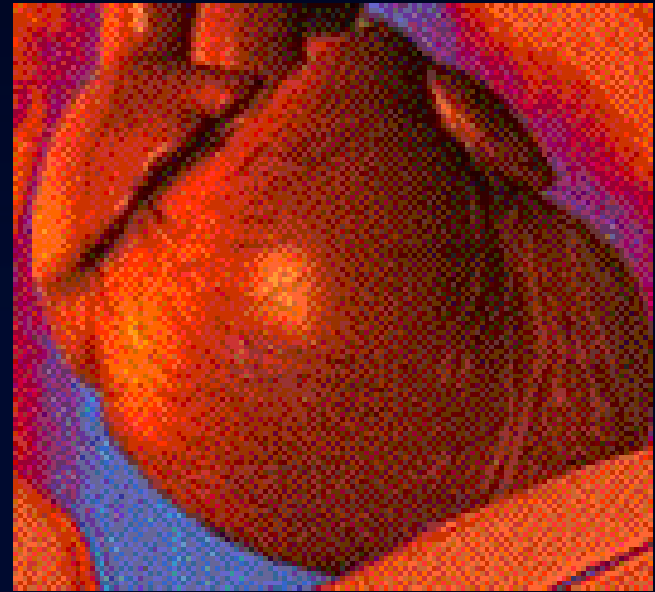


Updates in Paediatric Resuscitation

2005 International Guidelines:
Recommendations from NRC



By Dr Gene Ong
Dept of Emergency Medicine
KK Women's and Child's Hospital

5 phases of Cardiac Arrest

- Pre-arrest
- No Flow
- Low Flow
- Resuscitation
- Long term rehabilitation

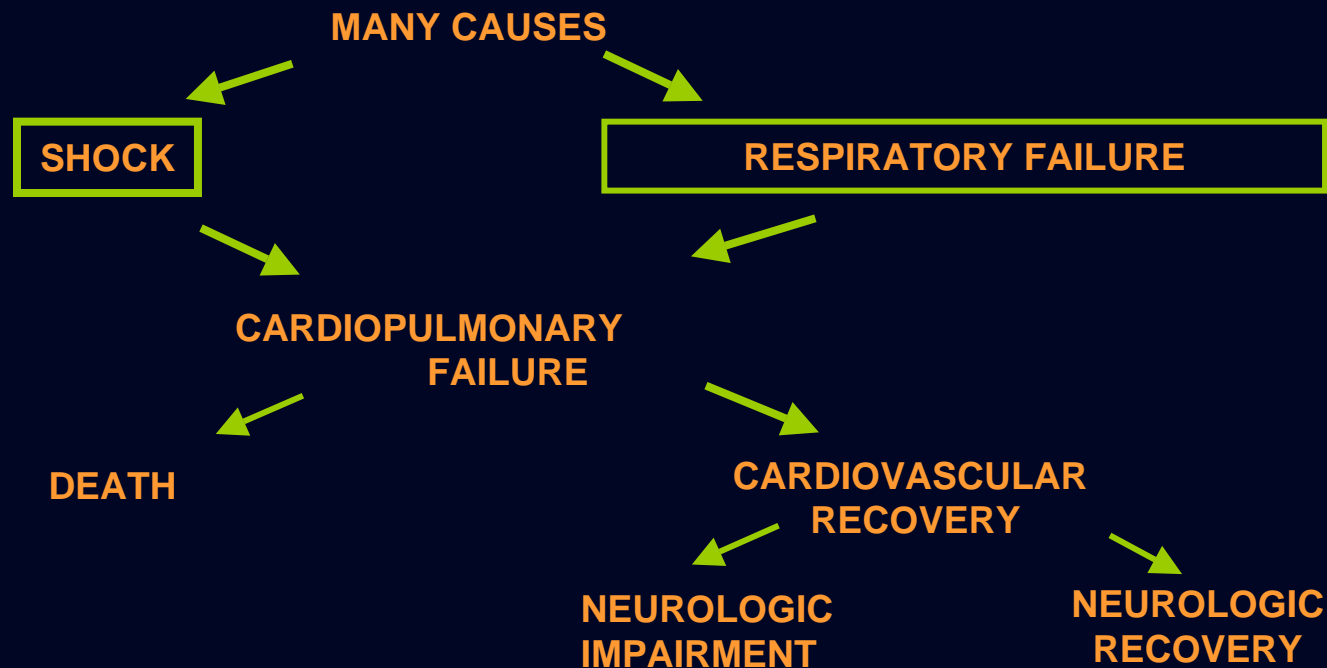
1: Pre-arrest

- Optimise community education regarding child safety
- Optimise patient monitoring
- Prioritise interventions to avoid progression of respiratory failure to cardiac arrest

Pre-arrest

- Prompt recognition of shock and respiratory failure and early intervention

CARDIOPULMONARY ARRESTS IN CHILDREN



2. No Flow(Arrest)

- 30% children receive bystander CPR in US
- In Singapore, only 22.9% of children received bystander CPR (*Tham and Chan 2005*)
- One of the positive predictor of survival was bystander CPR $p=0.03$

DO SOMETHING!

3. Low Flow (CPR)

- Push Hard
- Push Fast
- Full chest recoil
- Minimise interruptions
- Don't overventilate

4. Resuscitation(Immediate):

- Quality of CPR
(rate of 100/min, 10 ventilations/min)
- Airway:
 - Cuff vs uncuff ETT
 - Room air vs 100%
- Circulation:
 - Standard Dose Epinephrine vs High Dose Epinephrine
- Post resus management
 - eg hypothermia

Paediatric Resuscitation

NRC Recommendations



Call first vs Call fast

- If alone, do 5 cycles of CPR before activation of EMS
- If arrest is witnessed and sudden, Guidelines 2005 recommends calling first before starting CPR

NRC:

For simplicity of teaching, 5 cycles of CPR (~ 2 minutes) before calling EMS for all children and infants

