

## Etiologic Factors in Determining Explosive Colonic Gas Mixtures

*To the Editor:*—The article by Freund and Radka<sup>1</sup> that described an intraoperative explosion during colon surgery implies that consumption of Ensure® (Ross Laboratories, Columbus, Ohio) liquid nutrition was a contributing factor. The implied cause and effect between consuming Ensure and the explosion are not supportable.

Colonic methane or hydrogen could have been the gases responsible for the explosion. Methane production is related to bacterial fermentation of dietary nutrients, but such fermentation is a hereditary function; or, more probably, related to bowel flora established during childhood.<sup>2</sup> After establishment of such flora, methane production is a cyclic, but relatively constant, phenomena that is unrelated to dietary intake.<sup>3,4</sup> Calloway and Murphy<sup>4</sup> suggested that methane-producing organisms were either consistently absent or present in the colon of individual patients, in spite of uniform inoculum and substrate provided by a constant diet. Even prolonged fasting before surgery does not remove the possibility that methane can be produced.<sup>3</sup> There is no direct evidence that methane was responsible for the explosion, and, in fact, the odds are 2:1 against methane being involved. Only 30% of people produce methane.

Colonic hydrogen (H<sub>2</sub>) production is dependent upon bacterial fermentation of carbohydrates, and is related to the amount of carbohydrate fed, malabsorption of certain carbohydrates (*e.g.*, mannitol or lactose), and oddly enough, is increased during periods of emotional stress.<sup>4</sup> The caloric content of Ensure derived from carbohydrate (54% of total calories) approximates that of a normal diet and is considerably less percentage-wise than that present in clear liquid diets also used for colon preparation before surgery or colonoscopy. Ensure is lactose-free so that aspect was not a problem. It is conceivable that the emotional and surgical stress or possibly preoperative medications affected H<sub>2</sub> production in this patient. However, considering all these issues, I cannot identify a feature of Ensure that contributed to the explosion more than any other diet might have.

Condon, Nichols, and others<sup>5-8</sup> have extensively pointed out the importance for mechanical cleansing and oral antibiotic preparation of the colon prior to surgery. Their work demonstrates major differences in the total bacterial counts between colons properly prepared and those totally unprepared. The overwhelming conclusions for the past ten years of colon preparation studies have shown that a properly prepared colon has

a markedly lower complication rate in wound breakdown and septic events. Although the focus has been with resultant septic complications, one might infer that with proper mechanical and antibiotic treatment the resulting reduced colonic bacterial flora would attenuate any possible fermentation that might otherwise be present. I would strongly urge Drs. Freund and Radke to consider detrimental effects of an improperly cleansed colon rather than any special dietary preparation. We have modified our bowel preparation protocol over the past year to routinely provide Ensure (1,500–2,000 calories a day) for three days prior to surgery. Of course, standard enemas, laxatives, and antibiotics are also administered. With the above regimen, we have actually found the colon to be cleaner with less gas and liquid feces present than found in previous patients receiving standard clear liquid preparations.

Although our standard practice is to enter the colon with the scalpel, we have on occasion used the electrocautery on patients who have received our Ensure bowel prep and have experienced no difficulty.

In summary, I feel if the cause could be determined for this patient's misfortune, it was more likely related to inadequate mechanical and antibiotic preparation of his colon rather than any form of dietary intake. I certainly do not feel the Ensure should be implicated and, in fact, strongly encourage and endorse its use as an adjunctive measure in the preoperative preparation of the patient for colon surgery.

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*In reply:*—This is in response to the letter from Dr. Rumley. All of his points are almost meticulously correct and are well-taken, including the statements of implied cause and effect. However, we have considered the detrimental effects of improperly cleansed colons and this was clearly discussed in paragraph four of the discussion.

When the risks of parenteral administration equal the risks of long-term pulmonary aspiration in esophageal and dysphagic problems, peroral bulk of any kind must be avoided. Obviously, in these patients, orally administered antibiotic bowel preps also most likely will be less than optimum in terms of fermentative bacterial growth inhibition.

The conspiracy of factors including inadequate control of bacterial flora, fermentation of a nitrogen-carbohydrate substrate, explosive gas trapped by a cutting stapler, application of heat and spark, are cause and effect. One might add that we sometimes are not masters of our technology, and then in a sequential fashion get lulled and hoisted by our own petard. All of the explosion hazard and O.R. designs would not help this patient.

Certainly Ensure does not cause explosions. Sparks do. Since spectrophotometric studies were not done of

the explosion, it is impossible to determine the absolute components of the explosive mixture. Nevertheless, we will no longer open the colon with electrocautery, whether it be empty or full, clean or dirty, prepared or unprepared—unless it is vented or suctioned. We will certainly continue our efforts according to the excellent principles of bowel preparation expressed by Dr. Rumley, including the use of Ensure or an equivalent.

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## Nitrous Oxide and the Prevention of Tension Pneumocephalus after Craniotomy

*To the Editor:*—In a recent clinical report,<sup>1</sup> Artru states that his intraoperative observations of increased ICP with introduction of N<sub>2</sub>O and decreased ICP with discontinuation of N<sub>2</sub>O after dural closure in the sitting position fail to support my proposal for prevention of tension pneumocephalus in the *postoperative* period. I suggested that “it may be advantageous to maintain anesthesia with high inspired concentrations of nitrous

oxide until dural closure so that a pneumocephalus that formed intraoperatively would contain nitrous oxide that would then be reabsorbed rapidly when nitrous oxide was discontinued.<sup>2</sup> What Artru actually noted was a dramatic increase in ICP when nitrous oxide was *continued* after dural closure. There was then a rapid decrease in ICP (within five minutes) after discontinuing nitrous oxide. Had nitrous oxide been discontinued