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Guidance for Good Practice for Physiotherapists Working in Neonatal Care

Association of Paediatric Chartered Physiotherapists

Neonatal Specialist Committee

Contents

Introduction

This is a consensus document providing guidance on good practice relating to the Physiotherapy management of neonates including the preterm and term infant. The intention of this document is to create a resource for learning about physiotherapy assessment and management in neonatal care. The advice given in this document is based on the best available evidence in combination with the professional expertise of the authors who are experienced in the field of neonatal physiotherapy practice. This document was created by the members of the Association of Paediatric Chartered Physiotherapists (APCP) Neonatal Committee with the help of additional key specialists.

In recent decades there have been major advances in the acute medical management of neonates such as improved non-invasive ventilation and humidification strategies, the introduction of ante-natal steroids and artificial surfactant which has improved survival rates of infants born premature. As a result, there has been a growing research focus on neonatal assessment, accurate prediction of developmental outcome and therapeutic interventions for developmental sequelae associated with preterm birth and other perinatal risk factors. More recently, the contribution of Allied Health Professionals (AHPs) to neonatal care has become more prominent at a national strategic level with the peer review process in England, the publication of the staffing recommendations (Xanthidis, 2018) and the NICE guideline regarding developmental follow up of infants born preterm (National Institute of Health and Care Excellence (NICE), 2017) all highlighting the role of the Physiotherapist in neonatal care. The Long-Term Plan (NHS England, 2019a), Implementing the Recommendations of the Neonatal Critical Care Review (NCCR)(NHS England, 2019b), Action 5 and the Getting It Right First-Time_teams are increasingly recognising the roles AHPs play. It is therefore important that this document is read in the context of a rapidly changing area of clinical practice and the reader should seek the most current information from a variety of sources to inform practice at the point of care.

In an area that has historically seen only small numbers of therapists practicing, it is important that we work together to support peer learning, promoting both evidence-based practice and consistency across our neonatal population. It is the responsibility of each individual clinician to know they have a network of peer support and are able to both seek guidance and support as well as having an avenue for disseminating any new information that may be helpful to others. Neonatal Physiotherapists should be involved in the Neonatal Network AHP strategy, developed by all Neonatal Networks in response to the NCCR in March 2020. Close working with both the Network and Clinical teams to feed into this process is essential.

This document is divided into 7 sections. The first section outlines the theoretical knowledge base expected of neonatal physiotherapists at foundation and advanced levels and is intended to provide physiotherapists with an understanding of typical development in both term and preterm infants. From understanding normality, neonatal physiotherapists are then well placed to determine features of abnormality. The remaining 6 sections each address a different aspect of neonatal physiotherapy practice ranging from assessment techniques, environmental considerations, family integrated care (FIC), positioning, respiratory care and developmental follow-up post-discharge.

Throughout the document, each section is divided in to **Foundation** and **Advanced** modules with the foundation module being aimed at physiotherapists who are relatively new to neonatal care or may only be involved in neonatal care as part of a general paediatric caseload or who receive ad-hoc calls to the neonatal unit. For physiotherapists regularly involved in neonatal care, it may be appropriate to work towards the advanced module particularly for those working solely in neonatal care or in tertiary centres with the most vulnerable babies. Each section is further sub-divided in to Preterm and Term where relevant.

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CHAPTER 1: Preterm versus term - normal development.

This chapter outlines the knowledge base required at foundation and advanced level in order to understand the typical developmental trajectory for infants born preterm compared to infants born at term gestation. Term age is defined as those babies born at 37 weeks of pregnancy and beyond. It is important to recognise that there is a difference in what is expected in terms of development for preterm and term infants. It is therefore essential to have an excellent grounding in what typical development looks like when infants are born at different gestational ages. Preterm infants should always have their age corrected when assessing their developmental progress.

Foundation	Advanced
General attainment of developmental milestones for different gestational ages. Awareness that premature birth changes the developmental course and that ex-utero development differs to in-utero development. Awareness that normal maturation of muscle tone occurs in a caudo-cephalic direction. Aware of normal variations and of movement/quality of movement for different gestations and tonal development. Be aware there are different theoretical frameworks of motor development. Awareness of red flags for abnormal development at preterm and term age. Preterm: • Tone contradictions • Persistent thumb IP / index finger flexion • Persistent spinal hyperextension • Paucity of movement monotonous movement • Asymmetry • Lack of development on sequential assessment	Sound understanding of developmental milestones at different gestational ages. Understand how medical co-morbidities, and clinical course can influence developmental trajectory e.g. NEC, Gastroschisis, BPD Be able to identify normal variations relating to quality of movement and general movement development and use highly developed clinical reasoning skills to explain individual presentations. Awareness of the evidence base regarding expected developmental outcomes for infants born with specific risk factors. Epicure studies and NNAP are examples of relevant source (Moore et al., 2012). Be able to clinically reason which babies are most in need of developmental follow-up post discharge appropriate to local resource, expertise and national guidelines (NICE, 2017). Have sound understanding of the different theoretical frameworks of motor development, including the neuro-maturational theory, the dynamic systems model, the synactive theory of development and the theory of neuronal group selection.

Term • Asymmetry • Extensor patterning • Poor feeding / poor weight gain • Coarse jitters dominant in movement • Persistent ATNR • Persistent head lag • Abnormal tone	

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Moore, T., Hennessy, E.M., Myles, J., Johnson, S.J., Draper, E.S., Costeloe, K.L. and Marlow, N. (2012) Neurological and developmental outcome in extremely preterm children born in England in 1995 and 2006: The EPICure studies. BMJ, Vol. *345*, p.e7961.

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CHAPTER 2: Pre-term and high-risk term infant assessment

Introduction

"High-Risk" in relation to neonates refers to "one who requires more than the standard monitoring and care offered to the healthy term newborn infant (Raju, 2012). Infants who are at 'high risk' of adverse or non-optimal neurodevelopment include those who have been born prematurely and those who have suffered a brain injury at birth (term age). High-risk infants as defined by NICE (2017) should be included in a local systematic and integrated acute-community neonatal neurodevelopmental follow-up programme.

Morbidities that put an infant at high risk of adverse and non-optimal neurodevelopmental abilities/disability are well documented in literature (Moore et al. 2012; Spittle, McGinley et al. 2016; NICE, 2017) and may include:

- Preterm birth; with greatest risk to those with lower gestational ages.
- Low birth weight; including severe Intrauterine Growth Restriction (IUGR)
- Neonatal brain lesions; associated with prematurity or term age (PVL, IVH Grade 3 & 4, PHI, PAIS PHVD, congenital brain malformations)
- Hypoxic Ischemic Encephalopathy (HIE)(Grade 2 or 3, meeting criteria for therapeutic hypothermia)
- Chronic lung disease / Bronchopulmonary dysplasia (CLD / BPD)
- Congenital cardiac abnormalities
- Neonatal seizures; associated with many conditions
- Infection; meningitis, sepsis (Chorioamnionitis, HSV / congenital infections.
- Necrotising enterocolitis (NEC)
- Neuromuscular conditions
- Chromosomal abnormalities

Additionally, preterm and 'high risk' infants with other complex social and environmental factors are likely to be at higher risk of sub-optimal development (McGowan and Vohr, 2019; NICE, 2017). Active monitoring of the developmental progress of high-risk infants is an essential part of neonatal care (Walker et al, 2012; Doyle, 2014; Spittle 2015). Accurate prognostic information is valuable for patients (for access to early intervention), families (to prepare for the future), clinicians (to better understand effects on long-term health) and service benchmarking (for quality control between units) (Doyle, 2014, NICE, 2017, Pascal 2018). Importantly, developmental monitoring can also offer reassurance for families with infants

demonstrating age appropriate development despite antenatal, perinatal, structural or genetic risk factors.