CPR

Compression Rate and Ventilations

OLD

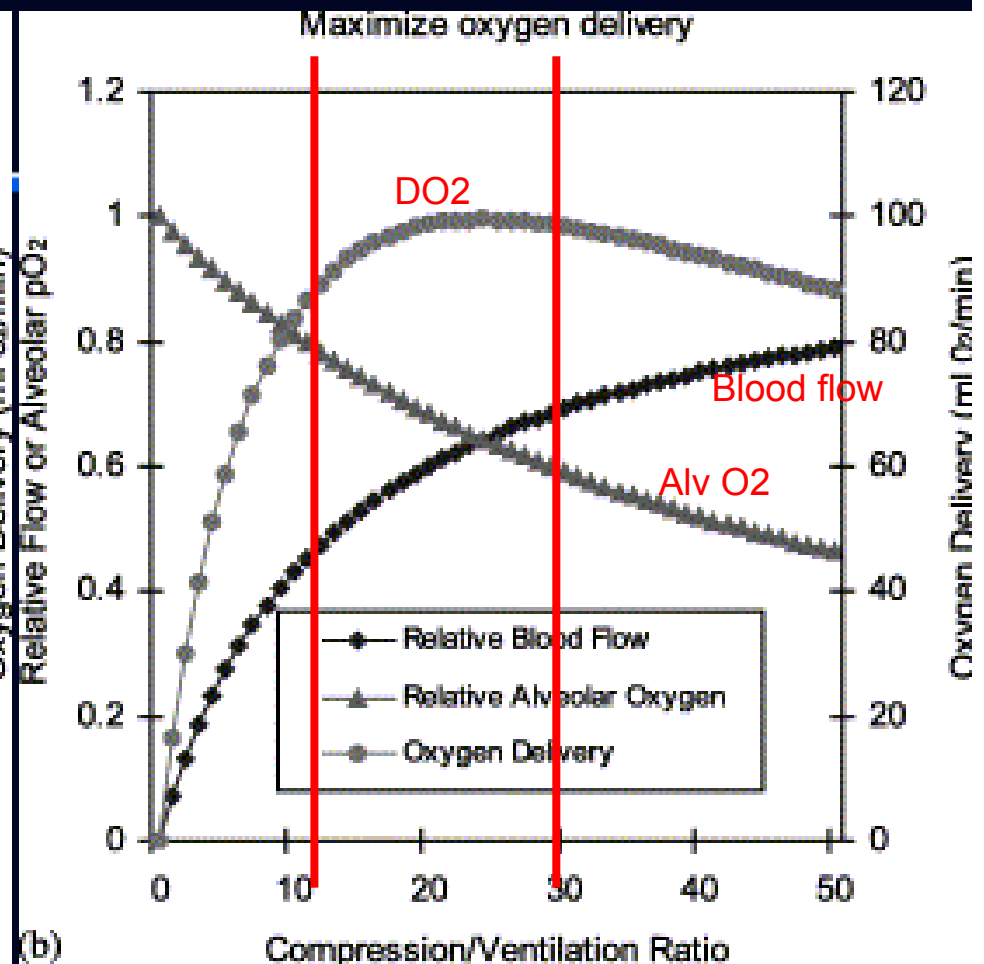
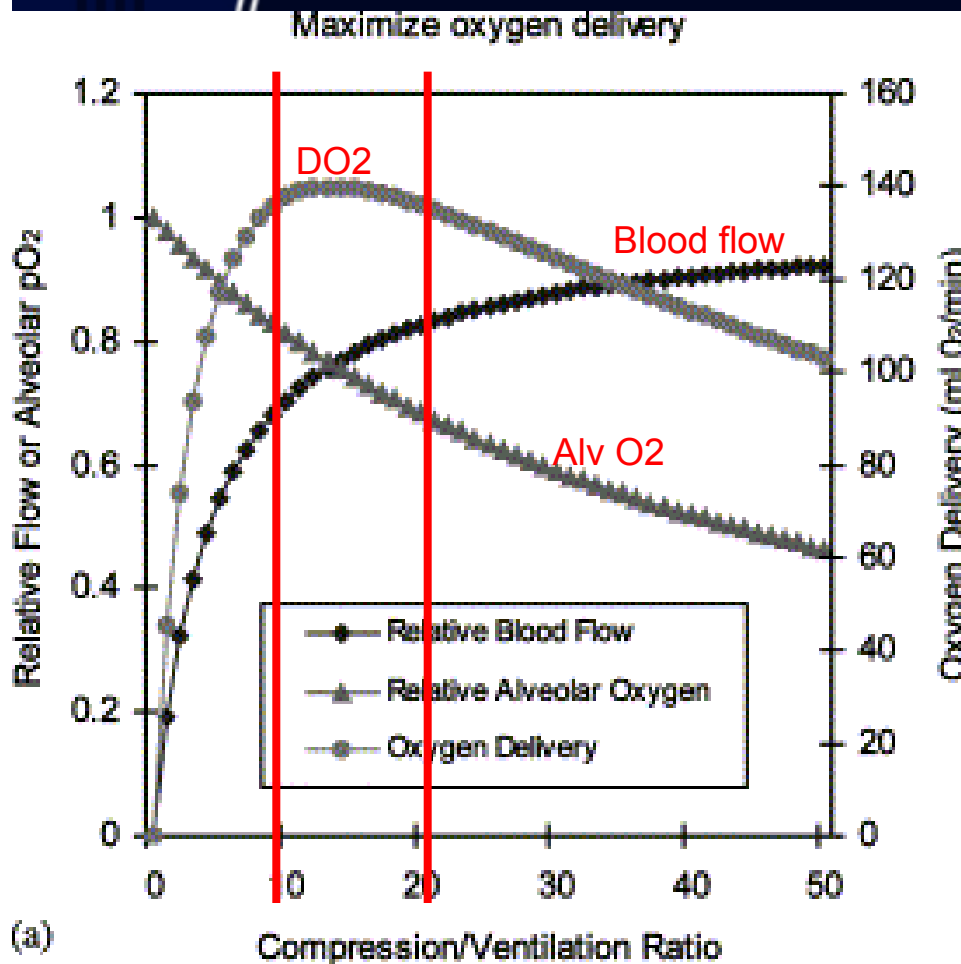
- Single rescuer
 - Adults 15:2
 - Child and infant 5:1

NEW

- Single rescuer
 - Adult, Child, Infant now are all 30:2 with compression ratio of \approx 100/min

Why change?

One universal compression-ventilation ratio of 30:2 limits the time between compressions and breaths and increases the number of compressions given and reduces the likelihood of hyperventilation, minimizes interruptions in chest compressions for ventilation, and simplifies instruction for teaching and skills



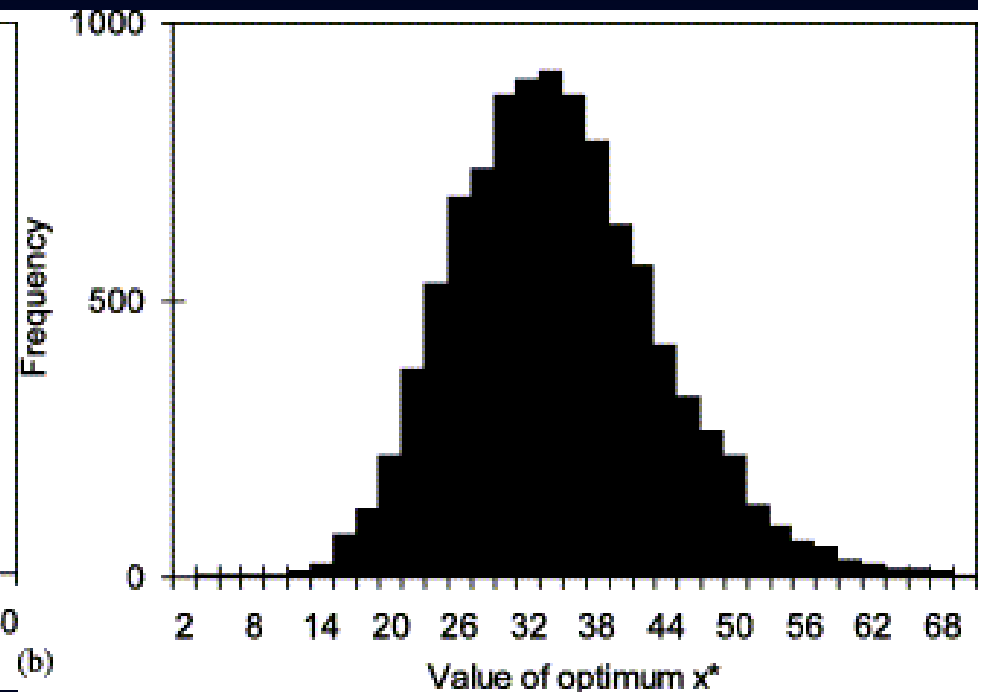
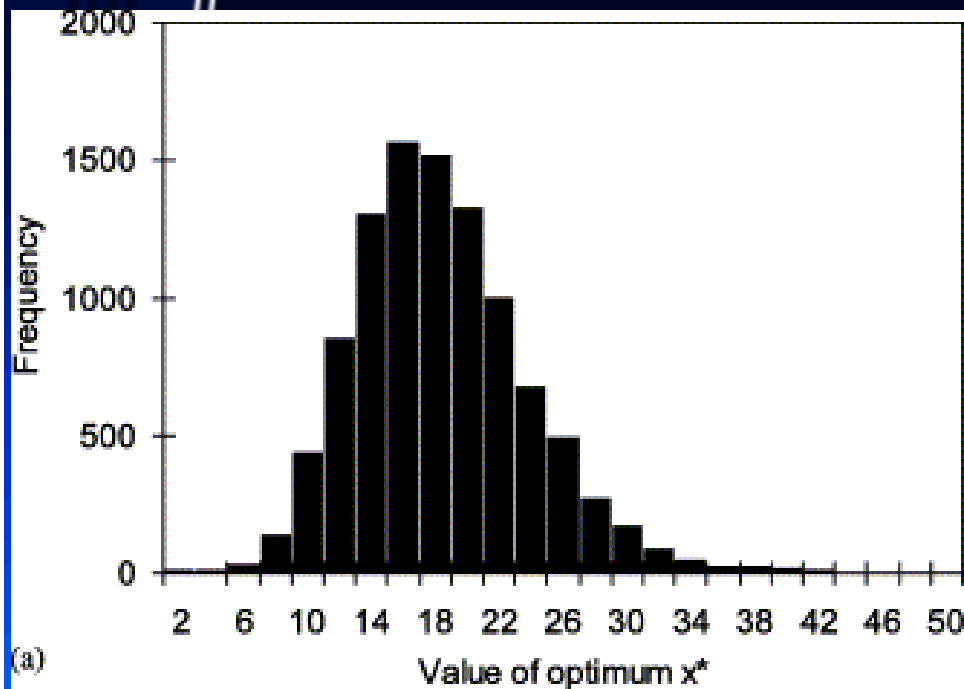
Oxygen delivery function of C/V ratio

