Neurologic Examination for Anesthesiologists: Comment

To the Editor:

Reshef *et al.*[1] describe neurologic events during induction of anesthesia to explain the relevant central reflexes. They describe that when giving a hypnotic drug as an IV bolus during a period of 5 to 10 s, the patient becoming unresponsive, atonic, and apneic follows rapidly. They attribute the apnea to anesthetic acting at "[γ-aminobutyric acid–mediated] synapses in the ventral and dorsal respiratory groups of the pons and medulla," and support this by citing a detailed and comprehensive review that discusses the central rhythm generators for respiration.[2] However, this review expressly excludes consideration of factors such as afferent modulation (such as chemosensors). In the conditions described by Reshef *et al.*,[1] afferent modulatory factors, such as carbon dioxide and consciousness, are very relevant.

Several observations counter the possibility that an induction dose of anesthetic causes respiratory depression and thus apnea: the most obvious is that after a short time without intervention, respiration often resumes, albeit with a different pattern. Indeed, one can induce anesthesia without apnea at all if the agent is given slowly, even though consciousness is lost.[3]

I suggest that loss of consciousness mediated by suppression of the arousal centers, which is also considered by Reshef *et al.*,[1] to be a more likely cause of apnea in these circumstances. In conscious subjects, respiration is generally sustained not by chemosensor stimulation, but by consciousness itself. For example, Lumb and Nunn noted that end-tidal carbon dioxide values in a study of normal awake subjects were just less than the value predicted to sustain ventilation.[4] After a bolus of the IV agent, loss of consciousness often causes apnea, because there is, for a short time, no alternative stimulus to provide respiratory drive. In hypocapnic patients, apnea at anesthetic induction is much more frequent.[5] Anesthesia can be induced without apnea, using a variety of agents, if care is taken to avoid hypocapnia. Indeed, if anesthesia is induced slowly (during a time period of ≈60 s), then interesting and important features of the loss of neural activity become evident.[6] The transition to the anesthetized state is shown by an altered pattern of breathing, from "self-conscious" breathing to a rhythmic, more rapid, and uniform breathing pattern typical of volatile agent anesthesia.[7] Indeed, this change occurs before other signs of anesthetic action are noted, such as loss of volitional activity, muscle tone, and the lash reflex.

After bolus administration, actions of IV agents involve kinetic and dynamic elements, and these often cannot be easily distinguished. Progressive changes in central reflexes, such as those described by Reshef *et al.*,[1] may be better observed using infusions or inhaled agents, where kinetic effects may be controlled.

These considerations have an important practical application. When inducing anesthesia by inhalation, when apnea causes problems, asking a patient to hold a maximal inspiration is a good way to prevent hypocapnia[8] and sustain breathing. Hypocapnia can also be avoided by allowing partial rebreathing, which is useful if the patient cannot follow instructions adequately.[9]

Competing Interests

The author declares no competing interests.

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In Reply:

Professor Drummond makes a good point that apnea induced by propofol does not occur entirely through its actions at γ-aminobutyric acid–mediated synapses in the dorsal and ventral respiratory groups in the medulla and pons. However, he further writes, "I suggest that loss of consciousness mediated by suppression of the arousal centers, which is also considered by Reshef *et al.*,[1] to be a more likely cause of apnea in these circumstances. In conscious subjects, respiration is generally sustained not by chemosensor stimulation, but by consciousness itself…After a bolus of IV agent, loss of consciousness often causes apnea, because there is, for a short time, no alternative stimulus to provide respiratory drive." These statements do not offer any specific circuit mechanism as to how loss of consciousness "causes" apnea.

What is highly plausible is that bolus administration of propofol leads to a preponderance of γ-aminobutyric acid–mediated inhibition in the brainstem. As we have pointed out previously, the brainstem component of loss of consciousness following bolus administration of propofol, is due most likely to its actions at the γ-aminobutyric acid–mediated projections from the preoptic area of the hypothalamus on to the arousal centers.[2–4] In addition, there is extensive γ-aminobutyric acid–mediated circuitry in the brainstem such that when an agent like propofol is administered as a bolus, it acts indiscriminately at all of these circuits, offering a myriad of possibilities to inactivate the respiratory centers.[5–7] More work is needed to trace out precisely the relationship between brainstem inactivation due to γ-aminobutyric acid–mediated mechanisms and apnea. We agree that bolus administration of propofol leading to apnea is different from an inhalational induction in which the patient becomes unconscious but can continue to breath.

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Competing Interests

The author declares no competing interests.

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Operating Room Fires: Comment

To the Editor:

I read with interest the recent article by Jones *et al.* titled "Operating Room Fires."[1] As someone who has a long-standing interest in this subject, I was pleased to see the publication of this excellent review. However, I would like to clarify a couple of statements published in the article.