terms: a feedback components or amplification of the feedback and a so-called feedforward component described as follows:

Feedback Term or Amplification of the Feedback:

With \( \varepsilon(t) = SE_p - SE(t) \), the Index Error corresponds to \( -\varepsilon(t) \) the feedback term is expressed as:

\[
C_i(t) = C_i(t - T_i)[1 - \varepsilon(t)/AFB]
\]

with AFB = Amplification of the Feedback.

The minimal interval \( T_i \) between two consecutive controls is set equal to the time to peak effect of propofol and remifentanil. This delay is modified by the activation of feedforward.

With \( u(t) = C_i(t), y(t) = SE(t) \) and \( y_p = SE_p \) the feedback term can then be written as:

\[
u(t) = u(t - T_i)[1 - \varepsilon(t)/AFB]
\]  (3)

Comparing equations (2) and (3), it is obvious that the feedback controller is then an integral controller; note that the gain, though, is a function of \( u(t - T) \) where

\[
\frac{K_T}{T_i} = \frac{C_i(t - T_i)}{AFB}
\]  (4)

A feedforward term was implemented, which can amplify the concentration corrections (every 5 s). This function is activated during the maintenance phase. The condition can be expressed as \( \varepsilon(t) + 2\varepsilon(t - 1) + \varepsilon(t - 2) > 10 \) when sampling every 5 s (compare with the derivative term in the PID). The correction is performed immediately with

\[
AFB = -\varepsilon(t) \cdot (RE - SE) \cdot u(t - T)
\]

with

\[
u(t) = u(t - T_i)[1 - \varepsilon(t)/AFB]
= u(t - T_i)[1 + 1/(RE - SE) \cdot u(t - T_i)]
\]

This gives

\[
u(t) = u(t - T_i) + \frac{1}{RE - SE}
\]

Finally, the controller calculates the SE “error” (difference between the set point of 50 and the actual SE value), allowing the titration until the target level of \( SE = 50 \) was obtained. The SE “error” is used to calculate new concentrations that are proportional to error size, sign (positive or negative), and actual drug concentration.

(Accepted for publication May 25, 2012.)

---

Central Venous Pressure Monitoring Is Not Reliable for Guiding Fluid Therapy in Patients Undergoing Spine Surgery

To the Editor:

The recent update of the report “Practice Advisory for Perioperative Visual Loss Associated with Spine Surgery” by the American Society of Anesthesiologists Task Force on Perioperative Visual Loss did not present any new guidelines.\(^1\) It did, however, continue a recommendation regarding the management of intraoperative fluid therapy from the 2006 Practice Advisory,\(^2\) which states that “central venous pressure (CVP) monitoring should be considered in high-risk patients.” Although there is a relationship between CVP and intraocular pressure,\(^3\) there is little data supporting the utility of CVP in guiding fluid therapy, particularly in patients undergoing spine surgery in the prone position.

Recognizing that the heart is the target organ of intravenous fluids, the goal of fluid therapy is to ensure adequate cardiac output for perfusion of vital organs. Furthermore, additional fluids should only be administered in a patient who is “fluid-responsive,” meaning that an increase in preload will cause a commensurate increase in cardiac output. This is the rationale for “goal-directed therapy.”

Unfortunately, CVP does not predict fluid responsiveness.\(^4\) Furthermore, CVP monitoring in the prone position may be particularly misleading to clinicians. A previous study comparing CVP and left ventricular end diastolic volume demonstrated that when a patient is turned from supine to prone, CVP rises, whereas left ventricular end diastolic volume falls.\(^5\) Thus, in the prone position, the CVP suggests that the left ventricle is more full when in fact it is more empty.

In addition to a lack of utility, CVP catheters present additional risks to patients, including both mechanical injury and infection. It is therefore difficult to recommend CVP monitoring when a host of minimally and noninvasive hemodynamic monitors, using a variety of technologies, are available for goal-directed fluid therapy.

Kenneth P. Rothfield, M.D., Saint Agnes Hospital, Baltimore, Maryland. krothfield@stagnes.org

---

References


(Accepted for publication May 29, 2012.)