(a) professionally trained rescuers (2 rescue breaths in 5 s)

(b) lay rescuers (2 rescue breaths in 16 s)

Babbs CF, Kern KB. Optimum compression to ventilation ratios in CPR under realistic, practical conditions: a physiological and mathematical analysis. Resuscitation. 2002 Aug;54(2):147-57.

For 10 000 simulations



OPTIMAL RATIO between 30:2 and 50:2

Evidence

“Bystander” chest compressions and assisted ventilation independently improve outcome from piglet asphyxial pulseless “cardiac arrest”

Berg RA et al. Circulation 2000;101:1743-1748

TABLE 4. Outcome Data

	CC+V	CC	V	No CPR
ROSC	10/10	6/10	6/10	4/10
ROSC (<2 min)	10/10‡§	4/10	6/10†	0/10
1-h survival	10/10	6/10	6/10	4/10
24-h survival	8/10‡	5/10*	6/10†	0/10
24-h neurologically normal	8/10‡	4/10	6/10†	0/10

ROSC (<2 min) Indicates ROSC during first 2 minutes of bystander CPR. Values are number of animals.

* $P \leq 0.05$ vs No CPR; † $P \leq 0.01$ vs No CPR; ‡ $P \leq 0.001$ vs No CPR; § $P \leq 0.01$ vs CC and V combined.

Paediatric BCLS

CPR Sequence (layperson)	Adult & Older children	Child (~1-8yrs)	Infant (< 1yr)
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Open Airway	Head-tilt, chin lift	Head tilt, chin lift	Head-tilt, chin lift
Check for breathing, if breathing, place in recovery position. If not breathing or agonal breathing: Initial breaths	2 breaths at 1 second per breath	2 breaths at 1 second per breath	2 breaths at 1 second per breath
Compression landmarks	Lower half of sternum	Lower half of sternum	1 FB below intermammary line
Compression method	Heel of 1 hand: other hand on top	Heel of 1 hand, with or without other hand on top	Ring and middle fingers
Compression depth	~1/2 to 1/3 depth of chest	~1/2 to 1/3 depth of chest	~1/2 to 1/3 depth of chest
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Foreign Body: Conscious	Abdominal thrust	Abdominal thrust	5 back blow-5 chest thrust
Unconscious	CPR, but to look for Foreign Body before breaths		

CPR Sequence (healthcare)	Adult & Older children	Child (~1-8yrs)	Infant (< 1yr)
Open <u>A</u> irway	Head-tilt, chin lift (jaw thrust if neck/HI)	Head tilt, chin lift (jaw thrust if neck/ HI)	Head-tilt, chin lift (Jaw thrust if neck/HI)
Check for <u>B</u> reathing. If not breathing/ agonal breathing: Bag & Mask	12 breaths per minute if for rescue breathing only	20 breaths per minute for rescue breathing only	20 Breaths per minute rescue breathing. In newly born:40-60/min
Check for <u>C</u> irculation: Pulse check	Carotid pulse	Carotid pulse	Brachial pulse
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Unconscious Choking Victim

OLD

- Child received 5 abdominal followed by checking the mouth
- Infant received 5 back blows and 5 abdominal thrusts followed by checking the mouth

NEW

- Adult, child and infant **all** receive **5 chest thrusts** after repositioning the head fails to deliver a breath

Why change?

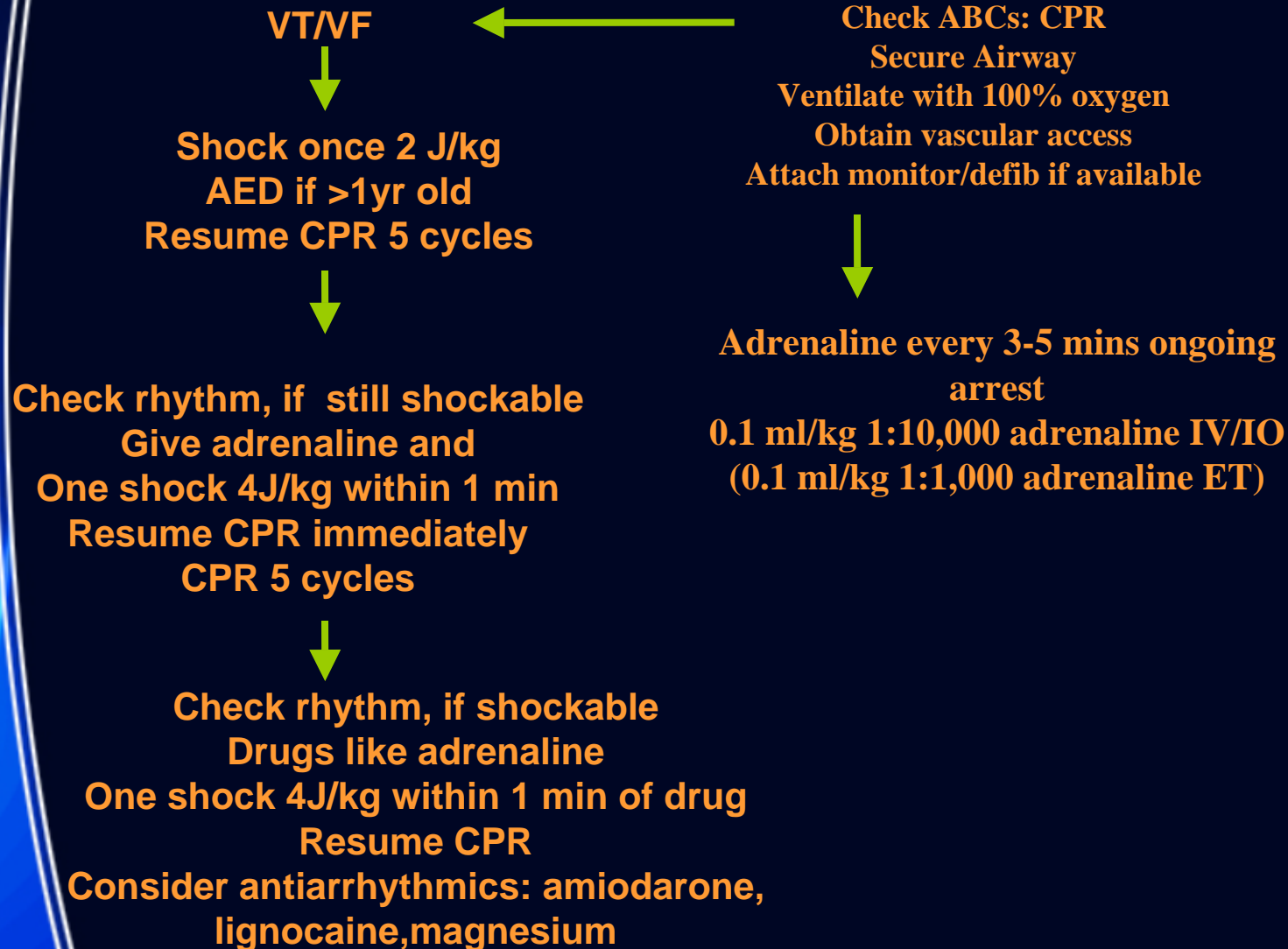
While case reports have demonstrated success in relieving FBAO with abdominal thrusts, higher airway pressures can be generated by using the chest thrust rather than abdominal thrusts.

