



Efficacy of Intravenous and Endotracheal Epinephrine during Neonatal Cardiopulmonary Resuscitation in the Delivery Room

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A retrospective examination is presented of intravenous vs a lower (0.03 mg/kg) and higher (0.05 mg/kg) dose of endotracheal epinephrine during delivery room cardiopulmonary resuscitation. Repeated dosing of intravenous and endotracheal epinephrine is needed frequently for successful resuscitation. Research regarding optimal dosing for both routes is needed critically. (*J Pediatr* 2017;185:232-6).

To evaluate the efficacy of intravenous (IV) vs endotracheal (ET) epinephrine administered during delivery room cardiopulmonary resuscitation (CPR), a retrospective cohort was studied from 2006 to 2014. Repeated dosing of both IV and ET epinephrine was required frequently for successful resuscitation. Further investigation of the optimal dosing for both routes is needed.

Neonatal CPR in the delivery room is rare, as less than 0.1% of newborns receive extensive resuscitation in the form of chest compressions with or without the use of epinephrine.^{1,2} Cardiovascular collapse in the neonate primarily is the result of fetal asphyxia around the time of birth and has high rates of mortality and morbidity.^{1,3-6} To achieve return of spontaneous circulation (ROSC) after asystole or severe bradycardia, the delivery of epinephrine often is essential. The American Academy of Pediatrics/American Heart Association Neonatal Resuscitation Program (NRP) recommends the administration of epinephrine if a heart rate greater than 60 beats per minute is not achieved with what appears to be adequate ventilation and cardiac compressions.⁷ Two routes of epinephrine administration have been used most commonly: ET and IV (primarily via umbilical venous catheter). In 1999, the American Academy of Pediatrics/American Heart Association guidelines recommended administering 0.01-0.03 mg/kg (0.1-0.3 mL/kg) of 1:10 000 epinephrine solution either via the ET or IV route.⁸ In 2006, greater emphasis was placed on the use of IV epinephrine and a greater dose of 0.03-0.1 mg/kg ET epinephrine was recommended if IV access was not available.⁹ Subsequently, the 2010 guidelines recommended further increasing the ET dose to 0.05-0.1 mg/kg (0.5-1 mL/kg).¹⁰ This recommendation primarily was based on one retrospective study in which the authors suggested that ET epinephrine frequently was ineffective compared with IV dosing¹ but was supported by studies in animals in which greater doses of ET epinephrine (0.05-0.1 mg/kg) were needed to achieve the same epinephrine blood concentrations and hemodynamic responses as IV epinephrine (0.01 mg/kg).^{11,12}

The objective of our study was to compare the efficacy of ET epinephrine with IV epinephrine and to determine whether the use of a greater ET epinephrine dose (0.05 mg/kg) was more efficacious than a lower dose of 0.03 mg/kg during neonatal delivery room CPR. We hypothesized that ET epinephrine would be less efficacious than IV epinephrine, even at a greater starting dose of 0.05 mg/kg.

Methods

Parkland Memorial Hospital is a large county hospital in Dallas, Texas, with approximately 11 000-16 000 deliveries a year over the past decade. Since 1989, Parkland has had a dedicated neonatal delivery room resuscitation team whose purpose is to attend high-risk deliveries to resuscitate and stabilize newborn infants. The team consists of a senior pediatric resident or a neonatal nurse practitioner, a neonatal nurse with special training in delivery room resuscitation, and a neonatal respiratory therapist. In addition, a neonatal fellow or attending neonatologist is present at all premature deliveries less than 30 weeks' gestation and those deliveries in which extensive resuscitation is anticipated or needed unexpectedly.¹ The goal of the resuscitation team is to follow NRP guidelines and to focus on effective ventilation and establish a secure airway when necessary (usually with an ET) before proceeding to the next steps of the NRP algorithm. During resuscitation, the team works together using closed-loop communication. Interventions offered and the newborn's responses are recorded on a standardized form every 30 seconds by an obstetric circulating nurse, who becomes part of the team if the resuscitation team is called. In 1990, an institutional review board-approved, detailed resuscitation database was developed to document prospectively the events of all extensive neonatal delivery room resuscitations, including unsuccessful cases.

In January 2006, Parkland Hospital increased the ET epinephrine dose from 0.01 mg/kg to 0.03 mg/kg in response to the 2006 change in the NRP guidelines, which stated that

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| CPR | Cardiopulmonary resuscitation |
| ET | Endotracheal |
| IV | Intravenous |
| NRP | Neonatal Resuscitation Program |
| ROSC | Return of spontaneous circulation |

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0.03-0.1 mg/kg should be used during neonatal CPR.⁹ In July 2008, ET epinephrine dosing was increased further from 0.03 mg/kg to 0.05 mg/kg out of local concern that 0.03 mg/kg remained insufficient to achieve ROSC following review of the database. Undiluted ET epinephrine was delivered by direct injection into the hub of the ET followed by several positive pressure breaths to distribute the drug throughout the lungs for absorption followed by resumption of coordinated cardiac compressions and ventilations. The dose of IV epinephrine remained the same during the entire study period: 0.01 mg/kg for the first dose, 0.02 mg/kg for the second dose, and 0.03 mg/kg for the third and all subsequent doses. Repeat epinephrine doses were given 3-5 minutes apart whenever the heart rate remained less than 60 beats per minute despite CPR and medications.

