**Ten concerns about blood pressure measurement and targets in paediatric sepsis**

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**Introduction**

Current paediatric sepsis guidelines suggest that resuscitation is titrated against clinical markers of hypovolaemia and end organ perfusion (1), including blood pressure (BP), heart rate and capillary refill time. BP is often used both as a defining feature of shock and as a target for therapy. This paper will focus on the measurement of BP, the definition of hypotension and on the target BP for therapy in children with sepsis.

**1. Blood pressure is rarely measured in paediatric acute care settings.**

BP measurement is not recommended in the UK National Institute for Clinical Excellence (NICE) guidelines for sepsis (2), which recommends BP measurement only in the context of tachycardia or prolonged CRT. This guidance reflects a tendency not to measure BP in children in Emergency Departments (EDs) the world over. One Australian study reported only 22% of children attending an ED had BP measured (3). In relation to inpatients, systolic BP is a component of the Bedside Paediatric Early Warning Score (4) but as BP is often neglected in the routine observations performed on hospitalised children, opportunities for early detection of the deteriorating child may be missed.

**2. Auscultation is the “gold standard” but rarely used in clinical practice.**

Although children receiving intensive care will often have invasive BP monitoring, in the Emergency Department or hospital wards children generally have non-invasive BP monitoring. The main techniques available to measure BP non-invasively are automated oscillometry or auscultation. Oscillometric devices determine mean BP from the maximum oscillation in cuff pressure as it deflates, then calculate systolic and diastolic values using algorithms. Auscultatory BP measurement remains the “gold standard” non-invasive method (5) but it is time consuming and difficult to perform in an acute care setting.

**3. Oscillometric BP monitors do not use a standard methodology and most have not been validated in children.**

The algorithms used to determine systolic and diastolic BP are proprietary and differ from device to device. Different devices produce results that vary widely (6). Oscillometric values may be up to 10mmHg higher than auscultatory values (7). Most oscillometric devices have not been validated for use in paediatric practice. Where validation data is available for oscillometric devices, this has generally been in the context of hypertension rather than hypotension.

**4. The most commonly quoted BP ranges in children are from the US NIH “Task Force”.**

The US NIH ranges were developed from population data, derived using auscultation, and published in a number of “Task Force” documents (5). The purpose was to define hypertension rather than hypotension. Thus, the Task Force presents systolic BP (SBP) tables of the 50th-99th percentiles by age, sex and height, but not lower centiles.

**5. Hypotension, defined as < 5th centile SBP for age, has been derived using mathematical modelling rather than by direct observation.**

By using the quoted standard deviations in the Task Force data and assuming a normal distribution, it is possible to calculate the lower 5th centile for SBP using the standard formula. This was performed subsequent to the initial Task Force publication and tables were published in 2007 (8).

**6. Very few observational studies have reported lower centile BP data**

There are few population studies which have presented lower centile data for BP in healthy children, and those which have done so used oscillometry. One study of 13,547 European children reported 3rd centile values which were higher than those calculated from the Task Force data (9). The use of oscillometry rather than auscultation may explain the higher BP centile values in such studies.

**7. The original consensus conference definition of hypotension in septic shock was retracted.**

One of the features used by the Paediatric Sepsis Consensus Conference to diagnose septic shock is hypotension (10). However, the centile ranges initially suggested were controversial; following correspondence the original table was retracted and a revised table was produced based on the Task Force data, and this is still in use (11) (Figure).

**8. Advanced Paediatric Life Support (APLS) and Paediatric Advanced Life Support (PALS) have differing definitions of hypotension.**

APLS and PALS definitions of hypotension vary from each other, from the revised Consensus Conference definition, and from the lower 5th centile derived from Task Force data (Figure). The existence of multiple definitions may cause confusion, with potential adverse impact on patients.

**9. There are no agreed BP targets for sepsis resuscitation in children and no trial evidence that adoption of such targets improves outcome.**

ACCM-PALS recommends targeting 50th centile SBP for age, APLS recommends 5mmHg higher than the 50th centile. However, one recent observational study of 367 children post cardiac arrest showed worse outcomes only when SBP was less than 5th centile (12). In adult medicine, the recommended target in sepsis is the 5th centile MBP or SBP (13). Recently, the SEPSISPAM trial demonstrated that targeting a higher BP target is not beneficial in adults with sepsis (14). Although there is no trial evidence upon which to base practice in children, it seems counterintuitive that a child would need a higher BP centile target than an adult. Furthermore, targeting a higher BP centile may be associated with additional risks from resuscitation fluid or side effects of inotropic support; therefore it is difficult to justify targeting a higher BP centile in the absence of evidence to support this.

**10. Evidence based targets for therapy do not exist in children**

The aim of therapy in the acute phase of resuscitation is to restore tissue perfusion. Restoration of BP is just one component of this. Currently the ACCM-PALS guidance recommends titrating resuscitation to both pressure and flow, targeting ‘‘adequate blood pressure and clinical monitors of cardiac output” (1). This process is unfortunately complicated both by a failure to define “adequate” and although retrospective data have been used to support the current guidelines, an absence of prospective trial data to support specific targets.

**Conclusion**

We suggest BP should be measured in any child presenting with suspected infection. We also suggest that in the absence of evidence, a reasonable approach would be to use the Task Force derived 5th centile SBP for males by age (and assumption of 50th centile height) as a cut-off for hypotension and as a target for therapy (8). This is also the recent conclusion of the Paediatric Task Force of the International Liaison Committee on Resuscitation (ILCOR) in regard to children post cardiac arrest (15). Such an approach would standardise treatment. Further research is required both to establish reliable oscillometric BP reference ranges to define hypotension and to determine optimal BP targets for therapy.

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**Figure legend**

Graph showing 5th centile systolic blood pressure according to various sources.

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