Langhelle A, Sunde K, Wik L, Steen PA. Airway pressure with chest compressions versus Heimlich manoeuvre in recently dead adults with complete airway obstruction. *Resuscitation*. 2000; 44: 105–108.

Guildner CW, Williams D, Subitch T. Airway obstructed by foreign material: the Heimlich maneuver. *JACEP*. 1976; 5: 675–677.

Ruben H, Macnaughton FI. The treatment of food-choking. *Practitioner*. 1978; 221: 725–729.

Cardiac Arrest in Children (Advanced)



Standard Dose Epinephrine vs High Dose Epinephrine

68 children double blind



Survival after 24 hours
SDE 20.6% vs HDE 2.9%

Asphyxia group 30 children



12 in HDE: no survival

18 in SDE: 7 survival

**NRC: High dose adrenaline no longer routinely recommended
except ET dose**

Sao Paulo Perondi NEJM 2004

Hypothermia

Good neurological outcome at 6 months:
55% in hypothermia vs 39% normothermia

SA Bernard NEJM 2002

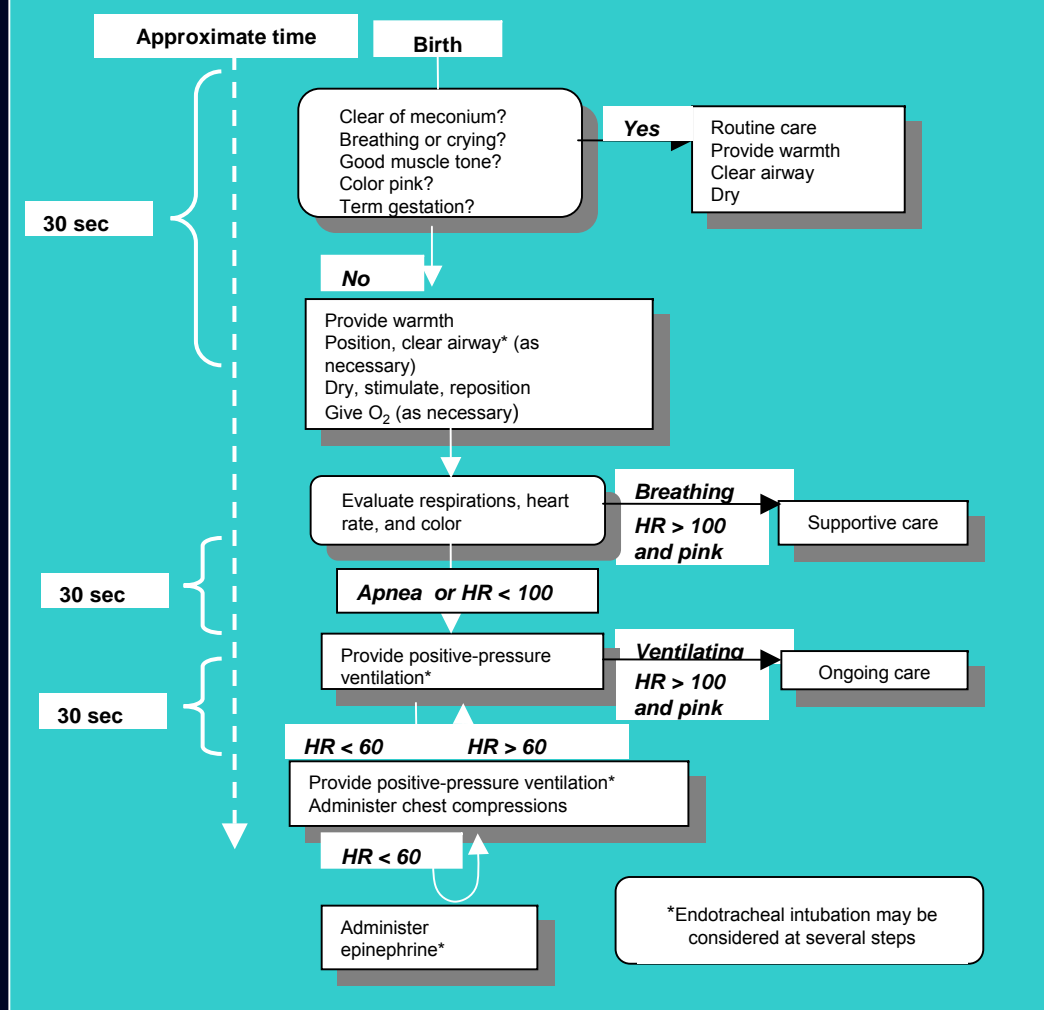
Hypothermia: Shivering, increase O₂ demand

Rewarming : Vasodilatation, hypotension

NRC: avoid hyperthermia

Newborn Resuscitation

Algorithm for Newborn Resuscitation



Oropharyngeal and nasopharyngeal suctioning of meconium-stained neonates before delivery of their shoulders: multicentre, randomised controlled trial

Nestor E Vain

	Suction (n=1251)	No suction risk	Relative (95% CI)
MAS	52 (4%)	47 (4%)	0.9 (0.6–1.3)
Need for mechanical ventilation for MAS	24 (2%)	18 (1%)	0.8 (0.4–1.4)
Mortality	9 (1%)	4	0.4(0.1–1.5)
Need for ETT, suction and PPV in the delivery room	106 (8%)	113 (9%)	1.1 (0.8–1.4)
Other resp disorders	61 (5%)	79 (6%)	1.3 (0.9–1.8)
Pneumothorax	3	3	1.0 (0.2–5.0)
Duration of O2 rx (days) in infants with MAS (mean, SD)	5.7, 8.8 (n=52)	5.1, 7.1 (n=47)	0.91
Duration of mv (days) in infants with MAS (mean, SD)	5.1, 4.9 (n=21)	4.2, 4.6 (n=14)	0.49
Duration of hosp care (days) in infants with MAS (mean, SD)	8.2, 10.7 (n=50)	9.0, 8.6 (n=43)	0.14

NRC: to continue practice of NP suctioning provided delivery of baby not delayed

Automated External Defibrillator (AED)

- Evaluates the victim's ECG
- Determines if a "shockable" rhythm is present
- Charges the "appropriate" dose
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Writing Group

R.A. Samson, MD*, R.A. Berg, MD*, R. Bingham, MBBCh, FRCA†

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In addition:

