flow through the carbon dioxide absorber, the anesthesia bag, and additional piping before entering the inspiratory limb, whereas the fresh gas flow in the Narkomed enters directly into the inspiratory limb. In pediatric anesthesia, where inhalation induction is common practice, this delayed increase in inspiratory concentrations of inhalational agents may result in significantly different induction characteristics. This requires adjustments of induction practices, for example abandoning gradual increase of inhalation agent in favor of initial high vaporizer settings, or the use of higher fresh gas flows to achieve comparable increases in inspiratory concentrations of inhalation agents. Similarly, increases in inspiratory concentrations, in particular at low fresh gas flows, during the case must be expected to reach the patient in a delayed fashion with the newer than in the older anesthesia machines.

Conclusions: We could demonstrate that the clinical observation of delayed inhalation induction with the newer anesthesia machine Dräger Apollo® compared to the older Narkomed 2B corresponds to slower increases of inspiratory agent concentrations at otherwise identical settings. This finding is explained by the difference in the fresh gas flow entry points in the circuits of the two machines.

References:

1. North American Dräger. *Apollo Operator's Manual*. 1988.
2. Dräger Medical, Inc. *Operator's Instruction Manual*. (6th Edition). 2006.