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# Strangulation With Intravenous Tubing: A Previously Undescribed Adverse Advent in Children

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**ABSTRACT.** Nonintentional strangulation in children is a widely recognized risk as a result of the vulnerability of their airway to occlusion by relatively low pressures. We describe 2 cases of strangulation by intravenous (IV) tubing in infants, 1 of which was fatal. This is the first documentation in the health science literature of this as a potential adverse consequence of IV therapy in young children. It is important that hospitals that care for such children recognize this potential risk and implement the appropriate strategies to minimize or eliminate it. Preventive interventions may include ongoing assessment of the need for continuous rather than intermittent IV infusions (saline or heparin locked IV sites), individualized level of supervision according to the child's age and behavior, and engineering modifications to the IV equipment. *Pediatrics* 2003;111:e732–e734. URL: <http://www.pediatrics.org/cgi/content/full/111/6/e732>; wounds and injuries, asphyxia, suffocation, accident, infants, safety management, beds, airway obstruction, prevention, hospital practice.

ABBREVIATIONS. IV, intravenous; PICU, pediatric intensive care unit.

Nonintentional self-strangulation of children with loose wires, cords, or other potential ligatures in or adjacent to sleeping areas is well-described.<sup>1,2</sup> A recent study from the US Consumer Product Safety Commission analyzed 2178 fatalities that occurred between 1980 and 1997, describing several patterns of unintentional infant suffocation. "Entanglement" leading to strangulation was responsible for 14.3% of the fatalities. Plastic bags, bedding (nonplastic), blind/drapery cords, pacifier cords, and other types of cords were the most common sources.<sup>3</sup>

Intravenous (IV) therapy is a common treatment modality for children who are admitted to a hospital; hence, if there is a serious risk of strangulation associated with its use, then it is critical that health care providers be aware of it. With the help of a qualified health librarian, we searched the health literature

and could find no previous description of this risk. We present 2 cases of mechanical asphyxia caused by IV tubing, 1 of which was fatal.

## CASE REPORTS

The first case involved an 11-month-old boy who had a history of prematurity and mild respiratory distress syndrome after being born at 28 weeks gestation and who remained in the neonatal intensive care unit for ~3 months. After being home for 8 months, the child was admitted to the hospital with a diagnosis of pneumonia and dehydration. Although his motor development was somewhat delayed as a result of his prematurity, during his hospitalization the child could roll, sit, and pull himself to stand in the crib. He was treated with oxygen therapy, IV fluids, and antibiotics. During the 24 hours before this fatal strangulation, the nurses and mother had noted the child to become entangled in IV tubing 3 or 4 times around either the abdomen or the legs. On the day before his planned discharge, he was receiving IV antibiotics but no longer required oxygen therapy. The last nursing check was done at 1630 hours, at which time the child was stable. The parents went home at that time. However, at 1715 hours, the nursing staff found the child lying in his crib apneic and pulseless with the IV tubing wrapped 3 times around the neck. A cardiac arrest code was called, and after 22 minutes of resuscitation, including intubation and 3 doses of IV epinephrine, bicarbonate, and atropine, he regained a hemodynamically stable cardiac rhythm. He was then transferred to the regional pediatric intensive care unit (PICU). On physical examination, there were erythematous marks around the child's upper neck consistent with strangulation marks by IV tubing, and the child had seizures on arrival. Both pupils became fixed and dilated. Because there was no chance for meaningful recovery, the family agreed to withdraw therapy 48 hours after admission to the PICU. The autopsy was consistent with death resulting from asphyxial damage from the IV strangulation. The IV pump (IMED, Alaris 960 A; Alaris Medical Systems, San Diego, CA) was examined by the hospital biomedical engineering department and was found to be operating as per the manufacturer's specifications. The length of the IV tubing, which extended beyond the IV pump to the patient, was 165 cm.