Neonatal and paediatric physiotherapists are an integral part of the multidisciplinary team involved within the enhanced developmental surveillance and support process and pathway (also known as developmental follow-up). Enhanced developmental surveillance and support for parents should start when preterm and high-risk term infants are on the neonatal unit and continue until they are two or four years of age (NICE, 2017). The NICE Guidelines (2017) for Developmental follow-up of children and young people born preterm provide minimum standards for neuro-developmental follow up. A systematic assessment trajectory, starting at the neonatal stage needs to be supported to expedite early identification and appropriate and timely referral to early intervention services for high-risk infants in most need (Herskind, Greisen and Nielsen, 2015; Novak et al, 2017).

Physiotherapists are key professionals involved in neonatal assessment and follow-up and must possess advanced clinical competences. More broadly, they will also require sensitivity to the environment and social needs of the child and his or her family. Having knowledge and understanding of the typical and atypical developmental trajectory of the preterm infant and high-risk term age infant is a critical learning experience for all therapists who assess and treat these young infants whether community or hospital based.

Generally neonatal and infant assessment should aim to:

- Evaluate age appropriate developmental progress
- Involve and empower parents/carers through effective communication and support
- Detect early signs of a neurological problem
- Identify likely origin / cause/ type disorder
- Estimate severity and prognosis
- Plan further investigations & treatment

The following guideline will identify foundation and advanced competencies required for neonatal and paediatric physiotherapists undertaking developmental assessment of preterm and high-risk term infants both on the neonatal unit and after discharge home as part of enhanced developmental surveillance and support (developmental follow-up).
A holistic approach to developmental follow-up should be undertaken and should include a combination of standardised tests and measures used to assess an infants' ability over time (Orton, 2018). Clinicians will need to use their clinical experience, expertise and critical

thinking to consider which assessments best fit their specific service requirements based on their specific caseload and resources.

	Foundation	Advanced
Assessment of preterm and high-risk term infants on the neonatal unit		
Subjective	Must be able to identify infant risk factors that indicate the need for neurodevelopmental assessment and follow-up. See NICE Developmental follow-up of children and young people born preterm (2017). https://www.nice.org.uk/guidance/NG72 (Appendix 1) Recognise signs of atypical development and neurobehavioral disorganisation and identify infants for referral to intervention services (Sweeney et al, 2009) Understanding of family-centered principles and how they could be applied within neonatal physiotherapy assessment e.g. involving and empowering parents (Pineda, Bender et al. 2018) Understanding how infant/carer bonding and interaction can influence infant development	Interpret perinatal and medical history along with results from medical investigations (such as cranial ultrasound scan) to identify specific developmental risks Identify risks to normal development based on social and environmental context Awareness of safeguarding risks and escalation (how this might impact on infant's 'journey') Recognise the importance of bonding and interaction between the carer and infant, identifying any signs of difficulties and supporting these as appropriate Individualise management approach based on parental confidence and experience / abilities
Objective	Identification of preterm and high-risk infant behaviour and communication related to stress and stability (state of alertness, irritability, social orientation, habituation to visual and auditory stimulus, consolability, feeding - timing and mode of feeding) Knowledge of timing for optimal age appropriate assessment	Assessments of preterm/high-risk term infants should aim to understand the infant's behavioural responses and stability within the context of the neonatal unit environment in order to support individualised developmental care. Assessments at this early age should be selected for their sound evidence base including predictive validity and reliability in order to support timely referral for early intervention.

	Knowledge of differences between typical postural, movement and tonal patterns for preterm and term infants Difference between posture, range and quality of movements between preterm and high-risk term infants. Consider how being in the NICU or prolonged hospital admission after birth would affect infant development Positioning for rest, sleep and play and handling of the infant and its effects on gross and fine motor development as well as posture Awareness of handling to ensure optimal stability throughout assessment by pacing, positioning and positive touch Recognise physiological status by interpreting autonomic responses from the infant (HR, O2 saturation, etc) during Physiotherapy handling, positioning and examination (Byrne and Garber, 2013). Neonatal developmental assessment should consider: • Motor observation (posture, quality and quantity of movement) • Neurological (muscle tone, reflexes, cranial nerves and abnormal signs) • Behavioural observation (regulation, attention and attachment) (Shah, Clements et al. 2011)	Knowledge, training and implementation of the most appropriate and relevant assessment is required (Noble and Boyd, 2012). Assessments are combined and include integration with radiological assessment information e.g. Magnetic Resonance Imaging and cranial ultrasound, to provide the most robust prognostic information (Maurizio Romeo, Guzzetta et al. 2008; Bosanquet, M. et al, 2013) Experienced neonatal and paediatric physiotherapists should be trained and experienced in a variety of assessment tools which they will be able to offer at age appropriate times depending on the individual needs/circumstances of the infant and carer. These may include (but are not limited to): • HNNE (Romeo et al, 2012) • HINE (Romeo, 2016) • LAPI (Lacey et al, 2004) • General Movements Assessment (Einspieler et al, 2004) • NBAS (Brazelton et al, 2011) • NBO (Barlow et al, 2018) • CHOP-Intend (Glanzman et al, 2011) Advanced neonatal physiotherapists should consider training and implementation of service delivery structure using the General Movements Assessment (Prechtl) (Einspieler at al, 2004; Novak, Morgan et al. 2017). Consider training in Brazelton newborn infant assessment and integration with sensorimotor assessment and treatment (Brazelton et al, 2011). Ensure early parental

	Understand that assessment at this early stage provides a baseline or reference point of the infant's emerging strengths, needs and risks which forms the beginning of a developmental trajectory (Johnson and Marlow 2006). The Neonatal Hammersmith Neonatal Neurological Examination (HNNE) (Romeo, 2012) provides insight across all of the domains noted above and does not require formal training.	involvement, assisting parents to recognize their infant's abilities and cues. Demonstrate appropriate handling of infants with increasingly complex medical needs and interpret infants attempts at self –regulation through behavioural cues and use of appropriate assessment tools (Byrne and Garber, 2013).
Communication	Observe parents' sensitivity to infant abilities (gestation or age appropriate) Ability to communicate key findings from specialist assessments with MDT Work with parents to identify their infants behavioural and social interaction abilities.	Observe and integrate ability of parent as part of management Identify infants requiring referral to community service or MDT Be able to tailor information to individual parents/carers understanding and needs Sensitively discuss the risk of emerging signs of disability within a supportive MDT environment. Collaborate with the infant's family / carers and the medical team to identify SMART goals for the short and long term to optimise developmental and functional outcomes and minimise risks. Use parent concerns and priorities to guide goal setting. Act as a resource for the wider MDT team for evidence based developmentally appropriate practices
Training and Development	Physiotherapists inexperienced in neonatal assessment will require a structured and supportive supervision programme to develop skills of	Experienced neonatal and paediatric physiotherapists will require regular opportunity to attend advanced training courses.

	appropriate approach and handling within assessment. Therapists should consider undertaking the following training to support their development in neonatal physiotherapy: • Family and Infant Neurodevelopmental Education (FINE) programme. Level 1 (www.bliss.org.uk/training-and-events/fine) • APCP Foundation Course in Neonatal Care • APCP Neonatal Assessment Course	Experienced neonatal and paediatric physiotherapists will require regular opportunity for peer review with other experienced therapists. Neonatal therapists are expected to work with their peers across their Neonatal Networks to look at services across the footprint. It is helpful for therapists working within the same network to work together towards consistency. Therapists should consider undertaking the Family and Infant Neurodevelopmental Education (FINE) programme. Level 2 (www.bliss.org.uk/training-and-events/fine) Support the development of less experienced neonatal physiotherapists in line with Foundation Level skills and knowledge and further towards Advanced Level outline as appropriate.

