W. S. Chan, M.B.Ch.B., F.A.N.Z.C.A., F.H.K.C.A., F.H.K.A.H.
Senior Medical Officer, Department of Anesthesiology
Wilfred C. G. Peh, M.B.B.S., D.M.R.D., F.R.C.R., F.H.K.C.R., F.H.K.A.M., F.A.M.S.
Associate Professor, Department of Diagnostic Radiology
K. F. J. Ng
S. L. Tsui
Professor J.C.S. Yang, M.D., Dip Am Board, F.F.A.R.C.S.(I), F.H.K.A.M.
Department of Anesthesiology
FZ Block
Queen Mary Hospital
102 Pokfulan Road
Hong Kong

References

1. de Leon-Casasola OA, Kent E, Lema MJ: Neurolytic superior hypogastric block for chronic pain associated with cancer. *Pain* 1993; 54:145–51

2. Plancarte R, Amescua C, Patt RB, Aldrete JA: Superior hypogastric block for pelvic cancer pain. ANESTHESIOLOGY 1990; 73:236–9

(Accepted for publication March 26, 1997.)

Anesthesiology
1997; 86:1430–1

Nomenclature for Computer-assisted Infusion Devices

To the Editor: — Computer-assisted infusion devices are open loop control systems that allow the anesthesiologist to select the target blood or plasma concentration or, in some patients, the target effect site concentration likely to be required to achieve a particular pharmacodynamic effect. Depth of anesthesia then is controlled by the anesthesiologist, making adjustments to the target setting as required for each patient.

All such systems require a microprocessor-controlled infusion pump programmed with infusion rate control algorithms linked to a pharmacokinetic simulation program. The program includes a pharmacokinetic model and a specific set of pharmacokinetic parameters for the drug to be infused. Individual academic groups have referred to this technology by a variety of acronyms, including CATIA (computer-assisted total intravenous anesthesia),[1] TIAC (titration of intravenous agents by computer),[2] CACI (computer-assisted continuous infusion),[3] and CCIP (computer-controlled infusion pump).[4] The term, *target-controlled infusion,* (TCI) also has been used in this context.[5] Although TCI covers the concept common to all the previous systems, it avoids implying that a computer rather than an anesthesiologist is controlling the depth of anesthesia. Additionally, commercial TCI systems will not likely require an external computer.

In using and describing any TCI system, there is a need for consistent terminology to identify the drug concentration described, the site at which this concentration is determined, and the pharmacokinetic parameters used in the system. The TCI system should display the target concentration that has been set by the user (C_T) and the concentration that the TCI system calculates will have been achieved (C_{CALC}). C_{CALC} is preferred to C_P (predicted concentration) to prevent confusion with C_P (plasma concentration). In assessing the predictive performance of TCI systems, drug concentrations are measured (C_M) and compared with C_{CALC}.[6]

In many cases, the site at which a particular concentration is determined is obvious and always should be mentioned in any article. Where there is a need to specify the site, the previous terminology can be expanded as follows:

Cp_T = target plasma concentration;
Ce_T = target effect site concentration;
Cp_M = measured plasma concentration;
Cp_{CALC} = calculated plasma concentration; and
Ce_{CALC} = calculated effect-site concentration.

The time course and magnitude of the pharmacodynamic response achieved at a given C_T will be influenced by the pharmacokinetic parameters incorporated in the system used.[7] Thus, whenever a target or calculated concentration is given in a manuscript, authors should ensure that they provide information on the pharmacokinetic model and parameter set used. When many models are being used, the use of a second subscript to identify the pharmacokinetic parameter set used would be unambiguous, *e.g.,* $Cp_{CALC,MAITRE}$ = calculated plasma concentration based on pharmacokinetic parameters published by Maitre, *et al.*[8]

In relating pharmacodynamic effects to drug concentrations, Cp50 has been used as the measured plasma concentration ($Cp50_M$), at which there is a 50% probability of suppressing a response to a certain stimulus.[9] This will continue to be an important index because $Cp50_M$ will be independent of the device used. In clinical research and routine clinical experience with TCI systems, wherein information on measured concentrations may not be available, observations based on C_{CALC} displayed by the TCI system when a particular effect is observed may be of more value to a clinician. Ideally, $Ce50_{CALC}$ or $Ce90_{CALC}$ (with the PK/PD model specified in the text) should be the index used, but $Cp50_{CALC}$ or $Cp90_{CALC}$ may be suitable alternatives,

with the important proviso that the calculated plasma concentration has been maintained for a sufficient period to permit equilibration with the effect site.

