

SHORT COMMUNICATION

Making MAC calculation application for desflurane using MIT App Inventor 2.

Received date: 27-01-2016; **Accepted date:** 08-02-2016; **Published date:** 26-02-2016

CORRESPONDENCE AUTHOR: Nobukazu Sato

Mailing address: Department of Anesthesiology, Toho University, 6-11-1 Oomorinishi, Oota-ku, Tokyo 143-8541, Japan.

Tel:+81-3-3762-4151; **Fax:**+81-3-3765-8022; **E-mail:** sato.nobukazu@med.toho-u.ac.jp

CONFLICTS OF INTEREST

There are no conflicts of interest for any of the authors.

ABSTRACT:

To calculate age-corrected MAC value of inhalation anesthetics, we made android application. Mapleson's formula was used for the calculation of MAC in this application. For programming the application, we used MIT app inventor 2 designed to create android application, which easily combines the blocks of numerical formula and logical elements without knowledge of programming language to make application. We calculated the MAC value with this application, and found the estimated MAC values were slightly higher in elderly people than the values we knew. We developed an application for calculating MAC of inhaled anesthetics and found an overestimation of MAC exists in the elderly compared with the values prepared by the industry, but overestimation is thought to be safe when we aim for preventing perioperative awakening.

KEY WORDS: simulator, android application, inhalation anesthetics, desflurane

INTRODUCTION

The goal of general anesthesia is to provide an environment of surgery, and to eliminate the stress of patients. Stress of patients consists of physical and psychiatry stress. Intraoperative recall during general anesthesia leads to a serious psychiatry stress, that we have to avoid. Various electroencephalographic monitors such as BIS monitors are utilized to prevent perioperative recall and to maintain adequate anesthesia. Some clinical studies about perioperative recall were reported. B-Aware trial [1] revealed that anesthesia managed with BIS monitoring reduce the incidence of intraoperative awareness than routine care management (0.17% VS 0.91%). But other studies showed different results. In B-Unaware trial[2], BAG-RECALL trial[3], Michigan Awareness Control Study[4], BIS monitoring management had no advantage for intraoperative recall compared with end tidal

anesthetic gas concentration monitoring management. Such differences are caused by the fact that BIS monitoring was initially designed with data from midazolam, propofol, nitrous oxide, and alfentanil. Based on these clinical studies, Avidan et al said that it is important to monitor exhalation anesthetic gas level during inhalation anesthesia [5], and recommended that we should maintain higher than 0.7MAC. Desflurane should be used with high concentrations, and the change of concentrations in 1MAC is wider than sevoflurane by age. There are anesthesia machines with a function to automatically calculate MAC by inputting age in the anesthetic gas analyzer, but does not spread out enough. Therefore, for the purpose of safe inhalation anesthetic management, we made the Smartphone application that could easily calculate MAC of desflurane.

METHOD

The calculation method of MAC used the calculating formula by Mapleson [6]. JAVA or C language-based programming was usually necessary for making of the smartphone application. We use MIT app inventor 2 to make this App. MIT app inventor 2 is open source visual programming language designed to create android application. Originally, it was delivered by Google, today provided by Massachusetts Institute of Technology (MIT). We can combine the blocks of numerical formula and logical elements to make application without knowledge of programming language (Fig. 1). We think that we can apply MIT app inventor 2 to various medication management by incorporating a calculating formula necessary for anesthesia management. The App shows 1, 0.7, 0.3 MAC value by inputting patient's age. It also displays present MAC value by inputting desflurane concentration. We compared this App with the MAC value revealed from Baxter Corporation and the MAC calculation function by other manufacture deployment gas module.

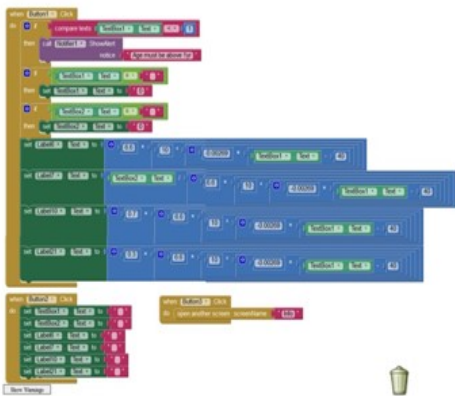


Figure 1: Structure of block based programming

RESULTS

When compare these MAC value with the measurements that drug company (Baxter) announces, age collected MAC values are more likely to do under estimate in young people on Dräger Perseus or GE Aisys (Fig.2). We do over estimate in elderly people by the App, Dräger Apollo, or NIHON KODEN moderately, but doing over estimate is thought to be safe when we aim for preventing perioperative awakening.

DISCUSSION

Mapleson reported the changing rate of MAC by the age is approximately equal to any inhalation anesthetic agent [6]. Mapleson and Eger [7] reported formula shown below which calculate age-corrected MAC value of inhalation anesthetics.

Mapleson's formula

$$\text{MAC}(\text{age-corrected}) = \text{MAC}(40\text{yo}) \times 10^{-0.00269 \times (\text{Age}-40)}$$

Eger's formula

$$\text{MAC}(\text{age-corrected}) = \text{MAC}(40\text{yo}) \times 1.32 \times 10^{-0.00303 \times \text{Age}}$$

(MAC(40yo) means MAC value for 40-year-old patient.)

Both the gas module of Dräger and this App calculates MAC using expression reported by Mapleson, but they uses different value for MAC(40yo) (App 6.6%, Dräger Perseus 6%, Dräger Apollo 6.65%). We decide 6.6% as MAC(40yo) from data in mapleson's article. Therefore the inhalation anesthetic levels are inferred moderately low in Dräger Perseus. (Fig.2)

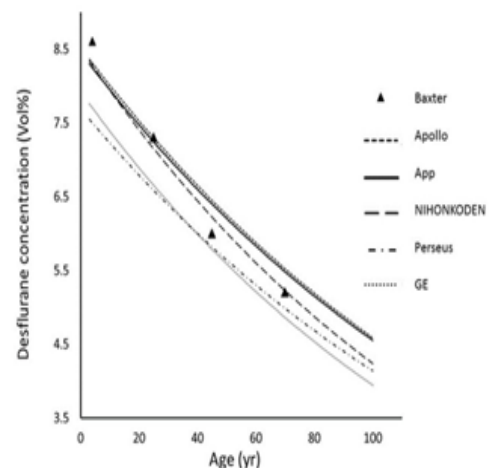


Figure 2: Disflurane concentration equivalent for 1 MAC. Black triangle shows age specific desflurane concentration revealed by Baxter.

We previously reported that there are the gas analyzers from various companies and calculation methods of age-corrected MAC are different, respectively[8]. GE Aisys and NIHONKODEN BSM 9101 uses Eger's formula for

age-collected MAC value, and the value of MAC(40yo) are also different in machines(Fig.3). This App little over estimate than other devices but it is thought to be safe and within reasonable value in clinical use.

	MAC(40yo) (Vol%)
Drager Apollo	6.65
Drager Perseus	6.00
DesCalc (App)	6.60
NIHON KODEN	6.45
GE	6.00

Figure3: Desflurane MAC value for 40-years-old on various gas analyser.

CONCLUSION

It is necessary for the age revision of MAC when we manage general anesthesia by inhalation anesthetics. This App tends to overestimate especially among elderly patients compared with Dräger Perseus or GE Aisys, but to avoid intraoperative recall, this over estimate is within allowable range in clinical situation. I think this App is clinically useful to manage general anesthesia using inhalation anesthetics appropriately.

APPENDIX

This application (DesCalc) can be downloaded free of charge at Google Play.

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