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RESUSCITATION



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Therefore, ILCOR encourages the placement of simple AEDs for use by first responders in public settings. In some settings, AED use has substantially improved the rate of survival from VF in adults [2,3]. The AED is the only defibrillator available for use by first-responding EMS personnel, and it is now consid-

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Defibrillation for Children

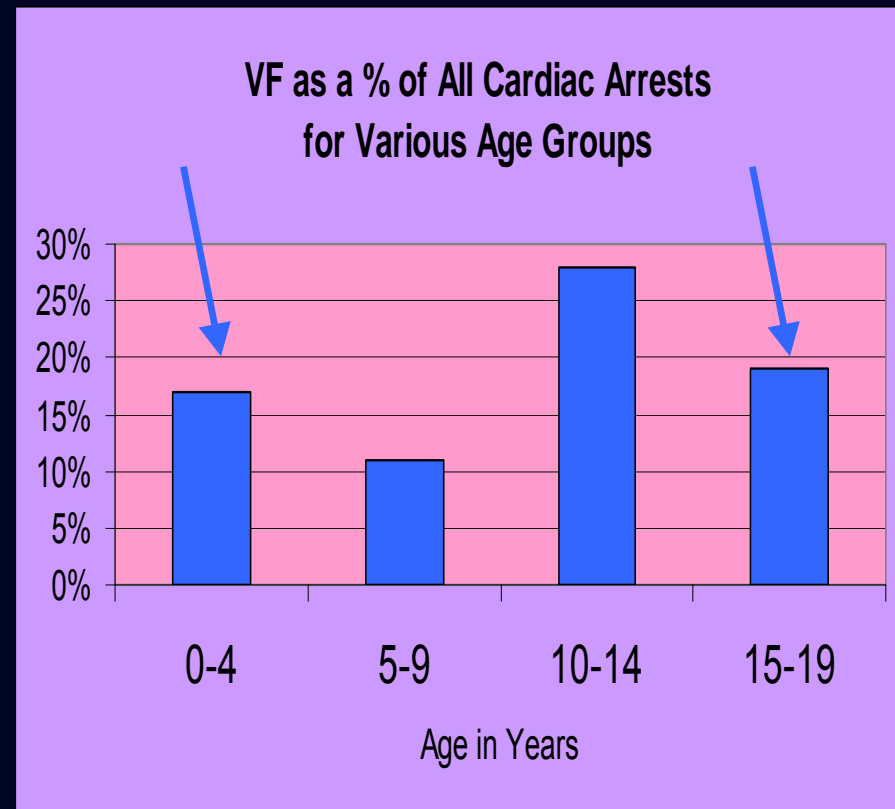
- **What Age?**
 - Do children have VF?
- **What Energy?**
 - What is safe?
 - What is effective?
- **Biphasic waveforms**
- **New Technology**
 - Rhythm identification
 - Attenuated pads

Do Children Have Ventricular Fibrillation?

- Incidence of ventricular fibrillation in children unknown
 - Resuscitation guidelines guided by in-hospital arrests
 - Cardiac rhythm *not* assessed in **40%** out-of-hospital pediatric arrests
 - Recent studies: 10-19% of pediatric arrests

Incidence of VF in Children

- The % of 0-4 year old VF is comparable to that of 15-19 year olds



Mogayzel et al. *Annals of Emergency Medicine* 1995;25:484-491

AED Use in Children

- 18 children, out-of hospital arrest
 - 9 with VF as presenting rhythm
- 67 analyses
 - 25 VF
 - 32 Asystole/PEA
- Sensitivity 88%
- Specificity 100%

Survival From Pediatric Out-of-Hospital Arrest

	<u>%VF</u>	<u>A/PEA</u>	<u>RR (95%CI)</u>
Mogayzel	17%	2%	4.5 (2, 8.1)
Paris	30%	2%	12.3 (7.2,21.2)
Losek	36%	5%	
Hickey*	25%	5%	20.1 (2.8,142)
Atkins	33%	11%	

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Defibrillation for Children

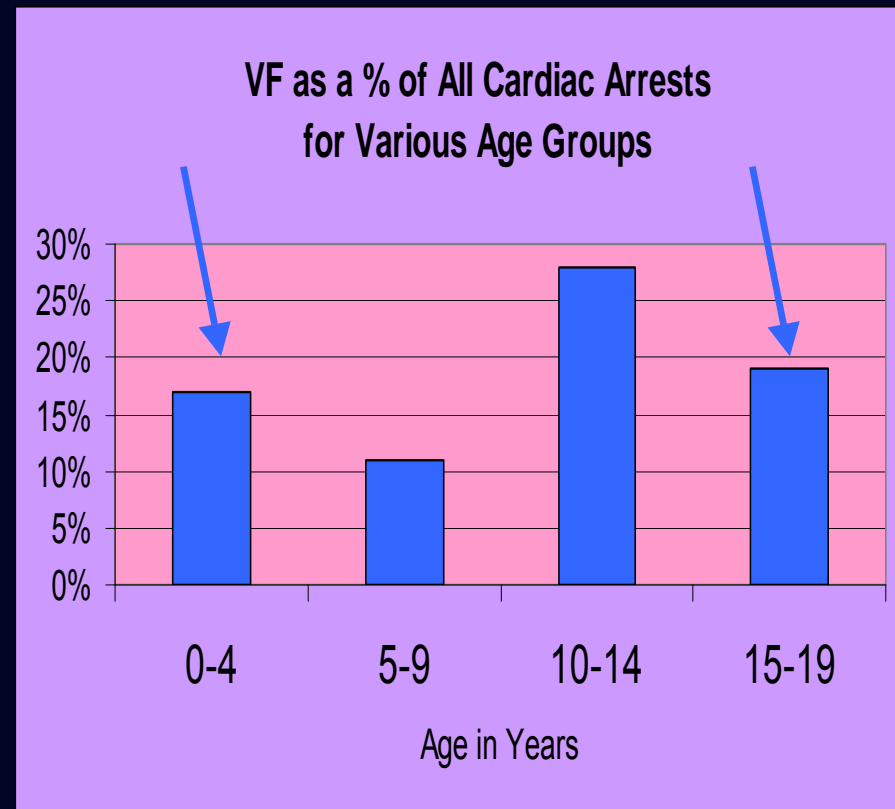
- **What Age?**
 - Do children have VF?
- **What Energy?**
 - What is safe?
 - What is effective?
- **Biphasic waveforms**
- **New Technology**
 - Rhythm identification
 - Attenuated pads

Do Children Have Ventricular Fibrillation?

- Incidence of ventricular fibrillation in children unknown
 - Resuscitation guidelines guided by in-hospital arrests
 - Cardiac rhythm *not* assessed in **40%** out-of-hospital pediatric arrests
 - Recent studies: 10-19% of pediatric arrests