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CHAPTER 3: The Neonatal Environment

The physical and psychological neonatal intensive care unit (NICU) environment is an important factor in neonatal development (Pineda, Raney and Smith, 2019). Frequent procedures, handling, and exposure to smell, light and noise may cause physiological stress to infants which may impact on long term neurodevelopmental outcomes (Smith et al., 2011). Environmental factors have also been shown to influence or alter the expression or effects of genes in preterm infants through a process called epigenetics (Altimier & Phillips, 2016).

Importantly, environmental factors (such as prolonged need for hospital care) also impacts on parents and family's ability to care for their baby. Increased stress and anxiety of parents and families may influence their ability to provide optimal care and bonding with their baby.
Developmentally supportive care aims to implement modifications to the nursery environment and care practices (through attention to noise, light and positioning, handling and sleep preservation) to reduce stress on infants and improve the parent-infant relationship. In particular, the Family and Infant Neurodevelopmental Education (FINE) pathway is designed to enable neonatal professionals to put the theory and evidence behind infant and family-centred, developmentally supportive care into practice (Warren, 2017). FINE is based on three over-arching principles:

- To practice care that is sensitive in order to; stabilize autonomic regulation, minimise stress and pain, protect sleep, and provide a nurturing sensory and social environment.
- To recognise that the parent-infant relationship is key to future development and well-being and to promote positive relationships between infants and caregivers, and between families and professionals.
- To individualise care because every individual baby and family are unique.

Neonatal Physiotherapists should be aware that the following environmental modifications may influence infant and family experience, wellbeing and outcome.

Noise

Noise is one of the most significant contributors adversely affecting infants in the NICU. The longer an infant's stay in the NICU, the more they are exposed to often continuous moderate noise levels. Sudden and loud noise leads to physiological and behavioural disturbances including sleep disturbance, motor arousals such as startles, crying, hypoxemia, tachycardia, and increased intracranial pressure (Cheong et al, 2020). Increased intracranial pressure can further contribute to intra-ventricular haemorrhage (Tan et al, 2018). Lowering the sound levels

to below 45 decibels can diminish stress on the cardiovascular, respiratory, neurological, and endocrine systems of an infant in order to promote growth and reduce adverse neonatal outcomes (Almadhoob & Ohlsson, 2020).

It must, however, be recognised that exposure to meaningful language is of huge developmental importance to a preterm infant. Studies have highlighted that infants not exposed to meaningful language show developmental language delays at 2 years (Barton & White, 2016). Parents should be encouraged and supported to connect with their babies through reading and singing.

Light

The retina and visual cortex are the last of the senses to develop. For preterm infants less than 32 weeks gestation, pupil responses are sluggish and eyelids are thin which means that they are unable to effectively filter out bright lights. Light can therefore bring about a noxious response in these infants which in turn, causes stress (Graven & Brown, 2008). Continuous, high-intensity light exposure and lack of systematic, rhythmic diurnal patterns are of concern regarding global development as well as the visual development of the premature infant (Blackburn, 1998).

Whilst it is important for very preterm infants to have light exposure minimised, it is equally important that from around 34 weeks gestation onwards, infants are gradually exposed to cycled light to help them to establish day and night cycles. Some studies have also shown that infants exposed to cycled light have a shorter length of stay compared with those exposed to continuous bright light or near darkness (Morag & Ohlsson, 2016)

Sleep

All environmental factors like light, noise, touch and positioning impact on sleep. Sleep is the predominant behavioural state in the premature neonate and is involved in maturation of the nervous system and brain development (Bonan et al 2015). The trajectory of sleep / awake states and feeding progressions are also linked in preterm infants (Park et al, 2019). Quiet sleep (non-REM) is necessary for energy restoration and the maintenance of bodily homeostasis. Active sleep (REM) is important for sensory processing, memory encoding and consolidation and learning (Holditch-Davis et al, 2004). Over time, disturbances to sleep can affect overall growth, brain development and organisation which can have lifelong implications. Sleep deprivation (both REM and non-REM) results in a loss of brain plasticity which is manifested by smaller brains, altered subsequent learning and long-term effects on behaviour and brain function. Facilitation and protection of sleep and sleep cycles are

essential for continued brain development through the preservation of brain plasticity (Kuhn et al, 2013).

Touch

The sense of touch is one of the earliest to develop in early foetal development. In extremely small premature infants, their skin is very fragile requiring gentle care, and some studies have indicated that certain types of touch may be more stressful rather than soothing (Nair et al., 2003). Preterm infants may have difficulty modulating their level of arousal after particular stimuli, such as handling during cares or medical procedures. However, positive touch can be beneficial for development, and recent evidence suggests a lack of sensory stimuli in preterm infants may act as a stressor and impact on the neurodevelopment (Asadollahi et al., 2016). Kangaroo care is a key part of positive touch, and is discussed below. Infants respond differently to different kinds of touch; therefore, frequency and type of touch should be dependent on how he or she responds. By taking these factors into consideration, infant stress may be reduced significantly (Field, 2017).

Positive smell experiences

The neonate quickly becomes familiar with the unique smell of their mother and gains great comfort from it. Once a baby is delivered, they will often spend many hours having skin to skin contact during which mum, dad and baby sense the unique smell of each other and the bonding process is initiated (Nishitani et al., 2009). If the baby needs to be admitted to the Neonatal Unit, this process is interrupted. It may be hours, days, weeks before they are able to be reunited in such a way, therefore other measures such as maternal scent, breast milk and colostrum can be used to connect mother and baby and must be implemented (Pineda et al., 2019). This ensures that the bonding process is able to continue.

Research has shown that maternal milk odour can have an analgesic role for babies, and babies who have constant exposure to familiar odours have a decreased incidence of apnoeas and bradycardias (Marlier et al., 2005; Zhang et al., 2018). It has also been found that mothers respond to the smell of their baby which may aid expression of milk by stimulating a hormonal response. Unlike other senses when a baby is sleeping, the sense of smell remains active and is not dulled; therefore, the presence of familiar odour provides positive effects at all times.

Oral Stimulation and Feeding

Sucking may be nutritive or non-nutritive and related to whether liquid (milk) in ingested (nutritive) or not (non-nutritive) (Lau, 2016). The development of the pharyngeal swallow is

seen at 10-11 weeks of gestation while suckling is seen to develop at 18-24 weeks gestation. Suck-swallow coordination starts to develop at 32 weeks gestation in a preterm infant. Full coordination of suck-swallow-breathe, necessary for full nipple feeding is not seen until 33-34 weeks gestation and even at this stage, may not be safe or fully developed/co-ordinated (Lau, 2016).

Positive oral experiences in and around an infant's face and mouth should be encouraged and can be provided by parents/carers (Pineda, 2019). The aim of positive oral stimulation is to avoid the infant becoming aversive to touch, particularly to the face/mouth and to support the development of nutritive and non-nutritive sucking (Grassi et al., 2019).

Practising non-nutritive sucking on a dummy or clean finger enables the infant to experience sucking and to practice coordination of sucking and breathing. Non-nutritive sucking should be introduced when it is considered safe. Under the guidance of qualified staff, infants may be offered the dummy or finger dipped in EBM or formula. This enables the infant to experience the taste and small amounts of fluid while keeping them safe until it is deemed that they are able to tolerate trials of nutritive sucking (Pineda, 2019).

Nutritive sucking is a more complex task and the infant must be able to maintain an appropriate state while coordinating sucking, swallowing and breathing. Advice from a specialist neonatal speech and language therapist should be sought for those infants that demonstrate difficulties with oral feeding (distress, coughing, eye-tearing/ reddening, desaturations during feeding, increased length of time to feed, colour change etc).

