

lead to bowel necrosis. Sedatives and potent volatile inhalation anesthetics might cause the same effect in sick neonates.

To reiterate, the author of the editorial is quite correct in stating that neonates may not need anesthetics or analgesics for various surgeries because of undeveloped central nervous system and brain functions, even though four⁶⁻⁹ of his references state the opposite. Those studies that led to publications took care of infants (babies) and not true neonates. Their papers⁶⁻⁹ plainly show on the day of surgery, their weight, gestation were all in the small baby stages and not *true* neonates, which in the true sense is an infant within the first 4 weeks of life and not weighing more than 3–4 kg in some instances. The study by Gruber *et al.*⁹ deals with babies 3–4 months old and weighing 4.5–5.1 kg. The Anand patients⁶⁻⁸ weighed approximately 3.5–3.6 kg, which is far from a neonate's weight. Gruber's patients⁹ had cardiac surgery *via* cardiopulmonary bypass. No wonder they had general anesthesia. Therefore, these authors mixed up the definitions of neonates and babies like apples and oranges.

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In Reply:

The editorial did not intend to argue that infants or neonates don't perceive pain and thus don't need analgesia and anesthesia for surgical procedures.¹ There is now very good evidence that painful stimuli increase cortical activation in preterm and term neonates.² The aim of analgesia therefore is not just to "cloud their minds," but to reduce acute distress and the morbidity associated with physiologic and behavioral responses, and also to minimize increases in activity in nociceptive pathways that can produce long-term changes in neuronal architecture and subsequent behavior.³ Neonates should be provided with effective analgesia for surgical procedures.

It is difficult to know the relevance of some of the studies quoted by Dr. Lippmann. Many aspects of care have changed since the 1970s. In 1976, Dr. Lippmann reported an acute mortality of 38%,⁴ and 3 of the 19 infants who survived to discharge also had neurologic impairment.⁵ Such mortality would be unacceptable now. However, more recent studies find significant rates of neurosensory impairment after surgical patent ductus arteriosus closure.⁶ These findings emphasize the enhanced sensitivity of the developing nervous system to early life insults, although the exact causes for these changes remain unclear.

Rather than argue there is no need for anesthesia, the editorial was intended more to question what we are aiming to achieve with general anesthetics. In an adult, we clearly wish the patient to be unconscious and have no memory. This gives us a measure of effective anesthesia. Neonates have no explicit memory, and it is difficult to assess a clear point of unconsciousness. On a practical level, this makes it very hard to determine what dose we should give. To take the argument one step further, the editorial raised the question of whether or not they need to be unconscious at all. From a humane perspective, most would also argue it is appropriate to strive to prevent both their pain and distress, regardless of any evidence for or against a quantifiably better outcome. But does a neonate need to be rendered oblivious with the commonly used general anesthetics to prevent distress? Perhaps not; perhaps opioids or other sedatives are sufficient to prevent distress. However, giving enough general anesthetic is certainly one way to guarantee they are not distressed (although this is easier said than done as we don't know the dose needed).

Another aim of anesthesia is to attenuate the humeral and cardiovascular responses to surgery. Given their vulnerability, this aim may be of particular importance to neonates; but once again we have little idea which anesthetic technique is optimal for this. We share Dr. Lippmann's concerns about causing hypotension. In neonatal anesthesia the fundamental requirement to avoid cardiovascular instability and respiratory compromise is far more important than any concern over possible neurotoxicity from too much anesthesia, or that a neonate may perceive vague sensations from too little. In other words, we don't know if neurotoxicity or nondistress-

ing awareness are clinically relevant, but we do know that hypotension and hypoxia are; don't use techniques to avoid largely unproven theoretical risks if they increase real risks.

Finally, we do not agree that there is no possibility to translate animal studies to humans. Rather than suggesting an "either/or" approach, collaborative and complementary laboratory and clinical studies are required, with an awareness of their relative strengths and limitations. Laboratory studies cannot evaluate the clinical impact or clinical effect size of potential alterations in neurodevelopment, and clinical studies cannot easily evaluate mechanisms at a network and cellular level or fully control for confounding illness and environmental factors.

In summary, rather than suggest neonates don't need anesthesia, our suggestion is that we need to carefully assess what we are actually trying to achieve with anesthesia in neonates. The neurotoxicity of general anesthetics may or may not be clinically relevant, but at least, as Dr. Lippmann indicates, it should prompt us to think more carefully about how and why we anesthetize neonates.

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