Incidence of VF in Children

- The % of 0-4 year old VF is comparable to that of 15-19 year olds



Mogayzel et al. *Annals of Emergency Medicine* 1995;25:484-491

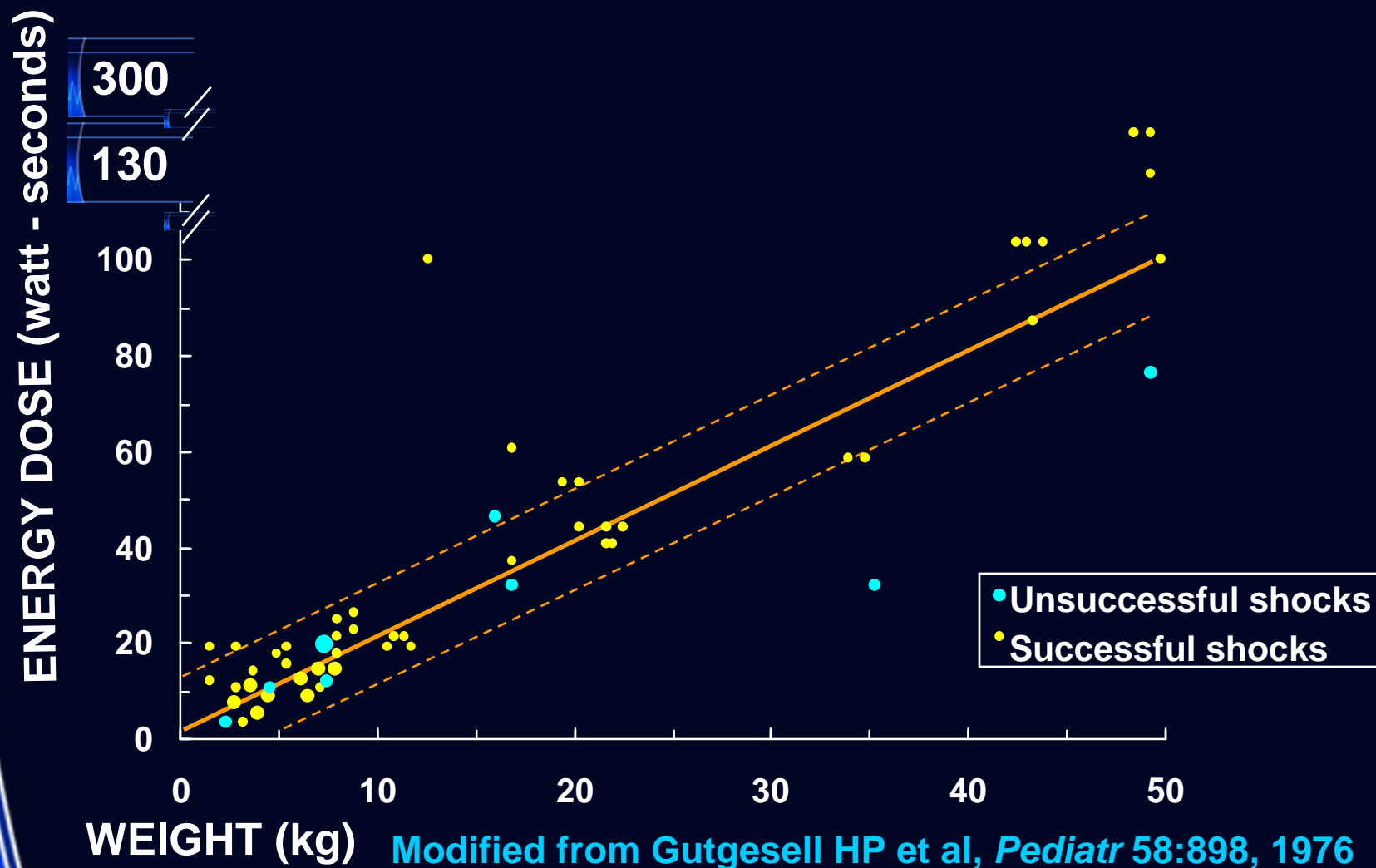
AED Use in Children

- 18 children, out-of hospital arrest
 - 9 with VF as presenting rhythm
- 67 analyses
 - 25 VF
 - 32 Asystole/PEA
- Sensitivity 88%
- Specificity 100%

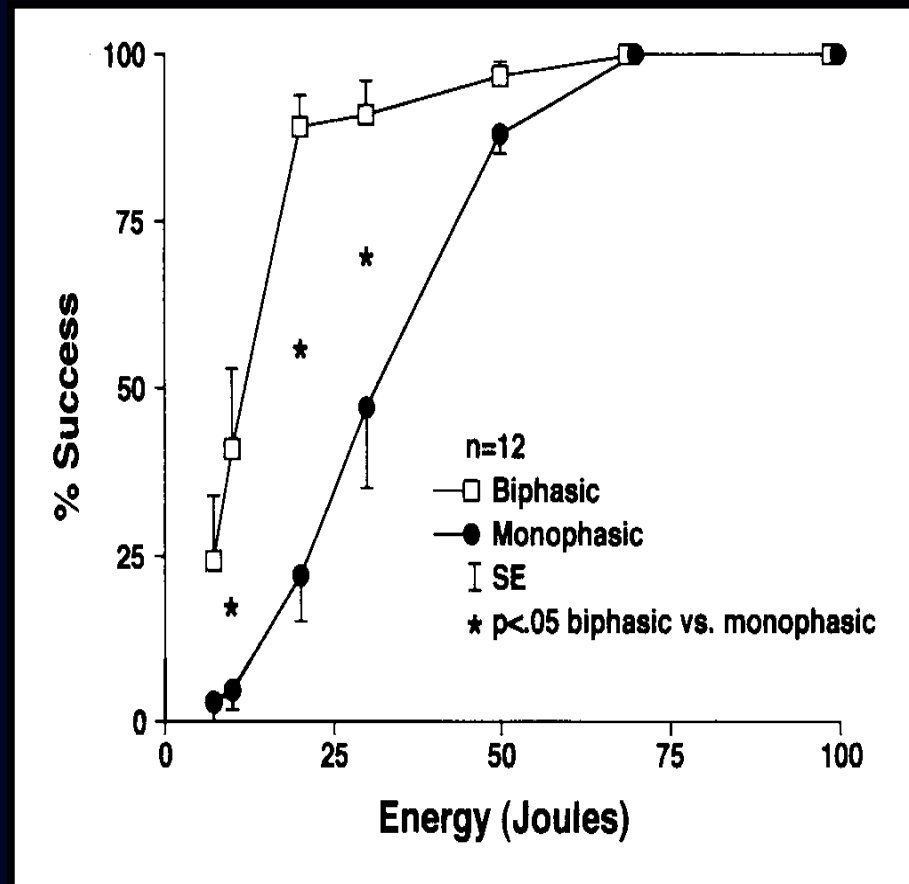
Survival From Pediatric Out-of-Hospital Arrest

	<u>%VF</u>	<u>A/PEA</u>	<u>RR (95%CI)</u>
Mogayzel	17%	2%	4.5 (2, 8.1)
Paris	30%	2%	12.3 (7.2,21.2)
Losek	36%	5%	
Hickey*	25%	5%	20.1 (2.8,142)
Atkins	33%	11%	

