**CLINICAL ASSESSMENT OF CONTROL PERFORMANCE IN CLOSED-LOOP ANESTHESIA**

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**Background**: A set of performance measures, proposed by Varvel et al. [1], have constituted the standard means of comparing systems. Their relevance to closed-loop control is debatable.

**Methods**: An alternative set of measures is proposed [3]: 1. For the induction phase: induction phase duration (ID) percent overshoot (OS). 2. For the maintenance phase: integrated error (IE), integrated absolute error (IAE), variability index (VI) and percentage of time outside the adequate range. 3. For the emergence phase: emergence phase rise time. We analyzed 112 clinical cases collected from a study on closed-loop control depth of hypnosis (DOH)[2].

**Results**: ID and OS assess fast transition to the DOH setpoint during induction phase. IE conveys information about the average error. VI measures variability in DOH. Percentage of time outside the adequate range reports how well the system managed to keep DOH within clinically feasible range. ER assess the emergence time. The IAE replaces the MDAPE and is obtained by taking the modulus of the sample-wise error. DOH values in the 40-60 range are considered clinically adequate and suggest a maintenance phase such as Figure 1(a) should be more desirable than Figure 1(b). The typically used MDAPE error metric reached the opposite conclusion. The MDAPE of both figures are 12.6, while the IAE are 6.62 and 6.78 respectively for Figure 1(a) and (b).

**Conclusion**: The proposed performance measurements analyze three phases of anesthesia separately and differentiate performance characteristics.

**References**  
[1] Varvel JR, et al. Pharmacokinetics & Biopharmaceutics, vol 20, no. 1, pp. 63-94, 1992.

[2] van Heusden K, et al. IEEE Transactions on Control System Technology, in press.

[3] Soltesz K, et al. 21st Med. Control Conf. Crete, 2013.

