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Physiological vital sign ranges in newborns from 34 weeks gestation: A systematic review

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ABSTRACT

Context: The birth process and the moments thereafter are a crucial time for newborns as they adapt to extra uterine life. The adaptive process begins immediately and can take a number of days to complete. The process involves initiating and maintaining respirations, thermoregulation, and the change from foetal circulation to newborn circulation. The majority of newborns successfully adapt to extra uterine life, some experience difficulty. Early warning tools may assist clinicians identify early signs of failure to adapt and/or deterioration but these are dependent on 'Normal' vital sign reference ranges for triggering an escalation of care. Age-matched early warning tools may improve the sensitivity of tools.

Objective: To identify physiological vital sign reference ranges for newborns ≥34 weeks gestation from two hours of age.

Design: Systematic Review.

Data sources: Between August 2016 and January 2017, PubMed, CINAHL, Embase, The Cochrane Library databases, and conference abstracts were searched for primary studies published between 1946 and 2017. Reference lists of retrieved articles were reviewed for potential studies.

Review methods: Primary studies published in English that reported physiological vital sign reference ranges pertaining to well newborns born from 34 weeks gestation were selected. Two authors independently assessed eligibility of studies for inclusion. Titles and abstracts were matched with the inclusion criteria: studies investigating heart or respiratory rate, temperature, blood pressure and oxygen saturations in well newborns greater than 34 weeks gestational age.

Assessment of quality and grading of level of evidence were assessed using National Health and Medical Research Council level of Evidence Hierarchy Table and the Quality Assessment Tool for Quantitative Studies. Any disagreements were resolved by consensus. Data were extracted by two reviewers.

Results: A total of 1497 primary studies were retrieved. Following screening and removal of duplicates and screening, 10 primary studies investigating heart rate (n = 1), respiratory rate (n = 1), temperature (n = 1), blood pressure (n = 4) and oxygen saturations (n = 3) were eligible for inclusion in this review. The populations studied included term (n = 6) or both preterm and term newborns (n = 4). No reference ranges for any vital sign measurements could be identified from the included literature. In addition, inconsistencies between vital sign parameters of newborns were identified between the studies.

Conclusion: There is paucity of normal vital sign data in the late preterm > 34 weeks and post term gestational age cohorts despite literature suggesting differences in physiological maturity between these cohorts.

What is already known about the topic?

- Well newborns as young as 34 weeks gestation are often cared for in the maternity setting alongside their mothers
- Late preterm newborns are still premature and are often viewed as small term newborns despite being physiologically immature compared to their term counterparts.
- Early warning tools are being used to identify signs of compromise in well newborns cared for in the maternity setting

Abbreviations: EWT/s, early warning tool/s; GA, gestational age; LPT, late preterm; ET, early term; T, term; PT, post term; BP, blood pressure; SpO_2, peripheral capillary oxygen saturation

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What this paper adds

- There is paucity and inconsistency in vital sign reference ranges of newborns greater than 34 weeks gestation
- Current early warning tool reference ranges may not be sensitive or specific to identify compromise in newborns of all gestational age groups
- Further research is needed into the physiological vital sign ranges of the newborn population

1. Introduction

Following birth, the newborn undertakes a significant adaptive process called the transition to extra uterine life (Graves and Haley, 2013). Transition is one of the greatest challenges a newborn must overcome and can take up to 2–4 weeks to complete (Hertz, 2005). The process involves initiating and maintaining respirations, thermoregulation, and the change from foetal (shunt dependent) circulation to newborn circulation (Graves and Haley, 2013; Murphy, 2005). Factors such as gestational age at delivery, mode of delivery, a significant intrapartum event, a congenital defect or infection can delay this process (Juve-Udina et al., 2015). Even though the majority of newborns successfully adapt to extra uterine life, some experience difficulty (Graves and Haley, 2013; Juve-Udina et al., 2015; Altman, 2017; Gardner et al. 2016). Therefore, if delay or compromise during this time is not recognised in a timely manner, the newborn can experience a serious adverse event.

Due to changes in health systems and care and management of postnatal mother/newborn dyads, there is an expectation that all well newborns will 'room in' with their mothers (Fleming et al., 2014). Therefore, it is not uncommon that newborns as young as 34 weeks gestation (late preterm) to be cared for in the postnatal ward of the maternity setting with their mother (Fleming et al., 2014). However, it is important to note that these newborns are still premature and are physiologically immature compared to their term counterparts (Australian Commissionon Safety and Quality in Health Care, 2010; Paliwoda et al., 2016). Thus, we have chosen newborns from the late preterm gestational age of ≥34 weeks for the focus of this review.

