DEFIBRILLATION

The Pediatric Task Force evaluated several issues related to defibrillation, including safe and effective energy dosing, stacked versus single shocks, use of automated external defibrillators (AEDs) in infants <1 year of age and paddle/pad type, size, and position. There were a few new human and animal studies on these topics, and the level of evidence (LOE) was generally 3 to 5. No new data are available to support a change in drug treatment of recurrent or refractory VF/pulseless VT. There were several human and animal publications on defibrillation energy dose, but the data are contradictory and the optimal safe and effective energy dose remains unknown.

The new recommendation of an initial dose of 2 to 4 J/kg is based on cohort studies showing low success in termination of VF in children with 2 J/kg. However, these studies do not provide data on success or safety of higher energy doses. The reaffirmation of the recommendation for a single initial shock rather than stacked shocks (first made in 2005) is extrapolated from the ever-increasing adult data showing that long pauses in chest compressions required for stacked shocks are associated with worse resuscitation outcomes and that the initial shock success rate is relatively high with biphasic defibrillation.

No changes are recommended in pad/paddle size or position. Although the safety of AEDs in infants <1 year is unknown, case reports have documented successful defibrillation using AEDs in infants. A manual defibrillator or an AED with pediatric attenuation capabilities is preferred for use in infants and small children.

Paddle Size and Orientation[Peds-029]

Consensus on Science

One LOE 5 study in adults[255] demonstrated that shock success increased from 31% to 82% when pad size was increased from 8×8 cm to 12×12 cm. Three pediatric LOE 4,[256,-,258] 3 adult LOE 5,[255,259,260] and 3 LOE 5 animal[261,-,263] studies demonstrated that transthoracic impedance decreases with increasing pad size. Decreased transthoracic impedance increases transthoracic current and, thus, presumably, transmyocardial current.

Pad Position

Consensus on Science

One pediatric LOE 4 study[264] observed no difference in the rate of ROSC between antero-lateral and anterior-posterior electrode positions for shock delivery. One pediatric LOE 2 study,[256] 2 adult LOE 5 studies,[265,266] and 1 LOE 5 animal study[263] demonstrated that transthoracic impedance is not dependent on pad position. Transthoracic impedance was increased in 1 adult LOE 5[267] study by placing the pads too close together and in 1 LOE 5[260] study when the pads were placed over the female breast. Additionally, 1 adult LOE 5[268] study showed that placing the apical pad in a horizontal position lowers transthoracic impedance.

Treatment Recommendation

There is insufficient evidence to alter the current recommendations to use the largest size paddles/pads that fit on the infant or child's chest without touching each other or to recommend one paddle/pad position or type over another.

Self-Adhesive Pads Versus Paddles[Peds-043A,Peds-043B]

Consensus on Science

There are limited studies comparing self-adhesive defibrillation pads (SADPs) with paddles in pediatric cardiac arrest. One pediatric LOE 4[264] study demonstrated equivalent ROSC rates when paddles or SADPs were used. One LOE 5[269] adult out-of-hospital cardiac arrest study suggested improved survival to hospital admission when SADPs rather than paddles were used.

One adult LOE 5[270] study showed a lower rate of rhythm conversion, and 1 small adult LOE 5[271] study showed at least equivalent success with the use of SADPs in comparison with paddles in patients undergoing cardioversion for atrial fibrillation. Two adult LOE 5[272,273] studies showed equivalent transthoracic impedance with SADPs or paddles. One adult LOE 5[266] and 2 LOE 5 animal[274,275] studies showed that SADPs had a higher transthoracic impedance than paddles.

One LOE 4[276] study described difficulty with fitting self-adhesive pads onto the thorax of a premature infant without the pads touching. One LOE 5[277] study demonstrated the improved accuracy of cardiac rhythm monitoring following defibrillation using SADPs compared with the combination of paddles and gel pads.

