Closed Loop Administration of Sevoflurane in O_2/Air with the Automated Gas Control Function (AGC®) of the FLOW-i®

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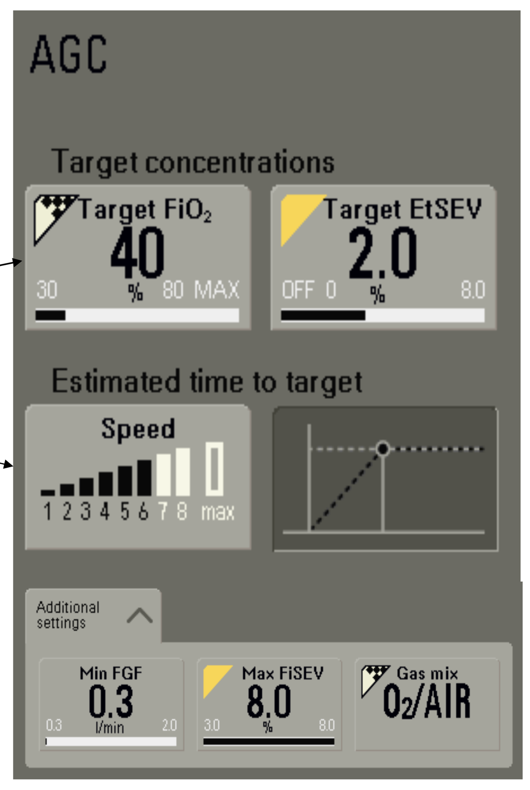
Background

Low fresh gas flows (FGF) = less anesthetic waste
but adjusting vaporizers and rotameters can be tedious
automation = more time to tend to other matters
especially during busy induction

FLOW-i® (Maquet,Sweden) has been equipped with AGC function, which entails
- preselection function user sets targets (see below) before start induction
- speed control feature users sets rate of rise of anesthetic agent

→ question: clinical performance of first released software version (4.0.0)?
- sevoflurane rate of rise and usage with different speeds
- depth of anesthesia (BIS) with different speeds after IV induction



Materials and Methods

IRB approval, informed consent

ASA I -II, abdominal and gynecological surgery, n = 24

IV induction

AGC® settings
- target inspired O_2 % (F_IO_2) = 40%
- target end-expired sevoflurane % (F_At sevo) = 2.0%, balance N_2
- 1 of 3 speeds:2, 4, or 6 (n = 8 in each group)
- 0.3 L/min= lowest possible FGF setting with this software version

Data collected:
- patient demographics
- in- and expired % of O_2, sevoflurane, and CO_2 %, BIS, FGF
- sevoflurane usage
  - weigh injector before and after exactly 60 min
  - XP10002, Mettler-Toledo, Columbus, Ohio
  - weight (g) converted into mL liquid (density 1.5203 g/mL)
  - comparison of usage with different speeds (ANOVA)
  - amounts compared those reported by FLOW-i (t-test)

For clarity, only average values are presented

Results

Patient demographics did not differ between groups (Table 1).

O_2 takes priority (Figure 1): the target F_IO_2 is attained within 1-2 min regardless of speed selection by the use of a very short lived (≈ 8 -10 sec) very high FGF (≈ 20 L/min). The initial rate of rise of $F_A$sevo did differ between the groups (Figure 2).

The fresh gas controller acts, at present and by design, the same irrespective of the selected speed (Figure 3). Yet, despite the FGF being the same in all groups, the selection use of speed 2 instead of speed 6 reduced agent consumption by 50 % (from 4 to 2 mL) after 10 min. After $F_A$sevo has been reached, usage does not differ: 5.0 (0.9), 5.2 (1.1), and 5.6 (1.0) with speed 2, 4, and 6, respectively (Figure 4).

Blood pressure, heart rate, and BIS did not differ between groups (Figures 5-6). Even with the slowest speed 2, BIS values remained acceptable in all patients (Figures 7-9).

Conclusions

AGC feature allows significant reductions in agent usage. This is related both to the ability to choose the rate of rise of the inhaled agent as well as the low 0.3 L/min maintenance FGF.

FGF usage is not the only determinant of agent efficiency – so is the selected speed.