The current study was approved by the institutional review board as a retrospective evaluation of the efficacy of IV vs ET epinephrine in the delivery room. Success rates of the lower and higher doses of ET epinephrine also were evaluated. The study included all newborns who received at least one dose of epinephrine in the delivery room at Parkland Memorial Hospital from January 2006 to July 2014. Choosing this time period allowed us to compare the efficacy between lower (0.03 mg/kg)

and higher (0.05 mg/kg) ET epinephrine doses. Infants with lethal anomalies and those born outside of the hospital were excluded. Successful resuscitation was defined as ROSC with a sustained audible heart rate greater than 60 beats per minute in the delivery room. Mortality was defined as death before hospital discharge.

Student *t* tests were used to compare normally distributed continuous data, and the Mann-Whitney *U* test was used to compare skewed (not normally distributed) continuous data. The χ^2 test was used for categorical data. Statistical significance was defined as a *P* value less than .05. All statistical analysis was performed with SigmaPlot (Systat Software, San Jose, California).

Results

During the 8.5-year study period, there were 114 367 births at Parkland Hospital. Of these, 56 (0.05%) received epinephrine in the delivery room (Figure). Baseline characteristics of infants who received initial ET vs initial IV epinephrine in the delivery room are found in the Table. The 2 groups were similar in all respects including birth weight, gestational age,

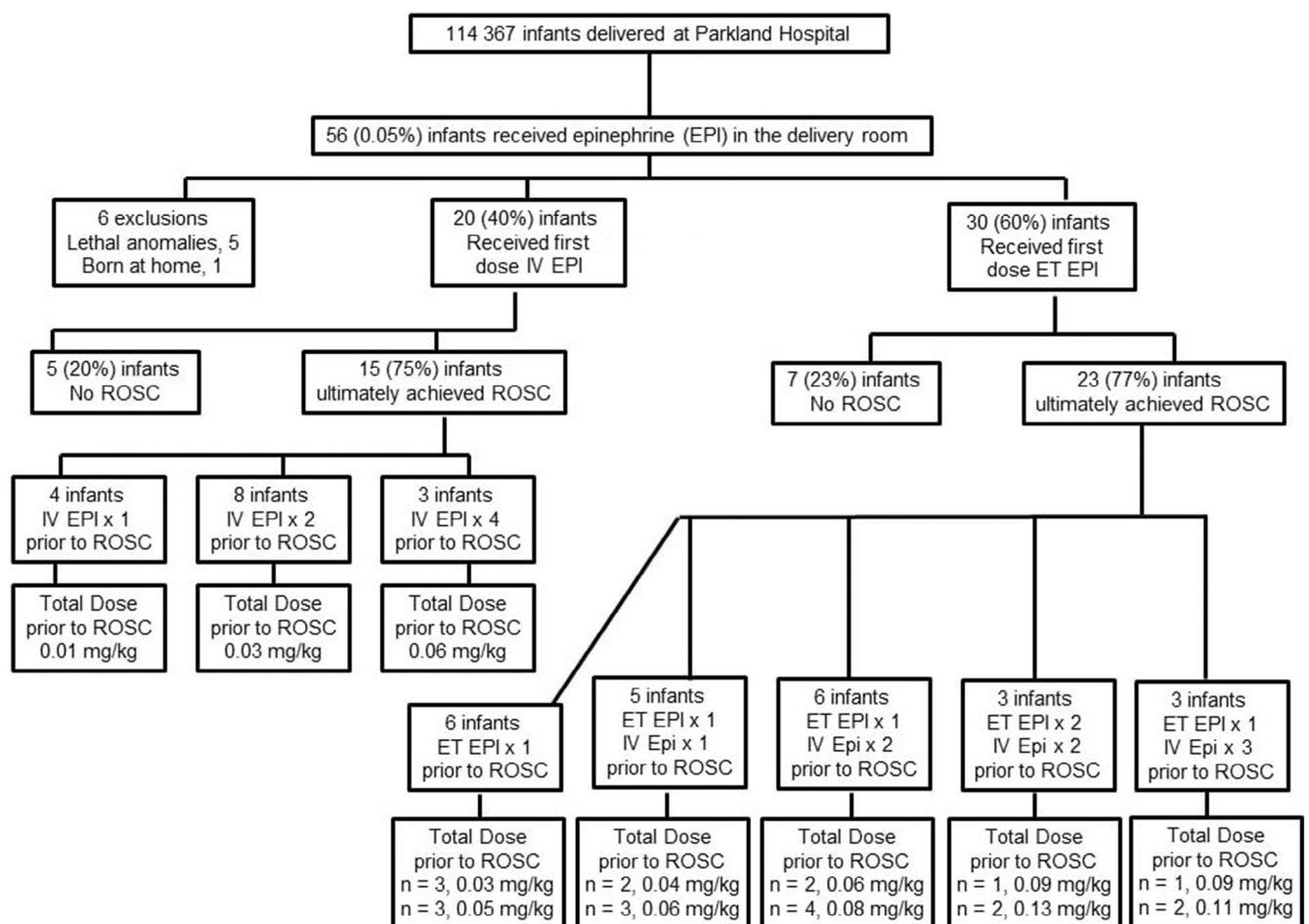


Figure. Infants receiving epinephrine in the delivery room (January 2006-July 2014).

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