

Normal physiological values for children:

what do we know?

Kevin McCaffery
Staff Specialist PICU
Brisbane

Areas to consider

- What are we attempting to assess?
- What is the evidence base?

Question

Who feels comfortable that they know /
can source reference ranges for Paeds?

Cardiovascular assessment

Heart Rate X Stroke Volume

- End diastolic / systolic wall stress (BP, CVP)
- Contractility

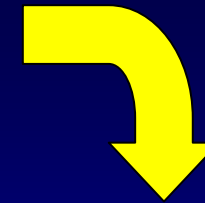


Cardiac Output



Tissue Bed Perfusion

- Perfusion abnormalities
- Oxygen carrying capacity



Tissue Oxygen Delivery

- Organ function
- O₂ uptake block
- (S_vO₂ / lactate)

Consider

- Pain, anxiety, fever
- Medications
- Pathophysiology

Respiratory assessment

RR

- Central depression
- Receptors

X

Vt

- Obstruction
- Pump failure
- Mechanical problems



Minute Ventilation



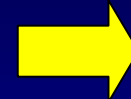
Alveolar gas

- Dead space
- Gas mix



Bloodstream

- Diffusion block
- V/Q mismatch



Tissue Oxygen Delivery

Normal values: common sources

- APLS
- Textbooks
 - Nelson Textbook of Pediatrics. 16th Ed 2000
 - Rudolph's Pediatrics. 21st Ed 2003
 - Macnab A. Care of the Critically Ill Child 1999
 - Rogers MC. Textbook of Pediatric Intensive Care. 3rd Ed 1996
 - Wong's Nursing Care of Infants and Children. 8th Ed 2007
 - Hazinski MF. Nursing care of the Critically Ill Child 2nd Ed 1992
 - Cameron P. Textbook of Paediatric Emergency Medicine 2006
- Literature Search

Normal values: Heart Rate

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Heart Rate

	< 1	1 - 2	2 - 5	5 - 12	> 12
APLS Cameron	110 - 160	100 - 150	95 - 140	80 - 120	60 - 100

	6 - 11mth	1 - 2	3 - 4	5 - 7	8 - 11	12 - 15
McNab	110 - 175	105 - 170	80 - 140	70 - 120	60 - 100	60 - 100

	<1	2	4	6	8	10
Nelson	80 - 160	80 - 130	80 - 120	75 - 115	70 - 110	70 - 110

Age related reference ranges for respiration
rate and heart rate from 4 to 16 years
Wallis LA et al. Arch Dis Child 2005

- 1109 school children, Plymouth UK
- No PMH / illness included
- Variations in numbers at different ages
 - 4yrs (49), 12yrs (162, 55m, 107f)
- Recorded values are at variance with currently published texts

Table 2 Respiration rate and heart rate; median and 2 ½, 97 ½ centiles by age

Age (y)	Heart rate (bpm)*			Respiration rate (bpm)†		
	2 ½	50	97 ½	2 ½	50	97 ½
4	81	103	131	20	22	26
5	74	95	121	19	21	25
6	69	89	115	18	21	24
7	66	85	111	17	20	24
8	63	83	109	17	19	23
9	62	82	108	16	19	23
10	61	81	108	15	18	22
11	60	80	108	14	17	21
12	59	80	108	14	17	21
13	58	79	107	13	16	20
14	56	77	106	12	15	20
15	54	74	103	12	14	19
16	51	71	99	11	14	18

*Beats per minute.

†Breaths per minute.

Normal values: Respiratory Rate

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Respiratory Rate

Age (yrs)	<1	1 - 2	2 - 5	5 - 12	>12
APLS Cameron P	30 - 40	25 - 35	25 - 30	20 - 25	15 - 20

Age (yrs)	1	2	5	10	15
Macnab A	25	25	22	19	18

Age (yrs)	2	4	6	8	10	12	14	16
Rogers MC	17-33	18-28	17-27	15-26	15-25	14-26	15-23	12-22

Age (yrs)	2	4	6	8	10	12	14	16
Wong	25	23	21	20	19	19	18	17

Age	Infant	Toddler	Pre-school	School	Adolescent
Hazinski	30-60	24-40	22-34	18-30	12-16

Table 3 Evidence base for heart and respiration rate values

First author	Year	n	Age range	Comments
Quetelet ¹⁷	1842	Unknown	Unknown	Unknown numbers and ages; 160 year old data
Shock ²⁶	1944	55	11–17	Small numbers; examined in laboratory; limited age range
Iliff ⁸	1952	188	0–18	One mile altitude; children asleep and awake
Cook ¹⁹	1955	25	0–1/12	Limited age range
Nelson ²⁰	1962	38	0–1/12	Limited age range
Voors ²	1982	3590	5–17	No reference ranges presented; examined in laboratory
Marks ³¹	1993	416	1–7	Measured by thermocouple; sleeping and awake
Rusconi ²⁴	1994	618	0–3	Limited age range

Blood Pressure

- APLS / Cameron P
 - No references
- Nelson, Rudolph, Wong, Hazinski
 - Report of the Second Task Force on Blood Pressure Control in Children—1987 Task Force on Blood Pressure Control in Children. *Pediatrics* 1987;79:1-25
- Rogers MC, Macnab A
 - Horan MJ, Sinaiko AR. Synopsis of the report of the second task force on blood pressure control in children. *Hypertension* 1987; 10; 115-121