The second case involved an 8.5-month old boy who was transferred from a peripheral hospital to the regional children's hospital with an invasive group A streptococcal cellulitis, secondary to chickenpox. Meningitis, pneumonia, bilateral otitis media, and anemia complicated his hospitalization. During the admission, he experienced a right-sided focal seizure, and neuroimaging revealed left occipital lobe abscess and a left superior parietal cerebritis. Cerebrospinal fluid cultures were positive for enterococcus. One month after admission, he was still receiving IV antibiotics through a percutaneously inserted central catheter for the enterococcal abscess and meningitis. One evening, at 1800 hours, the nursing staff performed a routine assessment and noted that his percutaneously inserted central catheter line was infusing well. At 1825 hours, he was observed by nursing staff to be sitting in his crib awake, then at 1835 hours was found sitting forward with his head on his lap and the IV tubing wrapped tightly 2 times around his neck. The tubing was 304 cm in total length from the bag, filling chamber, IV pump segment, and the extension to the patient. He was noted to be pulseless and apneic and hence cardiopulmonary resuscitation was initiated. He received full cardiorespiratory resuscitation with intubation, although he was noted to gasp after initial mouth-to-mouth respiration. During resuscitation, he had 2 generalized clonic seizures. The child was

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**Fig 1.** IV tubing enclosed in a plastic sleeve to prevent entanglement.



subsequently transferred to the PICU, and he eventually made an uneventful recovery. Neuropsychological assessment 2 weeks after the event, at 10 months of age, revealed a mild delay in cognitive (7 months) and motor function (8 months) but advanced social skills (12 months).

#### DISCUSSION

We believe that these are the first 2 cases of IV tubing strangulation described in the health literature. Our biomedical engineers accessed a database created by the Emergency Care Research Institute, which briefly describes 2 cases of fatal strangulation by IV tubing in the United States occurring in 1984 and the other in 1997. The actual risk of IV tubing strangulation in children is not known. As in other areas of medical misadventure, there may be an underreporting of this type of event.

The risk associated with cords placed close to children is well-described in the literature.<sup>2,3</sup> We found 1 case of nonfatal strangulation by the wires from an apnea monitor in a child.<sup>4</sup> The force necessary to asphyxiate a child seems to be relatively small<sup>5</sup>; therefore, they are particularly vulnerable to this airway compromise.

As in most areas of injury, prevention remains the best strategy. As any injury prevention initiative, passive primary interventions need to be implemented. First, it is important to examine critically the need for IV therapy in any child who is admitted to a hospital. If continuous fluid administration is not required but IV access is still needed, then the use of locking devices for peripheral and central lines is indicated. In our estimation, risk is related to the child's cognitive level, age, mobility, and the length of the IV tubing. The number of fatalities caused by entanglement was significantly higher in the group of children older than 7 months in the study by Drago and Danenberg.<sup>3</sup> In addition, the overall number of tubings and lines (eg, oxygen tubing, pulse oximetry, electrocardiographic leads, IV lines) required for care may increase the risk of strangulation; however, we do not have any data to support

this. It is not infrequent to see IV lines and other cables tangled when patients are very mobile, perhaps increasing the risk of pulling and tightening them around their limbs. Nonetheless, children who need more than 1 IV line and several other types of cords (saturation cable, electrocardiogram monitor leads, etc) are usually sicker, hence less mobile and under more constant supervision.

As another primary active prevention strategy, it is necessary to focus on reducing the potential of flexible lines and tubings to "wrap" and thus encircle limbs or the neck. A Canadian entrepreneur has developed a rigid, clear plastic sleeve that may be placed on the IV and any other tubing/wire close to the child. This device prevents the tubing from wrapping, while maintaining the function of the device and mobility of the child (see Fig 1).

As secondary active prevention initiative, the level of supervision necessary for any child needs to be scrutinized. For example, all children who are between 3 months and 3 years of age and admitted to the Stollery Children's Hospital and require IV therapy are evaluated regarding risk factors for entanglement. The bedside nurses, following a specific "policy and procedure" guideline, evaluate the potential risk on a shift-to-shift basis and take appropriate nursing actions on the basis of the risk assessment. Interventions for children who are deemed to be at risk include increasing the level of staffing or moving the child to a location where he or she can be observed more frequently.

To our knowledge, these are the first cases in the medical literature to describe strangulation by IV tubing; thus, it is important to recognize this as a potential adverse event in children who receive IV therapy. Carefully selecting patients for IV therapy, evaluating the appropriate level of supervision according to the child's age and behavior, and working with the industry to design safer systems should help to ensure that hospitals become safer places for children.

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