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Commentary: Exiting the highway to the danger zone

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CENTRAL MESSAGE

A surgeon's willingness to critically evaluate their own techniques and outcomes is imperative for continued improvement in the field of pediatric cardiothoracic surgery.

Cardiac surgery is not unlike flying fighter jets in that "the further on the edge, the hotter the intensity."[1] We are practicing in an era marked by a large volume of complex cases and increased transparency of surgical outcomes. It is indisputable that we are often pushing the limits of our scientific knowledge and our many "danger zones" are on display. As part of our adaptation to this reality, we need to become increasingly self-critical with the goal of recognizing our weaknesses as surgeons and modifying them to achieve the optimal outcome for our patients.

This manuscript is a single-center study from Vanderbilt analyzing the association between chest tube placement after congenital cardiac surgery and right-sided diaphragm paralysis/paresis. The authors hypothesized that their unusually high rate of right hemi-diaphragm elevation in their patients was related to injury of the phrenic nerve by the chest tube, which was placed in an area they termed the "danger zone."[2] After a single intervention, changing the position of the tube to avoid this location, the incidence of right hemi-diaphragm elevation was reduced from 6.6% to 0%.

I applaud the authors in their attempts to mitigate a known problem after cardiac surgery in infants and children. Given that phrenic nerve injury can create morbidity and prolong the hospital length of stay,[3-7] attempts to reduce the incidence are warranted. The potential for a chest tube to create phrenic nerve damage has been posited before,[7] but in the present study there was a definite association between chest tube position after cardiac surgery and ipsilateral phrenic nerve dysfunction.

As acknowledged by the authors, there are some limitations to this study. First, chest tube choice and location are very surgeon dependent and thus the concept of the "danger zone" for chest tube placement is somewhat nonspecific. The standard chest tube in this study was a 19 French Blake drain (Ethicon, Sommerville, NJ) that is inserted into the right pleural space. This seems to be a very large size drain for infant patients. Would this finding be consistent with different types of tubes in different sizes if they terminated in the same location? In addition, would there be a difference if the tube was placed via a subxiphoid incision below the sternotomy such that the tube first traversed the mediastinum before entering the pleural space? Are these conclusions applicable to the left-sided diaphragm paralysis?

Second, this is a heterogeneous patient population, and the study does not control for other anatomic or operative risk factors that might also increase the risk of diaphragm paralysis. Previous studies have shown that reoperations are at greater risk of diaphragm paralysis.[6] Is it possible that those with right-sided diaphragm paralysis are more "at-risk" for this injury than those without? Lastly, the post-intervention group is quite small compared with the

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preintervention group. Given that zero patients developed phrenic nerve injury in the postintervention group, a larger study group would create more power to detect a significant difference.

Despite these limitations, there are important strengths that make this manuscript worthy of attention. This paper reports an unusually high rate of diaphragm paralysis at nearly 7%, which is greater than previously described[3-5] and represents an excellent example of how a quality-improvement program with a concrete intervention can provide a favorable outcome within an institution. It must be emphasized that this manuscript does not definitively prove a causal relationship between the location of the chest tube and phrenic nerve compression. There are most definitely some confounding factors. However, if a change in position of the tube drastically reduces phrenic nerve injury without any additional risk to the patient, then this approach should be considered by other surgeons as they evaluate their own chest tube techniques and the outcomes associated with them.

The most impressive aspect of this manuscript is not the data, but the authors' humility and transparency in presenting it. The surgeon readily acknowledges that surgical his technique may be causing the injury, studies that technique, and then makes a concrete change in practice to improve the outcomes. It is not uncommon that as surgeons we become so fixated on our own methodology that we are unable to see flaws that could be improved. Although this unwillingness to admit our own potential faults rarely causes direct harm to patients, it can prevent transcendence into excellence. This research is designed and interpreted without ego and with a clear focus on improving patient outcomes and sharing acquired information with other surgeons who could also benefit. This example of self-awareness and the use of an analytical approach to surgical technique improvement should be commended. The manuscript subtlety models how all cardiac surgeons can improve their own patient outcomes by detouring slightly off the highway to avoid the literal and figurative "danger zones" in cardiac surgery.

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