APLS

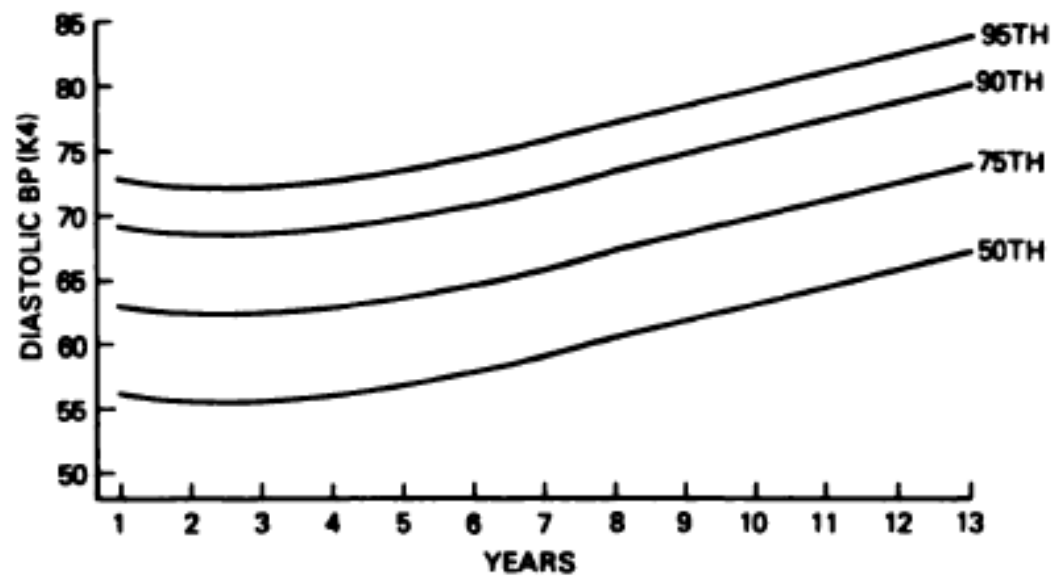
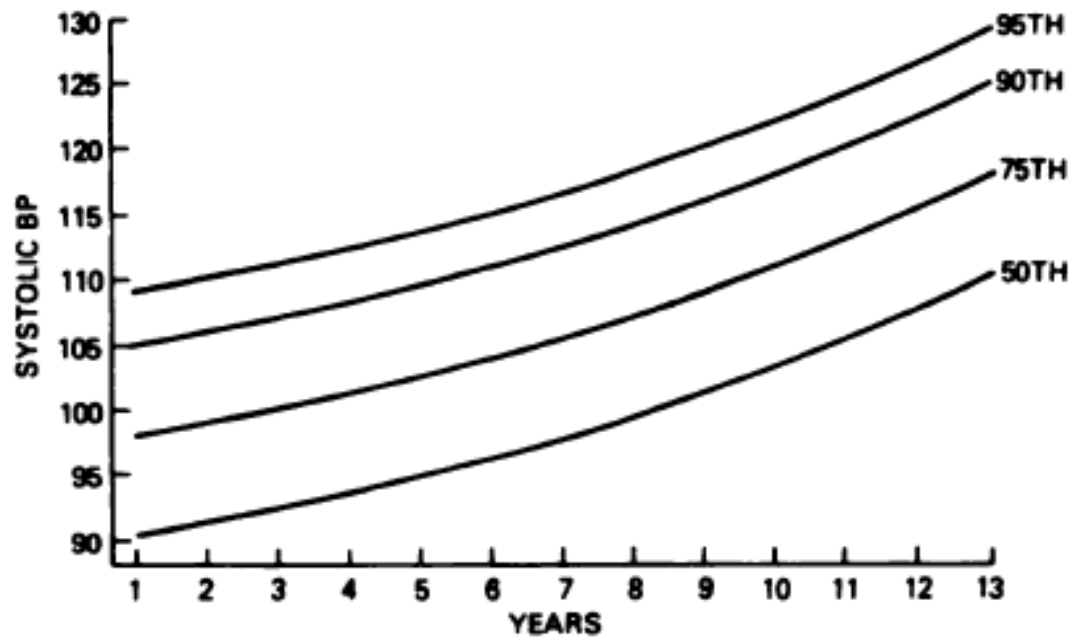
Minimal systolic BP (mmHg)

- Infant >60
- Toddler >70
- Preschool >75
- School-age >80
- Adolescent >90

Dieckmann et al. Pediatric Education for Prehospital Professionals. American Academy of Paediatrics 2000

Report of the Second Task Force on Blood Pressure Control in Children—1987 Task Force on Blood Pressure Control in Children

- 1977 - Report of the Task Force on Blood Pressure Control in Children
- ~ 70 000 children (majority adolescent)
- 9 studies - pooled results
- *Hypertension*
- 1st BP from each study used
- Height, weight and sex important



90TH PERCENTILE	1	2	3	4	5	6	7	8	9	10	11	12	13
SYSTOLIC BP	105	106	107	108	109	111	112	114	115	117	119	121	124
DIASTOLIC BP	69	68	68	69	69	70	71	73	74	75	76	77	79
HEIGHT CM	80	91	100	108	115	122	129	135	141	147	153	159	165
WEIGHT KG	11	14	16	18	22	25	29	34	39	44	50	55	62

Iatrogenic pitfalls

- Treatment effects
- "Normalisation" of arterial gases
- "Normalisation" of Hb / BP in trauma
- "Normalisation" of pO₂ in prematurity
- "Normalisation" of temperature

Question

Who feels comfortable that they know /
can source reference ranges for Paeds?

My thoughts...

- Not sure what reference ranges for patients should be
- Not sure how to do those studies
- Need for more sophistication in the assessment of unwell children
- And when I am asked
 - *What BP are you happy with...?*

Questions?