Feeding is one of the best times to start early communication. The carer is looking at the baby's face and due to the length of time feeding, the baby can start to focus and watch a carer's face. The carer should be encouraged to communicate with the baby at this time through non-verbal and verbal communication i.e. talking to the baby in words, singing and babbling at them. The majority of children prefer a higher pitched voice. The majority of parents naturally use Child Directed Speech (slow rate, highly repetitive, high pitch) but parents under stress may require support to feel confident in their interactions and reading their baby's cues.

Kangaroo care (see section below) is one-way parents/carers can provide an infant with opportunity to have positive oral stimulation as it enables the infant to become accustomed to having skin close to the face and mouth. Introduction of oral feeding, when clinically appropriate, is easier for the infant and parent/carer if oral aversion is avoided.

Kangaroo care

Kangaroo Care is skin-to-skin contact when a baby is placed against the parent's chest. It is one of the most well evidenced forms of supportive care for neonates and has significant benefits for both the mother and baby (Jadhao et al., 2020). Skin to skin contact provides the right environment for DNA, epigenes, neural circuits and physiological regulation to function most optimally (Altimier &Phillips, 2016). Benefits include improvements with lactation and with establishing breastfeeding, better sleep quality, better thermal control and better weight gain for the baby. Infants have also been shown to have improved neurobehavioral performance, and tissue oxygenation (El-Farrash et al. 2019). In the longer term, it helps parents to feel closer to their babies and more confident in caring for them (Akbari et al, 2018; Campbell-Yeo et al, 2015). Kangaroo Care can be used with babies with high medical needs, but this will require careful planning and collaboration with the neonatal staff.

Preterm infants

	Foundation module	Advanced module
Light	Have an awareness of the effect of light levels on preterm infants and modify your approach accordingly. This may include leaving incubator covers on during assessment and treatment where possible or shielding an infant's eyes from light where increased light levels are required. Be aware that preterm infants require increased light exposure from 32 weeks and encourage nursing staff to establish this during routine cares by cycling incubator covers.	Have an in depth understanding of research exploring the effects of light levels on preterm infants. Work with staff on neonatal unit to ensure appropriate light levels within nurseries, and ensure eye protection used when increased light levels required for procedures, phototherapy etc. Educate staff on appropriate practice. Audit adherence to quiet times on the unit when light levels are reduced and to audit the use of eye protection.
Noise	Understand that increased noise levels can lead to stress in preterm infants. Understand the benefits of positive sound experiences	Demonstrate an awareness of the research about the impact of noise on preterm infants.

	on brain growth and development. Ensure appropriate practice when working with preterm infants – use quiet voice, take care when closing incubator doors, do not place objects on top of incubator.	Educate caregivers on the impact of increased noise levels on brain development and appropriate practice to minimise the impact. Ensure quiet times (where set) are being adhered to on the unit. Audit noise levels on the unit and feedback the information to help raise awareness.
Touch	Understand an infant's readiness for touch and ensure handling appropriate for infant's gestational age and tolerance of handling. Apply appropriate hand placement, support, and adjustments during handling of neonates.	Be able to educate caregivers (nursing staff, doctors, parents etc) on appropriate handling and positive touch appropriate for an infant's gestational age. Support and encourage nursing staff to offer kangaroo care where appropriate for infants. Signpost parents to appropriate literature.
Positive Smell Experiences	Have an understanding of the positive effects of familiar smell on infant stress. Encourage parents to be present during therapy sessions as their smell will help settle infant. If parents are absent use a bonding square (or similar) placed close to infant to keep infant settled.	Educate caregivers on the importance of positive smell experiences.
Pain	Understand that pain is stressful for infants and have an awareness of how you can help to mitigate the stress caused by pain with	Educate caregivers on the impact of pain on stress levels and what can be done to mitigate the effects e.g. non-nutritive sucking +/-

	appropriate handling and comfort measures.	sucrose/EBM, comfort holding etc. Ensure appropriate practice when carrying out potentially painful procedures e.g. suction, dressing changes, bloods tests etc. to reduce stress for the infant.
Sleep	Understand that infant sleep cycles develop with gestational age.	Recognise infant sleep-awake states (REM and non-REM). Ensure that interventions and care giving promote optimal sleep. Educate parents on the importance of sleep and how they can facilitate their infant's sleep.
Assessment	Recognise physiological stress by interpreting autonomic responses from the infant and from monitoring equipment: heart rate, respiratory rate and breathing pattern, colour, oxygen saturation, blood pressure, temperature during physiotherapy examination and intervention, routine care, feeding and social interaction. Identify and interpret infant behavioural cues reflected in movement and posture, behavioural state, and attention and interaction.	Recognise consistent signs of neurobehavioural organisation or disorganisation in the physiological, motor, and state systems through repeated observations of infant caregiving and social interaction. Use of specialist tools to assess behavioural state e.g. NBAS, NBO
Education	Attend any appropriate education delivered on the neonatal unit to further develop your knowledge and understanding of	Act as a resource to nursing staff, medical staff, other therapy staff and families for unit and network wide support and implementation

	developmental care practices. Attend appropriate courses – FINE Level 1 http://www.bliss.org.uk/fine Access other organisations for support e.g. Bliss and signpost parents appropriately.	of environmental factors designed to improve neurodevelopmental outcome for preterm infants. Participate in audit of developmental care practices to ensure guidelines are being adhered to. Apply up to date research and evidence-based practice into caregiving plans and interventions. Educate parents to understand the behavioural communication of their baby to be able to interpret and respond to the baby's needs. Present or contribute to staff development initiated educational sessions/workshops and conferences. Attend appropriate courses – FINE Level 2 & Masterclass http://www.bliss.org.uk/fine Access other organisations for support e.g. Bliss and signpost parents appropriately.
Management	Implement therapeutic strategies appropriate to gestational age and matched to the physiological, motor, and state regulation strengths and vulnerabilities and	Analyse and modify the physical and social environment using environmental support measures (e.g. positioning aids, light and sound control measures) and individualised

	neurodevelopmental risk. These strategies include positioning, skin to skin holding (kangaroo care), handling, behavioural organisation, modified infant touch, and adaptive equipment use as required. Collaborate with neonatal nurses to implement modification of the physical, sensory and social environment in the NNU (e.g. day-night cycling, demand feeding, minimal handling, quiet time).	caregiving procedures to optimise neurodevelopment of all infants, and in particular, neurobehavioural responses of infants at high risk to physiotherapy assessment and intervention. Collaborate in identifying and analysing environmental problems across the unit and developing objectives and action plans to achieve optimal neurodevelopmental outcomes. Participate in developmental care ward round (if available). Play an active role in specialist developmental care groups that may run within the neonatal unit setting. Contribution to written guidance/policies to ensure a unit wide approach to developmental care

Term infants

Developmental care is often a phrase used exclusively to describe the care of premature babies. It is important to recognise that there are often term aged infants on the unit (with complex surgical, respiratory or neurological conditions), which require different developmental input to those that are still premature.

Evidence shows that a prolonged hospital admission, multiple surgical events and reduced enteral feeding can contribute to developmental delay in term children (Stolwijk et al., 2016). In addition, infants with severe congenital heart disease are known to be at risk of later neurodevelopmental difficulties, due to a combination of physiological and environmental factors (Marino et al., 2012). Many aspects of this are unavoidable within the neonatal environment; however, there are actions that can be taken to promote normal development within this patient group. Babies that have reached greater than term age and have remained on the unit for a prolonged period of time will benefit from physiotherapy input that is appropriate based on their medical comorbidities.