P. S. A. Glass, M.D.
Associate Professor of Anesthesia,
Duke University Medical Center,
Durham, North Carolina
J. B. Glen, Ph.D.
Clinical Specialist, Medical Affairs Department
Zeneca Pharmaceuticals
Alderley Park
Macclesfield SK10 4TG
United Kingdom
G. N. C. Kenny, M.D.
Professor of Anaesthesia
University of Glasgow
Glasgow, United Kingdom
J. Schüttler, M.D.
Professor of Anaesthesia
University of Erlangen-Nuremberg
Erlangen, Germany
S. L. Shafer, M.D.
Assistant Professor of Anesthesia
Stanford University
Stanford, California

References

1. Schuttler J, Schwilden H, Stoekel H: Pharmacokinetics as applied to total intravenous anaesthesia. Anaesthesia 1983; 38(Suppl): 53-6

2. Ausems ME, Stanski DR, Hug CC: An evaluation of the accuracy of pharmacokinetic data for the computer assisted infusion of alfentanil. Br J Anaesthesia 1985; 57:1217-25

3. Glass PSA, Jacobs JR, Smith LR, Ginsberg B, Quill TJ, Bai SA, Reves JG: Pharmacokinetic model-driven infusion of fentanyl: Assessment of accuracy. ANESTHESIOLOGY 1990; 73:1082-90

4. Shafer SL, Varvel JR, Aziz N, Scott JC: Pharmacokinetics of fentanyl administered by computer-controlled infusion pump. ANESTHESIOLOGY 1990; 73:1091-102

5. Chaudhri S, White M, Kenny GNC: Induction of anesthesia with propofol using a target-controlled infusion system. Anaesthesia 1992; 47:551-3

6. Varvel JR, Donoho DL, Shafer SL: Measuring the predictive performance of computer-controlled infusion pumps. J Pharmacokinet Biopharm 1992; 20:63-93

7. Vuyk J, Engbers FHM, Burm AGL, Vletter AA, Gladines MPRR, Bovill JG: Pharmacodynamics of propofol in female patients. ANESTHESIOLOGY 1992; 77:3-9

8. Maitre PO, Vozeh S, Heykants J, Thomson DA, Stanski DR: Population pharmacokinetics of alfentanil: The average dose-plasma concentration relationship and interindividual variability in patients. ANESTHESIOLOGY 1987; 66:3-12

9. Ausems ME, Vuyk J, Hug CC, Stanski DR: Comparison of a computer-assisted infusion versus intermittent bolus administration of alfentanil as a supplement to nitrous oxide for lower abdominal surgery. ANESTHESIOLOGY 1988; 68:851-61

(Accepted for publication March 26, 1997.)

Anesthesiology
1997; 86:1431-3

The Lower Limit of Autoregulation: Time to Revise Our Thinking?

To the Editor:—I am concerned that the popular conception regarding the normal lower limit of cerebral blood flow autoregulation (LLA), frequently identified as 50 mmHg, may be substantially in error. Clinically, one encounters frequent reference to the LLA in discussions regarding minimal acceptable blood pressures for patient management.[1] It has been argued that this relevance has been overemphasized (see below).[2] Nonetheless, the LLA is a widely quoted physiologic limit to which the anesthesia community, rightly or wrongly, has assigned considerable importance.

Depictions of autoregulation in many standard texts show an autoregulatory plateau between mean arterial pressures of 50 and 150 mmHg. It is likely that the common choice of a mean arterial pressure (MAP) of 50 mmHg as the LLA was significantly influenced by a figure in a review article by Lassen.[3] Lassen's depiction of an LLA of 50 mmHg was in turn an estimate based on data from an investigation by McCall (see table 1) published in 1953.[4] That investigation was performed in pregnant volunteers at or near term, in whom blood pressure was lowered with hydralazine and veratrum viride. The former is a cerebral vasodilator,[5] and the effects of the latter on the cerebral circulation are undefined. Yet, despite of the meager database that identified 50 mmHg as the LLA for healthy humans, the definition has remained widely accepted without thorough confirmation. In part, this may be because the LLA for several animal species is also approximately 50 mmHg. Nonetheless, a review of the literature more recent than McCall's 1953 publication does not confirm that an LLA of 50 mmHg actually prevails in humans. The majority of data derived in healthy, normotensive, nonanesthetized adults argues that the LLA is not less than an average value of 70 mmHg. In