The pre-selection and speed control features facilitate titration to individual patient requirements and anticipated time to incision. These features will prompt future research that will delineate the appropriate rise time of inhaled anesthetics concentrations that ensure an adequate depth of anesthesia during the dynamic post induction period when the effect of intravenous agents is waning.

AGC facilitates the integration of low flow into the over work flow of the anesthesiologist, in particular during the busy induction period

		Speed speed 2	speed 4	speed 6	p value
n		8	8	8	
Gender	female	5	4	6	
Age	years	66 (7)	62 (14)	60 (9)	0.506
Height	cm	167 (8)	170 (10)	164 (5)	0.482
Weight	kg	70 (13)	71 (14)	75 (17)	0.782
Cumulative mL liquid sevo	0-15'	3.2 (0.3)*	1.0 (0.4)	4.9 (0.5)*	<0.001 * differ
	15-60'	5.0 (0.9)	5.2 (1.1)	5.6 (1.0)	0.476
	0-60'	8.1 (1.1)*	9.2 (1.4)*	10.5 (1.4)	0.008 * differ

Table 1. Patient demographics and agent usage

Color code — **speed 2** (black) — **speed 4** (blue) — **speed 6** (cyan)

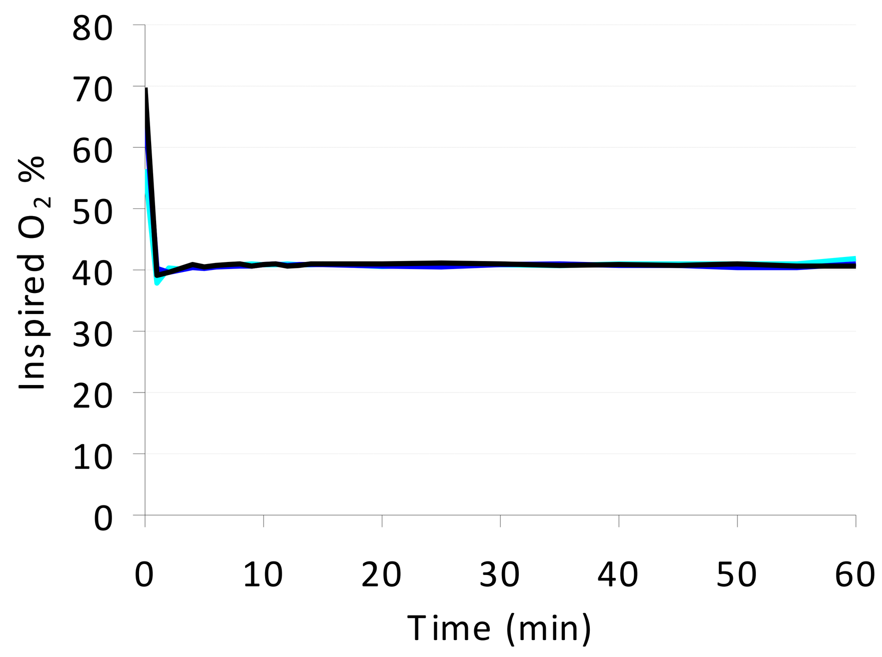


Figure 1. Average F_IO_2 course

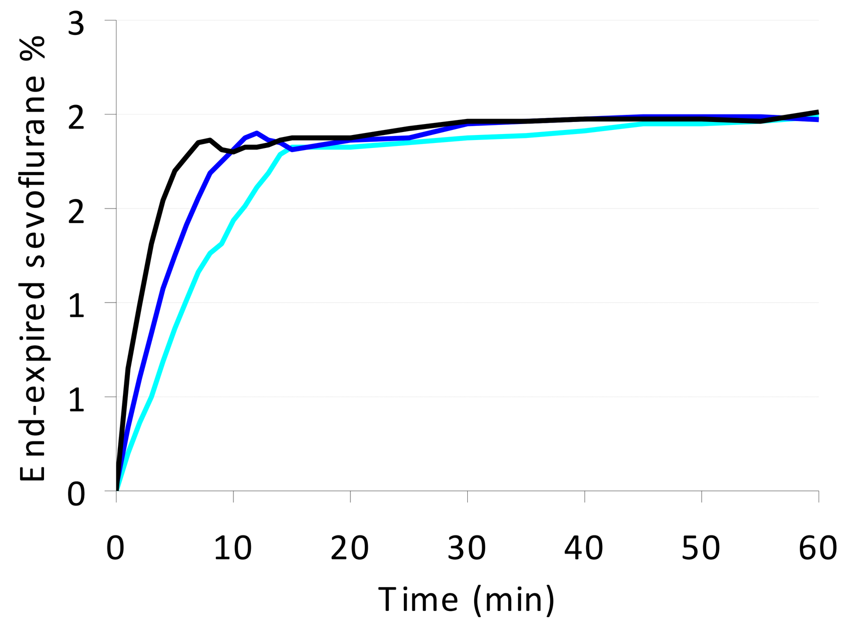


Figure 2. Average $F_A$sevo course

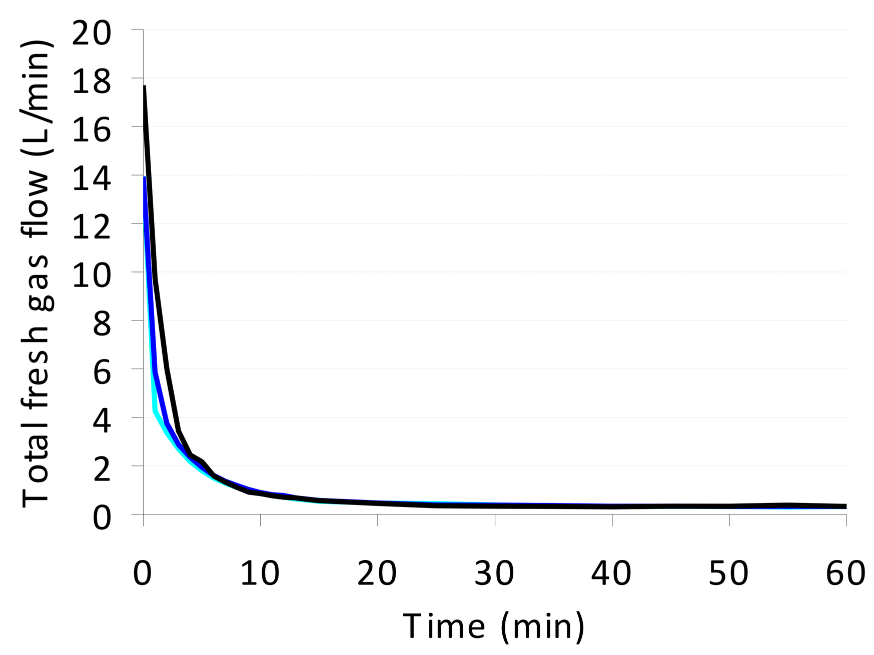


Figure 3. Average fresh gas flow course

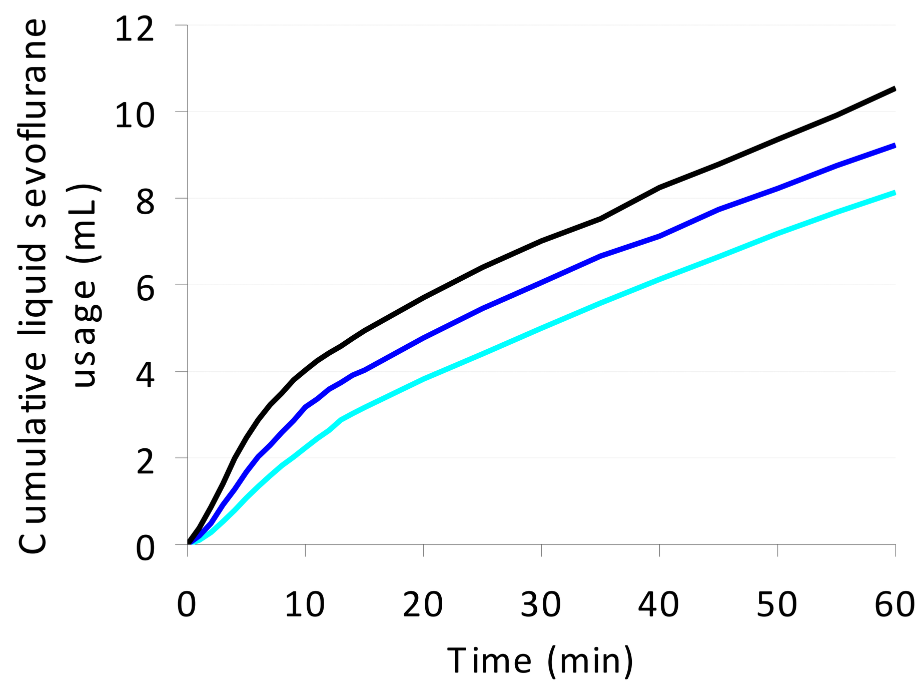


Figure 4. Cumulative sevoflurane usage

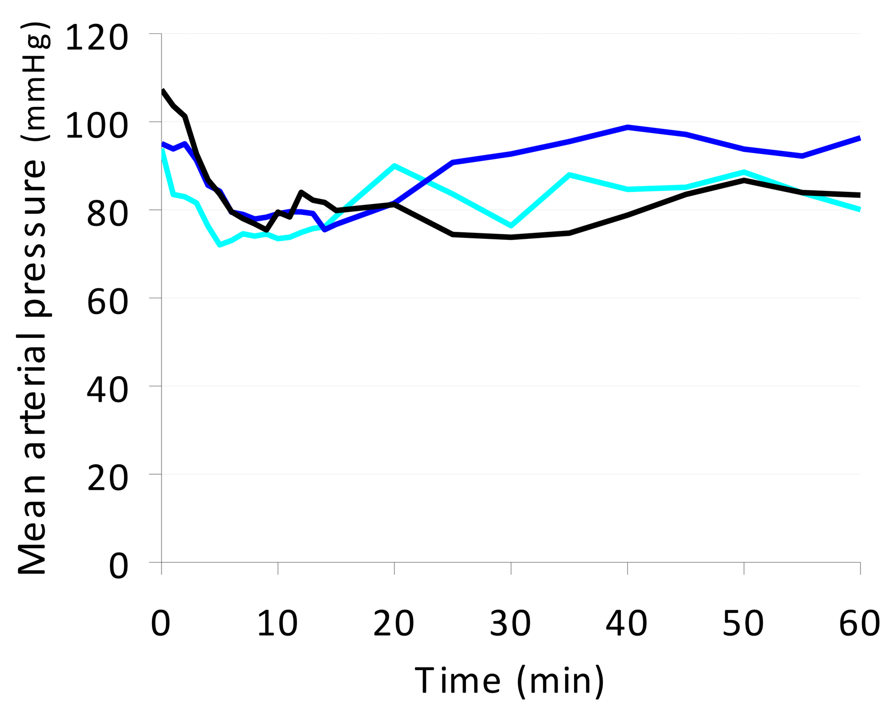


Figure 5. Average mean arterial pressure (mmHg)

