Gas Man derived compartmental vs Lerou physiological model for Desflurane

Mihai R Sadean, MD
Department of Anesthesiology, SUNY at Stony Brook

Introduction
Hendrickx et al derived a classical three compartmental model with two covariate, cardiac output and body weight, from the physiological uptake model used by the Gas Man program (Med Man Simulations, Inc., Chestnut Hill, MA) [1]. We tested the predictive performance of the derived compartmental model vs the Lerou physiological model used by AnesAssist program (Palma Healthcare Systems LLC).

Methods
For the simulations we used the model covariates weight (Wt) and fixed cardiac output (CO) at 5 l/min (not usually clinically available), the ventilation in volume controlled mod with tidal volume (VT), respiratory rate (RR), fresh gas flow (FGF), as ventilator settings, and vaporizer sevoflurane concentration (FD) as model inputs. Outputs of the model simulations are sevoflurane inspiratory (FI), end-tidal (Fet) and effect site, brain, concentration (Fb).

For the compartmental model we calculated the inspiratory concentration (FI) : F=Fe+t(Ft+Fe)*FGF/VT*RR and the uptake (Ul) : Ul=(Fi+Fe)/VT*RR.

For calculation of the brain sevoflurane concentrations we added an effect site compartment with a ke=0.61/min to the compartmental model (Rehberg et al).

We run 1 hour simulations for a virtual 70kg patient, Vt=600cc, RR=10 breath/min.

Washin, maintenance and washout Fet and Fb concentrations resulted for 3 different scenarios (S).

S1 : FGF=8ml/min, FD=8% time=0 to 45min than FD=0%;
S2 : FGF=2ml/min, FD=8% time=0 to 45min than FD=0%;
S3 : FGF=8ml/min FD=6% time=0 to 15 and FD=0% time=5 to 60 and FGF=2ml/min FD=6% time=16 to 45min.

Results

High Fresh Gas Flow Scenario (S1)

Effect Site Brain Concentrations for Shaper and Leroux Models for Scenario S1

Fig 1 Calculated desflurane effect site concentrations for Shaper (FtS), Leroux (FtL) at set vaporizer concentrations (FD) and the prediction error (PE) for Scenario S1.

Low Fresh Gas Flow Scenario (S2)

Effect Site Brain Concentrations for Shaper and Leroux Models for Scenario S2

Fig 2 Calculated desflurane effect site concentrations for Shaper (FtS), Leroux (FtL) at set vapor concentrations (FD) and the prediction error (PE) for Scenario S2.

High/Low/Fresh Gas Flow Scenario (S3)

Effect Site Brain Concentrations for Shaper and Leroux Models for Scenario S3

Fig 3 Calculated desflurane effect site concentrations for Shaper (FtS), Leroux (FtL) at set vapor concentrations (FD) and the prediction error (PE) for Scenario S3.

Conclusions
It appeared that it was a good estimation of the end tidal and brain desflurane concentrations of the compartmental vs the physiological model overall with an accuracy of <16%, negative bias for Fet and positive for Fs. However during washin it reached 13% for Fet and 31% for Fb with a positive bias and during washout 88% for Fet and Fb with a negative bias. The accuracy decreased with decreased FGF and more FD changes.

The acceptable approximation of the end tidal concentrations by the Gas Man derived compartmental model compared to the Lerou physiological model, that was previously clinically validated, is promising its use in the study of volatile anesthetic agents.

References
1 Hendrickx et al. BMC Anesthesiology 2006, 6:7