Energy Dose Vs Body Weight During Pediatric Defibrillation



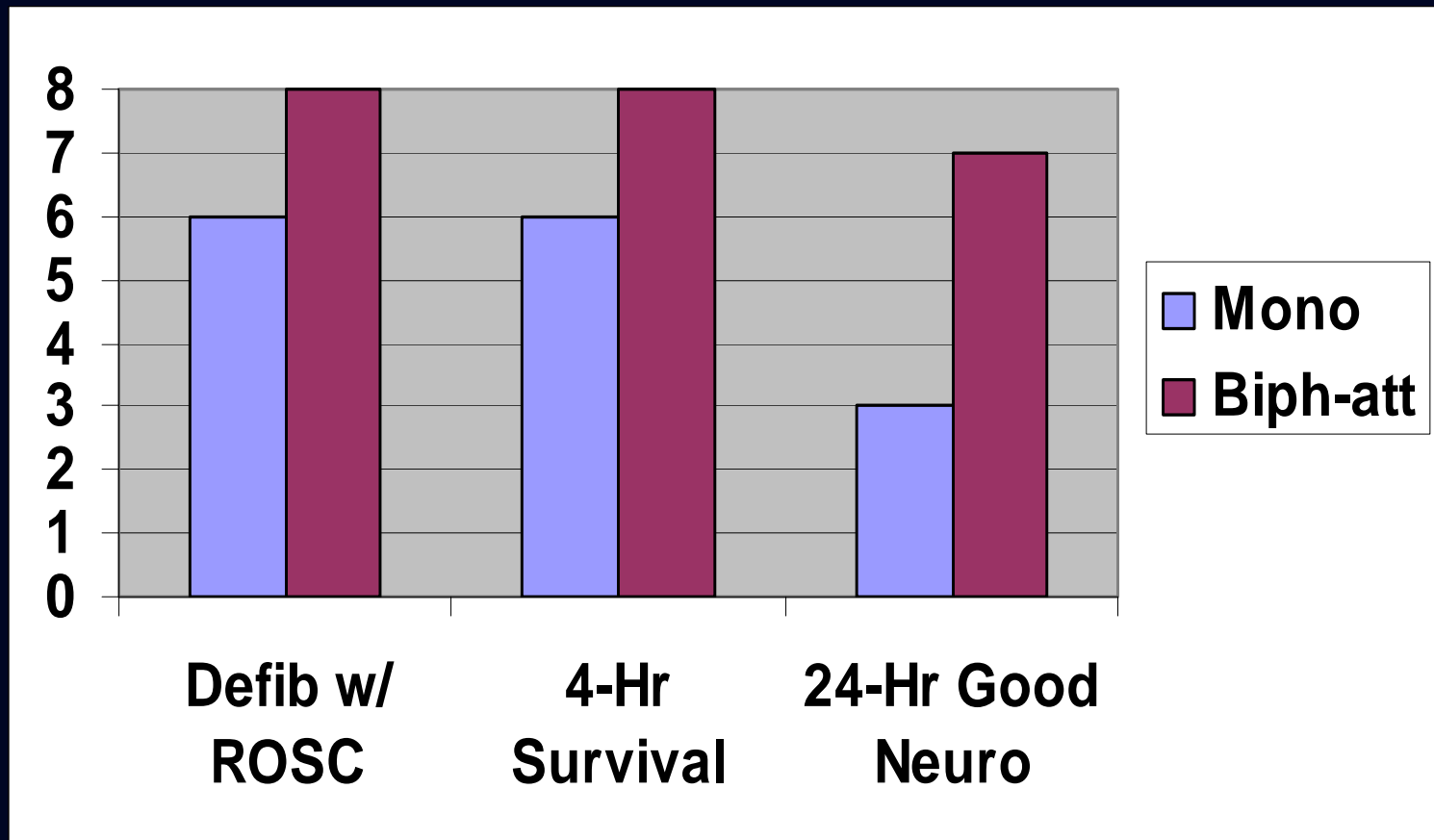
BPW Defibrillation in Young Pigs



Zhang, et al Resus 2001

Comparison of MDS and BPW

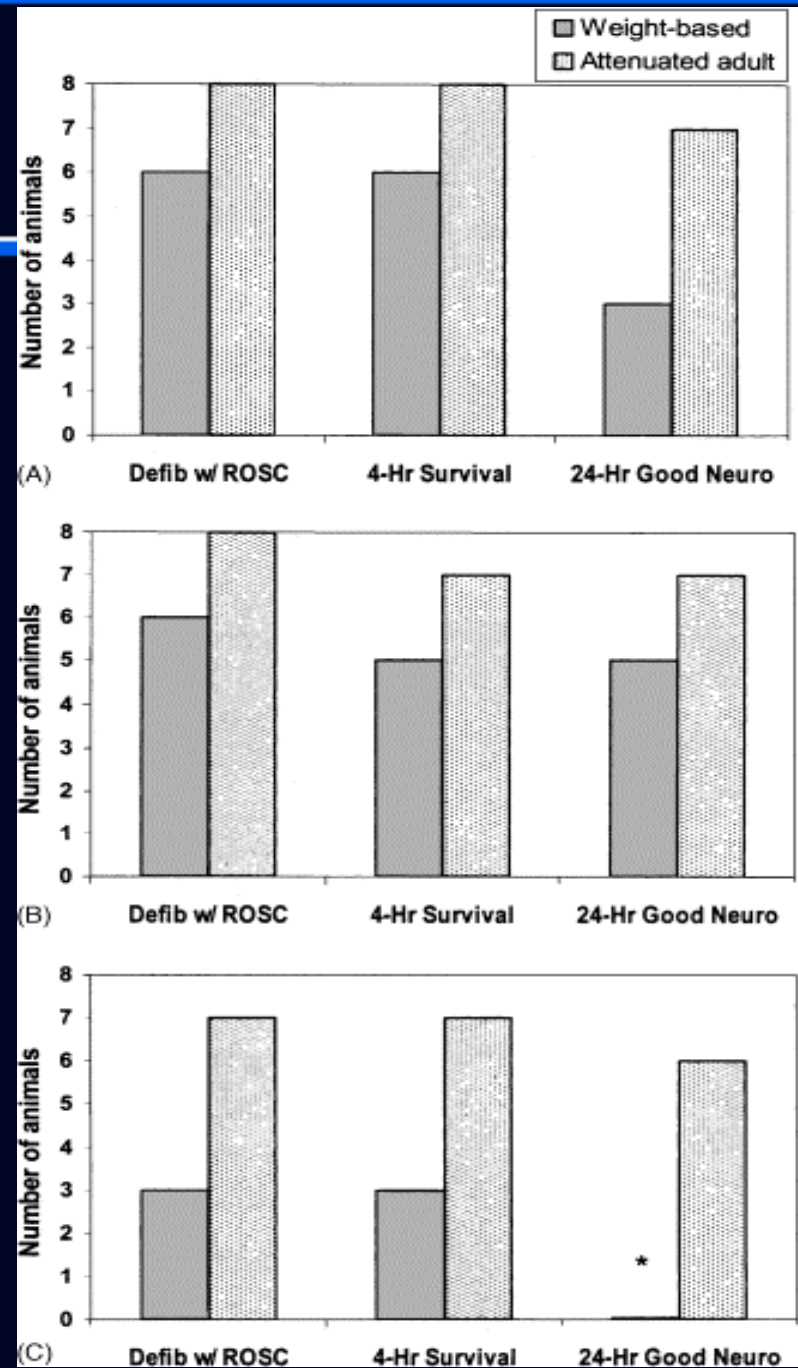
4-kg piglets, MPC AED



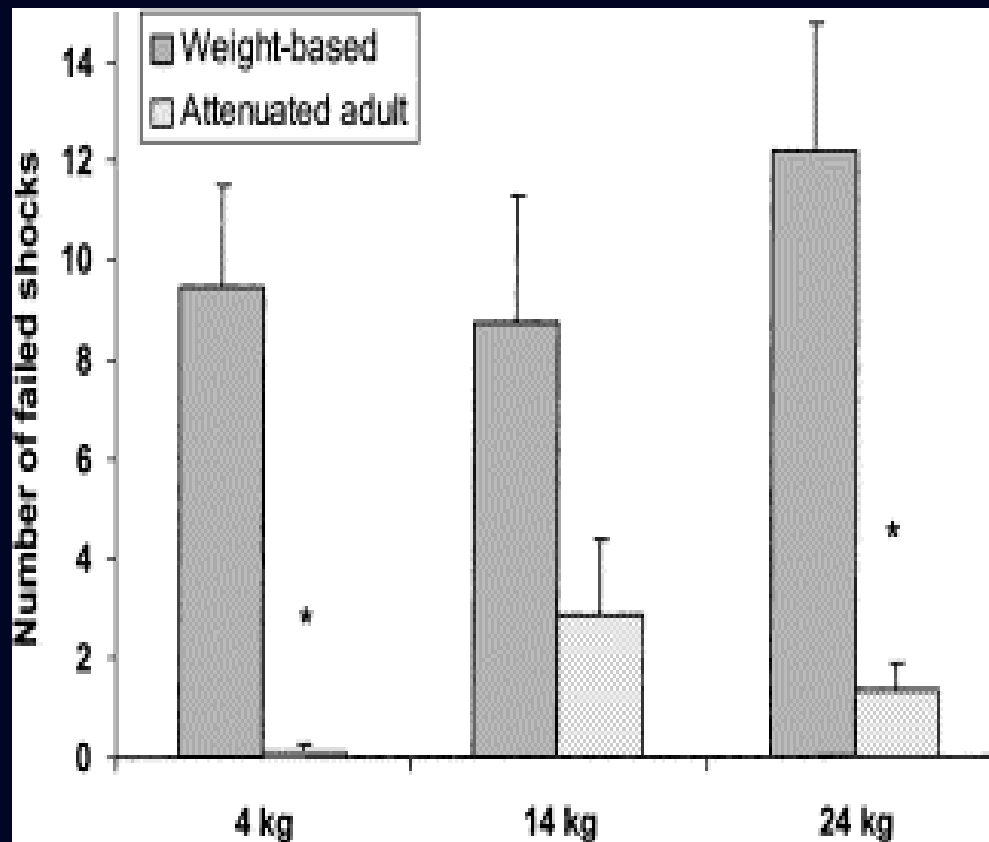
Berg RA, et al CCM 2002

ROSC and 4 & 24 h survival

Berg RA, Chapman FW et al
Attenuated adult biphasic shocks compared with weight-based monophasic shocks in a swine model of prolonged pediatric ventricular fibrillation.
Resuscitation 2004, 61:189-197



Biphasic defibrillation



Number of shocks that failed to terminate the initial VF episode for monophasic weight-based and attenuated adult biphasic shocks in the 4, 14 and 24 kg weight categories. * $P < 0.01$.

Evidence

- Kerber et al. demonstrated that AEDs demonstrate sensitivity of >90% for VF, >75% for rapid VT and specificity of >99% for non-shockable rhythms in children.
- Atkinson et al and Cecchin et al concluded that AED sensitivity for VF in children exceeds these recommendations
- Both studies have also demonstrated that AED's also exceed the recommended specificity for non-shockable rhythms in children.

Evidence

- MacDonald et al showed that 53.85% of all AED errors that occurred in Boston between 1995 and 1997 were due to mistakes by the operator.
- Energy attenuating pads decrease the need for complications in the operation of the AED
- Case reports suggest that adult AEDs can be successfully used for children however Berg et al 2005 suggests that paediatric energy dosing significantly reduces the risk of post-resuscitation myocardial damage and results in higher rates of survival.
- Therefore the use of energy attenuating paediatric pads in conjunction with adult AED's is recommended.

Evidence

- Isolated case reports of children <1 year of age with VF resuscitated with AEDs using attenuated paediatric pads (50J) did not show raised cardiac enzymes, showed good ventricular function and survived.
 - Yaniv et al, Resus, 2005, 65:1, 135-137
- However, the use of AED's in children <1 year cannot be recommended with confidence due to limited data, small sample sizes.
- Also, the usefulness of AED's in this very young age group may also be limited due to their lower incidence of shockable rhythms.

Automated External Defibrillators



**Philips Heartstream
FR2 with Pediatric
Electrodes**



**Medtronic Physio-Control
LP500 with Pediatric
Electrodes**

Paediatric AED Protocol (1-8 years old)

- Concerns about
 - amount of energy delivered
 - ability of the available equipment to accurately diagnose ventricular fibrillation in paediatric patients
- The US Food and Drug Administration (FDA) had approved an adaptation to an AED that allows the device to deliver a lower dose of electricity
 - Dose delivered by this device is 50 joules.
 - ~ 5 joules/kg in the average 10 kg, 1 year old child
 - ~ 2 joules/ kg in the average 25 kg, 8 year old child.

Singapore Pediatric AED Protocol (1-8 years old)

- Summary of Recommendations

- AEDs with attenuated pads may be used for children 1 to 8 years of age with no signs of circulation.
- Defibrillation is recommended for documented VF/pulseless VT (Class I).
- The arrhythmia detection algorithm used in the device should demonstrate high specificity for pediatric shockable rhythms, ie, the device will not recommend a shock for nonshockable rhythms (Class IIb).