Using standard resuscitation protocols in simulated clinical environments, 1 LOE 5[278] study found no significant difference in the time required to deliver shocks using either SADPs or paddles, and 1 LOE 5[279] study found no significant difference in time without compressions when SADPs or paddles were used.

Treatment Recommendations

Either self-adhesive defibrillation pads or paddles may be used in infants and children in cardiac arrest.

Knowledge Gaps

Is the use of hands-on defibrillation safe for rescuers and does it improve outcome for infants and children in cardiac arrest (eg, by presumably reducing interruptions in chest compressions)?

Number of Shocks[Peds-022A]

Consensus on Science

There are no randomized controlled studies examining a single versus sequential (stacked) shock strategy in children with VF/pulseless VT. Evidence from 7 LOE 5 studies in adults with VF[221,280,-,285] supported a single-shock strategy over stacked or sequential shocks because the relative efficacy of a single biphasic shock is high and the delivery of a single shock reduces duration of interruptions in chest compressions.

Treatment Recommendations

A single-shock strategy followed by immediate CPR (beginning with chest compressions) is recommended for children with out-of-hospital or in-hospital VF/pulseless VT.

Knowledge Gaps

Are there circumstances during which the use of stacked or multiple shocks can improve outcome from pediatric cardiac arrest?

Energy Dose[Peds-023A,Peds-023B]

Consensus on Science

Two LOE 4[264,286] studies reported no relationship between defibrillation dose and survival to hospital discharge or neurologic outcome from VF/pulseless VT. Evidence from 3 LOE 4 studies in children in out-of-hospital and in-hospital settings[264,287,288] observed that an initial dose of 2 J/kg was effective in terminating VF 18% to 50% of the time. Two LOE 4 studies[286,289] reported that children often received more than 2 J/kg during out-of hospital cardiac arrest, with many (69%) requiring ≥3 shocks of escalating energy doses. One in-hospital cardiac arrest LOE 4 study[264] reported that the need for multiple shocks with biphasic energy doses of 2.5 to 3.2 J/kg was associated with lack of ROSC.

Evidence from 2 LOE 5 animal studies[290,291] observed that 0% to 8% of episodes of long-duration VF were terminated by a 2 J/kg monophasic shock and up to 32% were terminated by biphasic shocks. Animals in these studies received both fixed and escalated doses, and most required 2 or more shocks to terminate VF. In 1 LOE 5 animal study[263] the defibrillation threshold for short-duration VF was 2.4 J/kg, whereas in another[291] it was 3.3 J/kg.

In 4 LOE 5 animal studies[290,292,-,294] of AED shocks delivered using a pediatric attenuator, 50 J and 50→76→86 J (2.5 to 4 J/ kg) escalating doses were effective at terminating long-duration VF but required multiple shocks. In 1 LOE 5 animal study[295] 10 J/kg shocks were more effective at terminating long-duration VF (6 minutes) with 1 shock than 4 J/kg shocks.

In 2 LOE 4 pediatric studies[264,286] and 4 LOE 5 animal studies,[290,292,-,294] energy doses of 2 to 10 J/kg for short- or long-duration VF resulted in equivalent rates of survival. Myocardial damage, as assessed by hemodynamic or biochemical measurements, was less when a pediatric attenuator was used with an adult energy dose compared with a full adult AED dose, but the degree of myocardial damage was not associated with any difference in 4- or 72-hour survival. An LOE 5 animal study[295] found no difference in hemodynamic parameters or biochemical measurements of myocardial damage comparing biphasic 150 J (4 J/kg) with monophasic 360 J/kg (10 J/kg) shocks.

In 2 LOE 5 animal studies[290,291] biphasic waveforms were more effective than monophasic waveforms for treatment of VF/pulseless VT. There are no human data that directly compare monophasic to biphasic waveforms for pediatric defibrillation.

Treatment Recommendations

An initial dose of 2 to 4 J/kg is reasonable for pediatric defibrillation. Higher subsequent energy doses may be safe and effective.