	Foundation module	Advanced module
Light	Ensure infant is exposed to diurnal light patterns. Provide appropriate visual stimulation within the cot space e.g. black and white pictures.	Identify infants who may benefit from reduced light exposure to help them to settle and advise caregivers accordingly.
Noise	Understand term infants are likely to have periods of awake time and may benefit from more sensory stimulation. To start with this may be in the form of talking/singing/language/music.	Provide individualised support for a graded approach to the introduction of increased auditory stimulation.
Sleep	Ensure that 'back to sleep' practices are role modelled as appropriate. Support infant's sleep and plan interventions accordingly as quiet time is important for deep REM sleep and continued brain development.	Support parents to promote infant sleep. Identify infants who may be struggling to habituate which could lead to increase stress and poor sleep.

Touch	Term infants will benefit from increased handling to aid neuromotor development. Kangaroo care remains important in the first four weeks. Exposure to different positions is important and can be supported by the introduction of an early developmental programme. This may include starting tummy time, and spending time in a bouncer chair (if appropriate depending on medical comorbidities). Sensory exploration of world around them is also important for their neurodevelopment. This can be done through the introduction of toys of differing textures.	Provide individualised developmental play programmes appropriate for the infant's needs. Provide specialist support and advice for positioning and handling infant's with abnormal tone. Cue-based therapy sessions working within the infant's own capabilities and limits. Progress intervention as appropriate over time.
Positive Smell Experiences	Understand the positive effects of familiar smell on infant stress. Encourage parents to be present during therapy sessions as their smell will help settle infant. If parents are absent use a bonding square (or similar) placed close to infant to keep infant settled.	Educate caregivers on the importance of positive smell experiences.
Pain	Understand that pain is stressful for infants and have an awareness of how you can help to mitigate the stress caused by pain with appropriate handling and comfort measures.	Educate caregivers on the impact of pain on stress levels. Ensure appropriate practice when carrying out potentially painful procedures eg suction, dressing changes, bloods tests etc. to limit reduce stress for the infant.
Assessment	Understand the difference between term and preterm development and ensure assessments used are appropriate.	Be able to use a wide range of neurodevelopmental assessments suitable for the infant's age and

	See Chapter 2	presentation eg Prechtl, AIMS, CHOP Intend, HNNE/ HINE. **See Chapter 2** Ensure timely reassessment to monitor progress and update treatment plans accordingly.
Education	Educate nursing staff and caregivers on developmentally appropriate stimulation	Educate nursing staff and caregivers on complex positioning needs for infants with complex neuromotor difficulties or co-morbidities that require different handling/ management.
Management	Be able to progress a developmental programme to address an infant's changing needs over time.	Be involved in multidisciplinary team meetings relating to infant to ensure developmental needs of patient are being met and everyone involved with the infant's care is aware of their needs.

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CHAPTER 4: Family Integrated Care

Introduction

Family Integrated Care (FIC) is a philosophy that puts the baby and their family at the centre of care. Through consistent education and support, parents become active partners and advocates for their infants, working in partnership with professionals, in the care of their baby during their neonatal stay.

Parents are supported to be involved in as much of their babies' care that they are comfortable with. Parents may be involved in tube feeding, general observations, charting and nappy changes, administration of medication, positioning/postural care, transferring and presenting their baby on ward round as well as skin to skin/kangaroo care. This list is inclusive but not exhaustive.

FIC has demonstrated that babies show increased weight gain and decreased nosocomial infection. Other benefits include improved parental bonding, decreased parental stress, increased breast-feeding rates and decreased readmission rates (O'Brien et al 2018). All of these factors may contribute to reduced stress and trauma related to neonatal admission and therefore improve long term developmental outcomes for such infants.

FIC can be broken up in to 4 'pillars'; staff education, parent education, environment and psychosocial support. As a physiotherapist working in the neonatal environment being aware of FIC is vital to promote parents being partners in their babies care wherever possible. The physiotherapists' role is likely to involve education for parents and staff in many different formats such as presentations in groups, 1:1 teaching, cot side training or the completion of competency documents. It is also important to be aware of how to sign post staff and parents to relevant resources available within your neonatal setting.

Foundation	Advanced
Aware of the concept of FIC, the emerging evidence base including the impact on infant outcomes and parent well-being. Awareness of quality improvement (QI) methodology and its role in service development.	Support parents to be partners in their baby's care, in particular the developmentally supportive aspects of care documented in Chapter 3. Demonstrate an understanding of how parents learn and gain confidence in handling and caring for their baby, ie parents may be more confident in certain cares at certain stages and both parents may be at different stages.

	Support staff to overcome barriers of traditional roles within the NICU environment, enabling parents, with staff being facilitators. Participate in the FIC parent and staff education/training sessions including developing relevant teaching materials to support sessions. Contribute towards the development and dissemination of written information regarding FIC Collect appropriate data to facilitate evaluation of aspects of FIC Able to analyse data relevant to FIC Contribute towards MDT discussions regarding ongoing evaluation of service changes Develop in-depth knowledge regarding the drivers and evidence base for FIC Able to plan, deliver and evaluate service changes using QI methodology

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Chapter 5: Infant Positioning

The concept of developmentally supportive care in relation to environmental factors has been discussed in Chapter 3 however provision of postural support or "positioning" the neonate is another important aspect of care delivery that can influence infant development. Positioning infants in the NICU is a core skill required of any neonatal clinician however, the therapeutic influence of positioning on infant development is not always well recognised across the MDT. Motor skill development begins with postural control which is demonstrated as the capacity to maintain body alignment and orientation during rest, body part displacement and during active, spontaneous movement (Ferrari et al, 2007). This foundational motor milestone requires tactile, vestibular, and proprioceptive input for development and maturation (Hadders-Algra, 2013). Since these early movement experiences contribute to the refinement and strengthening of neural pathways in the last trimester, it is of great importance that clinicians utilise the best available evidence to inform practice in order to optimise outcomes for infants born preterm (Blackburn, 1998).

There are a variety of suggested benefits to substantiate the need to provide premature infants with postural support such as; aiding digestion (Chen et al, 2013), improving hip posture (Downs, 1991), preventing cranial moulding (Hummel & Fortado, 2005), preventing unplanned extubation (Joseph, 2015), reducing the risk of intra-ventricular haemorrhage (IVH) (Joseph, 2015), promoting motor-sensory development (Sweeney and Gutierrez, 2002), improving sleep (Waitzman, 2007) and reducing stress (Altimier et al, 2015; Sweeney and Gutierrez, 2002). Positioning also has important implications for respiratory function. Varying the position of the baby is important for facilitating an improvement in lung function (Hough et al, 2016). In babies with respiratory complications, prioritising more frequent changes of position can optimise respiratory status.

A large body of research literature exists in relation to provision of postural support / positioning of preterm infants however, the variety of positioning aids used and differing outcomes measured as part of the research design has made it difficult to perform meta-analyses or confirm superiority of one method over another (Symington and Pinelli, 2006). However, many authors are agreed on the core principles of optimal positioning; flexion, midline symmetry and containment (Bowden et al, 2000; Ferrari et al, 2007) to promote normal movement and posture.

Nests are one form of positioning aid commonly explored in the literature (Ferrari et al, 2007; Nakano, 2010; Zahed et al, 2015). A variety of nest-like structures are commercially available

or can be created using rolled towels, blankets or sheets but typically aim to promote flexion of the trunk and limbs and a circumferential boundary to provide containment in the infant. Analysis of infant movement and posture when supported in manufactured nest-like positioning aids demonstrates that infants adopt more flexed and midline orientated postures similar to in-utero than infants without this type of positioning support (Ferrari et al, 2007; Nakano et al, 2010; Zahed et al, 2015) and less commonly display unfavourable extended spinal postures (Zahed et al, 2015). Studies also demonstrate improved quality of movement including elegant forearm rotations and contact of hands and feet with other parts body parts (Ferrari et al, 2007; Zahed et al, 2015) which is vital for optimal neuro-sensory development (Hadders-Algra, 2013). Favourable outcomes in relation to head shape, visual pursuit and behavioural assessment have also been associated with a manufactured nest more so than structures created by nursing staff using rolled sheets (Vaivre-Douret and Golse, 2007).