Recent patient safety mandates have prompted improvements in the care of newborns in health care settings in Australia and overseas (Australian Commissionon Safety and Quality in Health Care, 2010; Paliwoda et al., 2016; Paliwoda and New, 2015). Early Warning Tools have been implemented in healthcare settings for the identification of early signs of deterioration in all 'patients' including newborns cared for postnatally in the maternity setting. It has been proposed that the use of an early warning tool might assist clinicians to identify and respond to clinical deterioration by providing a systematic process to document physiological observations using pre-defined vital sign parameters (Australian Commissionon Safety and Quality in Health Care, 2010).

Early Warning Tools are designed to indicate when physiological observations deviate from predefined 'normal' reference ranges. Potential clinical deterioration is often indicated by a colour coded zone or aggregate numerical score (Australian Commissionon Safety and Quality in Health Care, 2010) and alerts the clinician to 'escalate care'. However, the authors of a previous study reviewing early warning tools in newborns ≥34 weeks gestation who were deemed well and cared for in the maternity setting, reported that the ineffectiveness of three neonatal early warning tools was attributed in part to differences in reference ranges of identified 'normal' physiological parameters (Paliwoda et al., 2016). That is, each tool had different cut-off points for vital signs with the exception of respiratory rate. The researchers concluded that this influenced whether an escalation of care was required and resulted in inconsistencies in care escalation. In addition, differences were noted for gestational age indicating that a single universal tool may not be appropriate for the newborn population given that physiological maturity is inversely related to gestational age. (Paliwoda et al., 2016; Paliwoda and New, 2015)

In view of the identified limitations with the early warning tools previously tested, we hypothesise that their effectiveness may be improved with age-specific vital sign parameters. Therefore, this review sets out to identify the normal physiological reference ranges for five vital signs (heart rate, respiratory rate, temperature, blood pressure, and oxygen saturation) following the initial stabilisation period for well newborns cared for in the maternity setting: late preterm (34^{+0}–36^{+6}), early term (37^{+0}–38^{+6}), term (39^{+0}–41^{+6}) and post term ($\geq 42^{+0}$) (American College of Obstetricians and Gynecologists, 2013).

1.1. Objective

To examine the literature to identify vital sign reference ranges for newborns ≥34 weeks gestation from two hours of age.

2. Methods

We conducted a systematic review, which we report according to the PRISMA guidelines (Moher et al., 2009). Between August 2016 and January 2017, PubMed, CINAHL, Embase, The Cochrane Library databases, and conference abstracts were searched for primary studies published between 1946 and 2017. All primary studies published in English that reported physiological vital sign reference ranges of well newborns born from 34 weeks gestation were selected. Search terms used were: "Neonate/Infant" AND "vital sign*" OR "heart rate" OR "respiratory rate" OR "temperature" OR "blood pressure" OR "oxygen saturation*". Medical Subject Headings (MeSH) included: Infant, newborn.

2.1. Primary studies

Primary studies of all study designs pertaining to well newborns following birth ≥34 weeks gestational age during the first week of life and included either: heart or respiratory rates, temperature, blood pressure, and oxygen saturations were retrieved. Literature was limited to the English language and human subjects. Reference lists in retrieved articles were reviewed for potential studies.

2.2. Study selection and extraction

Two reviewers (MP, KN) independently screened the titles and abstracts. Full text articles from databases and additional sources were assessed for inclusion by two reviewers (MP, KN) and discrepancies were resolved by discussion or by involving a third person (FB). A data extraction spreadsheet was designed and data extraction, quality and grading of level of evidence was completed independently by two reviewers (MP, KN) for each of the included studies. Due to the heterogeneity of the included studies, meta-analysis could not be performed. Sample size, outcome measures and study design were synthesised narratively and are presented in Table 1.

3. Results

The initial search identified 1497 references. Following removal of duplicates and review of titles and abstracts, 1335 were excluded. The remaining 162 full text articles were reviewed for eligibility and, of these, 154 were subsequently excluded (see Fig. 1). Two additional primary studies were identified from the reference lists of reviewed articles and were eligible for inclusion resulting in a total of 10 primary studies included in this review

The ten studies were assessed for level of evidence and risk of bias using the National Health and Medical Research Council Level of Evidence Hierarchy Table (National Health and Medical Research Council, 2009) and the Quality Assessment Tool for Quantitative Studies (Effective Public Health Practice Project, 1998). The studies