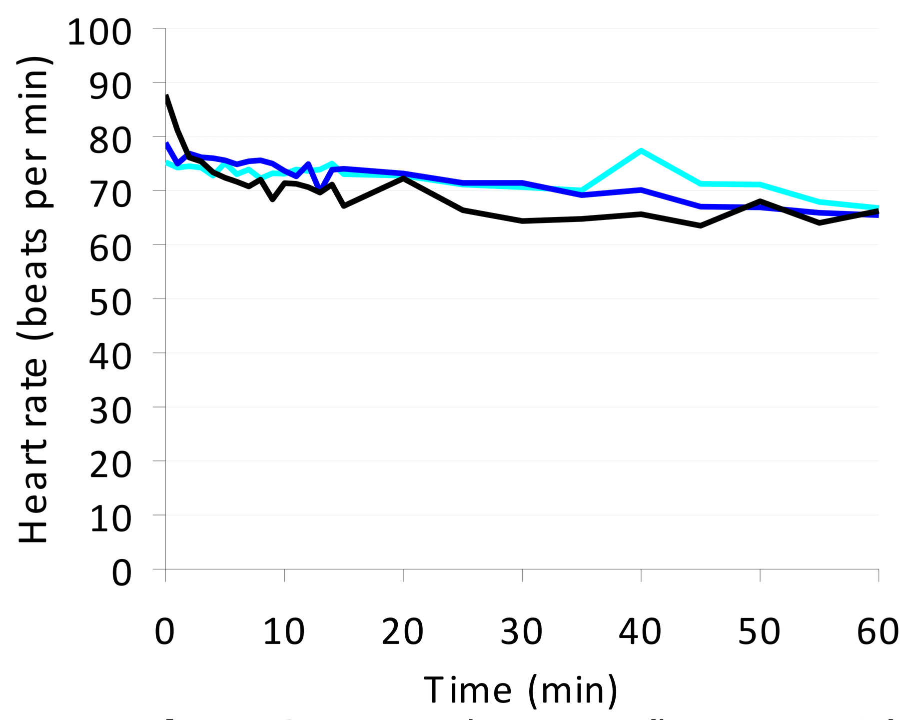


Figure 6. Average heart rate (beats per min)

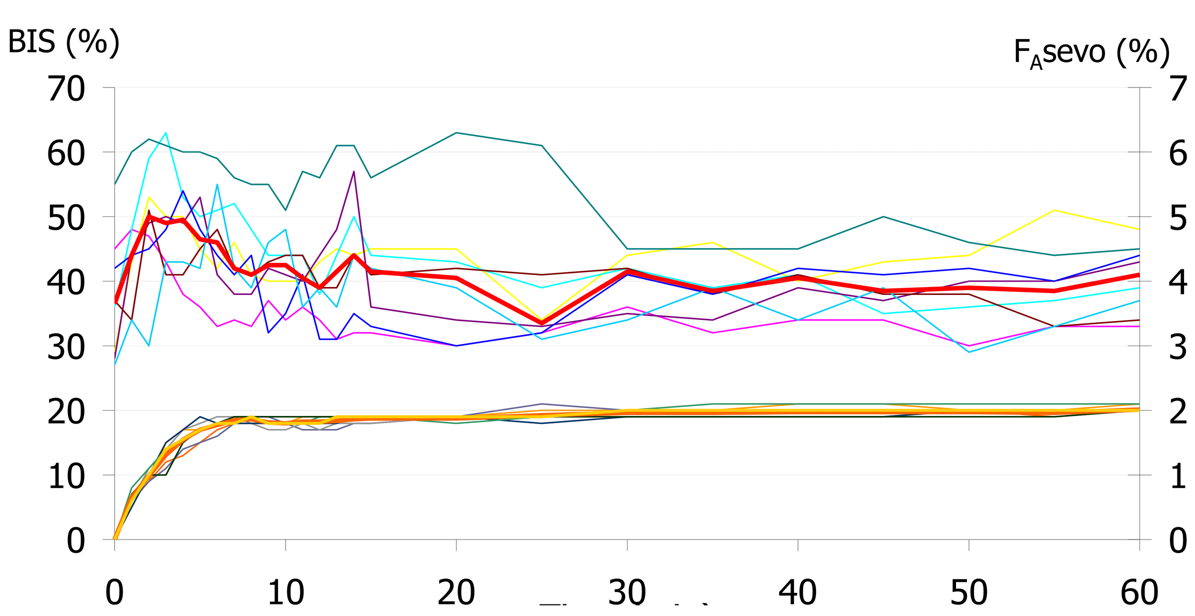


Figure 7. Speed 2 group - BIS (left Y-axis,%) and $F_A$sevo (right axis,%) versus time (min)