Other types of positioning aids include head supports, mouldable mattresses and prone pillows / rolls. Use of a prone roll has been found to improve upper limb and shoulder girdle posture (Monterosso et al, 2003) which may positively influence later development in terms of reaching skills and sitting balance (Sweeney and Gutierrez, 2002). Vaivre-Douret et al (2004) found that use of a mouldable mattress for positioning support was associated with improved posture, movement, behaviour and auditory and visual responses when compared with positioning support created with rolled blankets. Infants who were cared for using rolled blankets as positioning support were more likely to display scapula retraction, unilateral head preference, over-excitability and spinal extension (Vaivre-Douret et al, 2004).

Despite the range of positioning aids available for neonatal clinicians to use; understanding the rationale for providing positioning support and being able to assess positioning adequacy is fundamental to positively influencing outcomes for these vulnerable infants. Incorrect or suboptimal use of any positioning aid may have negative consequences on infant development despite the good intentions of the clinician. Attention to detail, self-evaluation and peer mentorship are essential aspects of skill acquisition in relation to infant positioning.

Each neonatal unit will have access to a different range of positioning aids, with some clinicians having to create their own positioning supports using rolled towels and blankets depending on local budgetary constraints. Equipment availability and the number of different clinicians involved in positioning a baby across the duration of their neonatal stay can make it difficult to achieve optimal positioning consistently (Jeanson, 2013; Hunter, 2015). In recognition of this, it is important that neonatal physiotherapists have sufficient skills to act as

a source of expertise in relation to infant positioning on neonatal units and are able to engage in activities such as teaching and audit in order to support effective practice (Coughlin et al, 2010; Hunter, 2015).

<table>
<tr><th>Assessment</th><th>Foundation Module</th><th>Advanced Module</th></tr>
<tr><td>Theoretical Knowledge</td><td colspan="2">Rationale
The aim of supportive positioning is to maintain the baby’s musculoskeletal integrity and to promote optimal early neuro- muscular and neuro- behavioural development.

Core principles of using postural support / positioning aids
1. Promote FLEXION of the trunk and limbs
2. Promote MIDLINE
3. Promote SYMMETRY
4. Promote NORMAL MOVEMENT and POSTURE

Benefits
• Reduces the effects of gravity on an immature musculoskeletal system maintaining normal muscle length-tension relationships.
• Facilitates development of osteo-articular structures
• Reinforces development of 'typical' flexor motor patterns which are important for future neuro-motor development
• Improved flexor muscle tone can result in improved ability to coordinate suck and swallow, improving feeding and growth
• Promotes mid-line orientation and development of self-regulatory behaviours
• Reduces stress and promotes physiological stability which can negatively impact on the developing brain
• Promotes sleep as baby comfortably positioned in a contained posture
• Promotes infant/family bonding
• Aids digestion
• Reduces cranial moulding
• Reduces risk of intraventricular haemorrhage
• Reduced risk of unplanned extubation

Contraindications
There are no absolute contraindications to supportive positioning. It is important to follow the principles of effective positioning and practice within the limits of your own level of competency. The level of support can be adjusted to suit every baby’s clinical condition and professionals using supportive positioning equipment are encouraged to think about the postural support needs of each baby as an individual.</td></tr>
</table>

	Precautions Ventilator tubing Central, arterial and venous lines Temperature control especially if baby is prone to becoming hyperthermic	
Patient Selection	Supportive positioning should be used with ***all*** babies born at less than 32 weeks gestation and/or weighing less than 1500 grams. It should also be considered for: • babies born at less than 35 weeks who struggle to maintain anti-gravity postures or are not yet fully orally feeding • babies with intra-uterine growth restriction • babies with an identified neurological condition. • Babies with Neonatal Abstinence Syndrome (NAS) Be aware that babies born extremely preterm may need postural support beyond 35 weeks CGA and this should be assessed on an individual basis in the context of their anti-gravity movement and neurobehavioural regulation.	
Equipment selection	**Foundation**	**Advanced**
Practical Skills	Clinicians are able to make suggestions to optimise the infant's position but will need support from an experienced neonatal clinician to handle infants less than 32 weeks CGA or those with complex medical co-morbidities. Clinicians are able to develop their skills through working with experienced clinicians to independently position stable infants > 32 weeks gestation.	Experienced clinicians develop their skills in handling vulnerable infants born less than 32 weeks gestations and those with complex medical co-morbidities through post-graduate training, peer review and reflective practice. Utilise advanced clinical reasoning to determine optimal positioning on an individual basis for each infant taking in to account contextual factors such as medical stability, neurobehavioural regulation and musculoskeletal factors.
Audit	Clinicians have awareness of infant positioning assessment / audit tools that are available such as the IPAT (Coughlin, 2010) and other published examples (Hunter, 2015). Clinicians are able to assess infant positioning through observation and assign a positioning score using a recognised assessment tool.	Experienced clinicians are proficient in the use of audit tools to assess infant positioning. Experienced clinicians are responsible for data collection and analysis relating to positioning practices on neonatal units. Experienced clinicians use audit data to provide feedback to nursing,

		medical and AHP colleagues to support training and inform practice change both locally and across regional networks.
Training and Education	Clinicians may be involved in explaining to parents the rationale for the using postural support with infants on the neonatal unit. This may be delivered on a 1:1 basis or by use of cot cards, provision of relevant parental information leaflets, website information, poster / information board advertising within neonatal units.	Experienced clinicians are able to deliver training +/- assess competency of nursing and other physiotherapy colleagues in the appropriate therapeutic positioning of infants. Experienced clinicians can also teach parents how to use the positioning aids to appropriately support their babies.
Discharge Planning	It is important to ensure that parents are made fully aware that their baby should sleep on their back with no additional supports or blankets in the cot once home in line with the national Sudden Infant Death (SIDS) campaign. In order to help parents and babies prepare for home it is recommended that once a discharge date is identified all positioning aids are removed from the hospital cot. This conversation may be delivered by a therapist or a member of the nursing team and documented in the baby's medical record.	

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CHAPTER 6: Respiratory Care of the Neonate

Neonatal chest physiotherapy is a highly specialised area of respiratory care. Very little evidence supports the use of physiotherapy techniques, therefore detailed understanding of the literature and professional consensus is required in order to apply treatment techniques judiciously and safely to preterm infants, which differ in vulnerability and physiology from their term counterparts. The physiotherapist should approach assessment of the infant with a thorough understanding of the pathophysiology of the premature baby. This enables the physiotherapist to accurately identify respiratory problems that have the potential to be addressed by physiotherapy approaches and treatments.

Respiratory Physiotherapy Service

Each neonatal unit should have a neonatal respiratory physiotherapy service specification; written and approved by both the neonatal unit and the physiotherapy department. This should detail a plan for management of babies who may benefit from respiratory physiotherapy intervention. The service specification should identify arrangements for out of hours cover. The arrangement may range from no service, to a full service covered by physiotherapists on the on-call rota, or an arrangement where nursing and medical staff receive training from an experienced Physiotherapist. Routine review and evaluation of the neonatal respiratory physiotherapy service should examine the effectiveness and sustainability of the programme, including a plan for ensuring the competency of all staff expected to cover the neonatal unit on the on-call rota, which has many challenges.

Opportunities for physiotherapists to gain experience of respiratory care in the neonatal setting are lacking. Where an “ad-hoc” service is provided it should be clearly understood that the attending physiotherapist will not be expected to work outside his or her level of experience and competence.