Singapore Pediatric AED Protocol (1-8 years old)

- Summary of Recommendations

- For a lone rescuer responding to a child without signs of circulation, provision of 5 cycles of CPR is still recommended before any other action such as activating EMS or attaching the AED.
- Currently the evidence is insufficient to support a recommendation for or against the use of AEDs in children less than 1 year of age.

Singapore Paediatric AED Protocol (1-8 years old) - Summary of Recommendations

- Lay rescuer should perform 5 cycles of CPR on unresponsive child prior to calling for ambulance 995 / get AED (Phone Fast).
- AEDs may only be used on children 1-8 years old if dose-attenuating system available (US FDA approved for paediatric usage).

Singapore Pediatric AED Protocol (1-8 years old)

- Summary of Recommendations

- Lone rescuer: If a child is unresponsive, start performing CPR immediately at a compression-ventilation ratio of 30:2 for 5 cycles before activating EMS and retrieving AED, if available.
- If two rescuers are present, one rescuer should begin CPR while the other rescuer activates EMS and gets the AED.

Singapore Pediatric AED Protocol (1-8 years old)

- Summary of Recommendations

- Check for responsiveness
 - if none, shout for help, send someone to phone 995 and get the AED if available
- Airway : Open the airway – head-tilt-chin lift
- Check for breathing – Look, Listen, Feel
- No breathing – 2 rescue breaths, watch chest rise
- Begin CPR : 30:2
- After 5 cycles, if alone, phone 995 and get AED if available

Singapore Pediatric AED Protocol (1-8 years old)

- Summary of Recommendations

- After 5 cycles of CPR and once an AED is available, attach child pads (attenuated pads) to the chest
 - one to the left of the left nipple and the other to just below the right clavicle.
- “Clear” and analyse
- If VF “Clear” and “Shock” and resume CPR immediately for 5 cycles
- If not VF, resume CPR till paramedics arrive.

Singapore Pediatric AED Protocol (1-8 years old)

- Summary of Recommendations

- Every shock will be followed by 5 cycles of CPR, at the end of which assessment of breathing, pulse and rhythm check may be performed to assess need for further CPR, chest compressions or defibrillations
- The shock with 5 cycles of CPR sequence would continue till ambulance arrives.

No response or movement
Send someone to phone 995, get AED if available

Open **AIRWAY**, check **BREATHING**

If no breathing, give **2 BREATHS**
that make chest rise

If no response, check for signs of life or pulse check within 10 seconds

Definite pulse or signs of life

RESCUE BREATHING :
Give 1 breath every 3 seconds
Recheck for signs of life or pulse every 2 minutes

No definite pulse or No signs of life

Give cycles of **30 COMPRESSIONS** and **2 BREATHS**
Push hard and fast (100/min) and release completely
Minimise interruptions to chest compressions

For lone rescuers, PHONE 995 and get AED if available after 5 cycles of CPR
Infants (<1 year old): Continue CPR till paramedics arrive or victims starts to move
Child (>1 year) : Continue CPR, attach AED with attenuated pads after 5 cycles of CPR

Give 1 shock
Resume CPR immediately for 5 cycles

Shockable

Child > 1 year
Check Rhythm
Shockable rhythm?

Not Shockable

Resume CPR immediately for 5 cycles
Check rhythm every 5 cycles
Continue until paramedics take over or victim starts to move