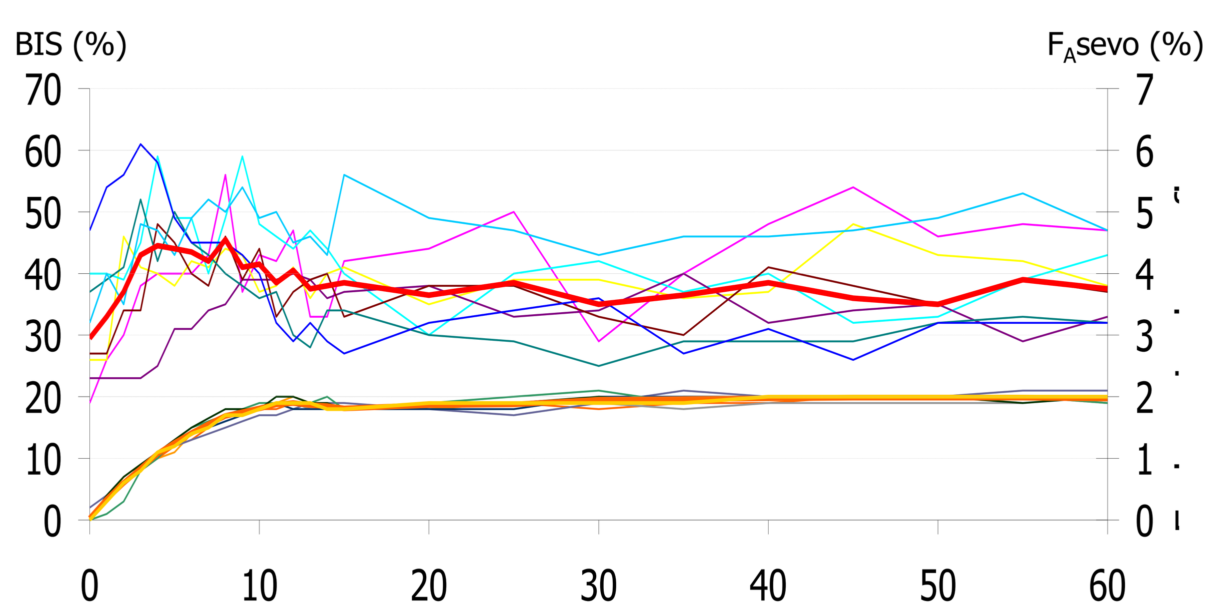


Figure 8. Speed 4 group - BIS (left Y-axis,%) and $F_A$sevo (right axis,%) versus time (min)

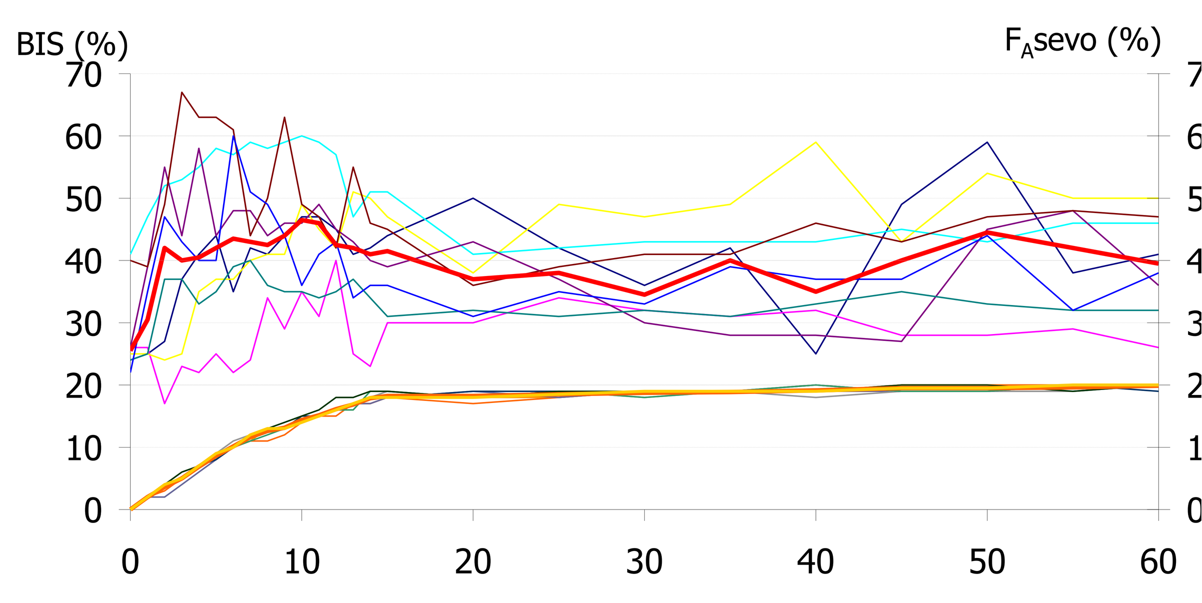


Figure 9. Speed 6 group - BIS (left Y-axis,%) and $F_A$sevo (right axis,%) versus time (min)