Foundation level includes any physiotherapist working on a neonatal unit, either starting out in their role with funded hours as part of their job plan, or those units where an ad-hoc arrangement with the physiotherapy department is in place. At **foundation** level, it would be expected that a physiotherapist would have the ability to assess the baby alongside an experienced member of the neonatal team, and identify any problems potentially responsive to physiotherapy interventions. If the physiotherapist has little experience in handling a premature baby, or does not feel competent to do so, then this should not be expected. It is

reasonable to assess the baby at the cot side with an experienced nurse or doctor, and any handling for position changes can be undertaken by unit staff.

In units where a full respiratory service is provided, the physiotherapist would be expected to work at an **advanced** level. The physiotherapist providing a respiratory service must ensure he or she has a plan for maintaining all competencies and handling skills in an area where direct hands on treatment is not routinely required. This should involve strategies for ensuring peer support, keeping up to date with the relevant literature and clinical experience. Succession planning should be considered, utilising rotations of junior staff alongside an experienced neonatal therapist.

At **advanced** level, the physiotherapist will act as a resource to nursing, medical and therapy staff and families for unit wide implementation of evidence-based chest physiotherapy strategies. This will involve service planning to ensure the needs of the unit are met both insuring quality of assessment and interventions and timely response. Physiotherapists will utilise a reflective, critical thinking and problem-solving approach to the respiratory care of the preterm infant that is evidence based, promotes clinical decision making and enables the development of clinical protocols.

Background knowledge base		
	Foundation	**Advanced**
Anatomy and physiology and understanding of the neonatal journey	Anatomical and physiological differences between term and pre-term babies Anatomical differences: • Airway size • Muscle fibres • Heart size • Rib cage configuration • Intercostals • Preferential nasal breathing Physiological differences • Increased O2 consumption • Sleep state	• Full understanding of NNU medical terminology and abbreviations • Development of neuromuscular, musculoskeletal, integumentary, sensory, cardiovascular, pulmonary and other physiological systems of the foetus. • Epidemiology and embryology of foetal malformations, deformations and consequences of exposure to maternal infection, substance misuse and inadequate nutrition. • Epidemiology and pathophysiology of prenatal, perinatal and post-natal diagnoses • Indications for and effects of general medical and surgical procedures in preterm infants.

	• Periodic breathing • Mucocilliary escalator • Immature reflexes (cough and gag) • Hypothermia • Pores of Kohn, channels of Lambert (Absence of) • Surfactant Normal pre and post-natal lung development • Understanding of impact of stage of development on assessment of baby, expectations, and potential interventions. *Awareness* of common medical and respiratory conditions affecting neonates • Surfactant deficiency/RDS/BPD • HIE - Hypoxic Ischaemic Encephalopathy • CLD - Chronic Lung disease • CDH – Congenital Diaphragmatic Hernia • NEC – Necrotising Enterocolitis • IVH – Intraventricular Haemorrhage • MAS – Meconium Aspiration Syndrome • CHD – Congenital Heart Disease • IUGR – Intrauterine Growth Retardation • Hyperbilirubinemia • PDA – Patent Ductus Arteriosus • PVL – Periventricular Leukomalacia	• Indications for and effects of respiratory management strategies in preterm infants. • Effects of the NNU environment on the infant. • Interaction between environmental factors and infant neurobehaviour. • *Aetiology and pathophysiology* of common medical and respiratory conditions affecting neonates (see foundation) • Infection control procedures, clean and aseptic techniques. • History behind the risks associated with chest physiotherapy and its relevance to current practice.

	• PPHN – Persistent Pulmonary Hypertension of the Newborn • Congenital Pneumonia • ROP – Retinopathy of Prematurity Knowledge of risks associated with chest physiotherapy. Framework and principles of developmental care for preterm infants. Role of members of multidisciplinary team. It is acceptable to assess alongside an experienced member of the NNU team.	
Screening		
	Foundation	**Advanced**
Screen infants on NNU to determine the need for physiotherapy services based on referral or diagnostic criteria	• Identify and interpret perinatal and medical history and current infant status from the medical notes and by communicating with medical and nursing staff. • Recognise signs of changing respiratory status and potential indications and contraindications for chest physiotherapy.	Identify infants for referral to physiotherapy, e.g. through participation in NNU medical ward rounds, review of BadgerNet. Identify opportunities for potential referrals, collaboration, and resource sharing among other disciplines or services.
Examination and Evaluation		
	Foundation	**Advanced**
Examine infants and interpret findings	Recognise signs of secretion retention, atelectasis, or lobar collapse due to mucous plugging also surfactant deficiency, Air leaks (e.g. PIE	Identify and interpret infant behavioural cues based on nursing assessment and observation of the infant. Determine a safe and effective approach to start the assessment and

	(pulmonary interstitial emphysema), pneumothorax) hyperinflation, deranged clotting and low platelets by identifying and interpreting information from: • Medical and nursing staff • Medical notes and nursing charts • Chest x rays • Monitors and ventilator settings • Blood and biochemistry result • Observation. Evaluate and interpret the information and identify need for clinical examination. In discussion with nursing and medical team, and using clinical reasoning and decision-making skills: • Identify any problems potentially responsive to physiotherapy intervention • Identify measurable treatment goals • Identify the most appropriate chest physiotherapy intervention(s) that either the therapist or medical staff are competent to undertake • Modify suggested interventions to be appropriate for preterm infants.	intervention, balancing the need for intervention with the physiological cost to the infant of handling. Locate all leads, lines and respiratory tubing from the infant to medical equipment and explain the function of each. Function, modes and clinical applications of respiratory support. Understand use of accessories including humidifiers, suction equipment and resuscitation equipment. Demonstrate appropriate handling of infants with increasingly complex medical needs on physiological monitors, respiratory equipment, infusion or parental feeding lines and other medical support devices. Apply appropriate hand placement, support and adjustments during handling of preterm infants. Analyse and modify the physical environment using environmental support measures (e.g. positioning aids, light and sound control measures) and individualised caregiving strategies to optimise neurobehavioural responses of infants during examination and treatment. Select and carry out clinical examinations and evaluations appropriate for the infant's gestational age and physiological stability determining the indications for, contraindications and precautions to chest physiotherapy treatment. Competent in the components of chest physiotherapy assessment:

	Where neither the physiotherapist nor the nursing or medical staff have sufficient competence in the specific skills required, advice should be limited to positioning recommendations and reviewing best practice suction technique.	observation, auscultation and palpation. Using advanced clinical reasoning and decision-making skills from the examination identify the physiotherapy problem, measurable treatment goal and select the most appropriate chest physiotherapy technique(s), modifying those techniques to be appropriate for preterm infants.
Assessment and treatment of physiotherapy problems		
Problems potentially responsive to respiratory physiotherapy interventions	**Volume loss** • Collapse/atelectasis on CXR • Ventilator parameters (e.g. decreased tidal volume (TV)) • Auscultation/palpation **Secretion retention** • Auscultation/palpation • Suction yield (consistency/colour/volume) • Ventilatory parameters (e.g. increased Peak Inspiratory Pressure (PIP), decreased volumes) • Collapse/consolidation on CXR	
	Foundation	**Advanced**
Treatment options	**Positioning** Positioning is the only area of respiratory physiotherapy where there is robust evidence that it impacts on the respiratory function of the infant. • Variety is most important for optimising respiratory function (Hough, 2016) therefore change positions frequently (balanced with need for sleep). Prioritise frequent turning where there is clear evidence of volume loss or excess secretions.	**Percussion** (By experienced staff only). A percussor is generally recommended however, an appropriately sized facemask may be used in accordance with your local policy and equipment availability. Three tented fingers may be used where appropriate by experienced physiotherapists. • Stabilise head with one hand at all times • Ensure whole circumference of the percussor makes contact with baby's chest, ideally directly on baby's skin • Ideal rate approximately 3/sec • Use short percussion episodes according to baby's stability/tolerance/gestational age

	• Consider all positions (unless contraindicated), including prone or semi-prone, and kangaroo care. • Dependent regions are prone to atelectasis and collapse (Hough 2014), therefore avoid spending long periods in one position. • Consider 24-hour plan for positioning not positions in isolation. **Ensure optimisation of:** **Humidification** • Ensure humidifier set up and working correctly, minimise rain-out • Ensure appropriate fluid balance for patient • Ensure appropriate mouth care **Sedatives/paralysing agents** • Review regularly to ensure baby not over sedated/paralysed unnecessarily **Suction technique (open and closed):** • Optimise ETT and catheter size (1/2 diameter of ETT) (Goncalves 2015) • Suction pressure (6-13kPa) (Gardner 2009) • Measured length (ETT length +adapter +0.5cm) (Morrow 2008) • Quick pass down, slow and steady up	• Maximum of 1–2 min (up to 2–3 min for more robust babies) • Address signs of stress by pacing baby or giving time-out/comfort holding • Treat only when clinically indicated and a maximum of 4-hrly, except when an acute deterioration necessitates additional treatments • Use a maximum of 2 positions in one session • Avoid using excessive force by moving just the wrist and fingers, not the whole forearm • Suction following percussion **Vibrations** (by experienced Physiotherapist only) Vibrations are often not indicated in the preterm population given the very small tidal volumes, fast respiratory rate and very compliant chest wall. Closing volumes are often reached before mobilisation of secretions, rendering the technique ineffective. In term babies or those close to or beyond corrected term age the technique may be effective in certain situations by experienced therapists only. **Mucoactives** The role of mucoactives in the neonatal population is uncertain. Where collapse/ consolidation persists, consider discussing mucoactives with colleagues. Mucoactives include: • DNase • Hypertonic saline (Luca 2011) **Change in ventilation** • Consider cause of the problem and optimise ventilation. Aim Tidal Volume 4-6ml/kg (Bedside Clinical Guidelines Partnership 2017)

	• Minimise number of passes (Goncalves 2015) • Pre-oxygenation may be required but do not use routinely. Aim to keep SaO2 and fiO2 as stable as possible. • Inline suction only – ensure flush of inline circuit after every suctioning episode	• Note there is evidence to suggest 7mls/kg in babies with Bronchopulmonary Dysplasia (BPD) to reduce work of breathing (Hunt 2019) • MHI is not a valid therapeutic treatment for neonates due to: – High and poorly restricted volumes and pressures it has the potential to deliver. – Detrimental effects on cerebral blood flow – The physiology of the pre-term does not support proposed mechanisms of action. (parker 1993, Aversa, 2016, Chitty 2015, Price & Ronan 2014) **Saline instillation** Saline ONLY if indicated by secretions not mobilising up the catheter and only small volumes (0.2-0.5ml) (Shorten et al.1991 in Morrow et al 2008). If indicated, saline should be warmed in the incubator prior to use. There is no rationale for "lavage". Saline instillation should not be routine. NOTE: Saline use not generally supported in literature (Gardner 2009, Myers 2017).
Contraindications and precautions to chest physiotherapy techniques.		
Technique	**Precautions**	**Contraindications**
Manual Hyperinflation	MHI is contraindicated as a therapeutic technique in preterm infants. (Price & Ronan 2014) MHI has a detrimental effect on cerebral blood flow and has a high risk of pulmonary complications. (Price & Ronan 2014)	• Cardiovascular instability • Air leaks (including: Pneumothorax, PIE (Pulmonary Interstitial Emphysema), Bullae, Surgical Emphysema) • Acute pulmonary haemorrhage • Intraventricular haemorrhage (IVH) within 48 hr • Prematurity <37 weeks

	In infants closer to term age it may be discussed but consider the mechanisms behind action and whether the intervention will have the desired effect. Chakraporty (2010)	
Percussion	• Poor skin integrity • Platelet count <100 x 109/L • Avoid chest drain sites and Broviac lines/proximity of wounds/stomas • Effectiveness reduced in chest wall oedema • Distended abdomen	• Cardiovascular instability • Air leaks (including: Pneumothorax, PIE (Pulmonary Interstitial Emphysema), Bullae, Surgical Emphysema) • Acute pulmonary haemorrhage • Metabolic bone disease/fractured ribs • Intraventricular haemorrhage (IVH) within 48 hr • Extreme prematurity (<1500 g/<26 weeks' gestation) in first week of life • Platelet count <50 x 109/L and/or prolonged clotting and/or active bleeding (Hough PhD 2008)
Position Change	• Follow any surgical instructions (e.g. Abdominal surgery, myelomeningocele) • Care with lines e.g. umbilical • Consider optimising position for both respiratory function and long-term neurodevelopment • Ensure no condensate in tubing prior to turns (Weber 2016)	• Head down tip contraindicated (Price & Ronan 2014) • Prone contra-indicated in the presence of umbilical lines
Suction	• Follow any surgical instructions e.g. in TOF (Tracheo-oesophageal Atresia)	• Do not suction ETT for 8 hrs following surfactant instillation • Suction is contraindicated in Surfactant-deficiency disease for 48

	• Consider analgesia (breast milk or sucrose) • Position for reduced stress and pain. Use facilitated tucking (Alinejad-Naeini 2014) and 2Xcarers (Cone 2013) • Do not suction routinely	hrs (Bedside clinical Guidelines Partnership 2017) When indicated, there is no absolute contraindication to ET suction (AARC 2010).
Saline	The research does not support the use of saline. In fact, saline can cause numerous deleterious effects including immediate (e.g. vagal response) and subsequent (e.g. VAP secondary to washing URT bacterial colonies to the LRT). The only rationale for use is to lubricate the catheter to allow viscous secretions to move along the catheter, thus relieving obstruction. Saline should only be used if absolutely indicated, and not routinely, and in small doses. (Goncalves 2015, Morrow 2015, Gardner 2009). Documentation should give sufficient justification for its use.	
On-going evaluation		
Evaluation of treatments	Evaluate the intervention, and make a plan based upon the goals of intervention and the effectiveness of the treatment strategy. Where experience of working with the neonatal population is lacking, combined evaluation alongside a clinical colleague would be expected. Determine frequency, intensity and either direct or consultative methods for implementing chest physiotherapy plan. Explain and discuss chest physiotherapy plan with family. Work collaboratively with members of multidisciplinary	Understand the acceptable range of physiological parameters based on acuity levels and ages of infants. Collect data, monitor progress, evaluate effectiveness and modify chest physiotherapy plan and goals accordingly to accommodate changes in the infant's respiratory status, stopping treatment when the problem is resolved. Read, interpret and respond to neurobehavioural cues demonstrating homeostasis, self-regulation and calming as well as cues indicating stress and overstimulation. Understand the effect of medical and surgical conditions on the respiratory status of preterm infants. Provide physiotherapeutic rationales for interventions utilising current

	team to implement treatment plan. If members of the MDT are expected to carry out physiotherapy techniques such as percussion, there will be a clear prospective plan for training and support. This expectation will differ between units.	specialist knowledge and best practice in neonatal respiratory care. Knowledge of resuscitation techniques is vital, with attendance at annual update.
Incorporate evidence-based literature into neonatal practice		
	Foundation	**Advanced**
	Ensure robust method for keeping in touch with changing clinical practice. This could include: • Direct peer support • Unit visits • Remote discussions with peers • Attendance at courses • Local in-service training • Independent literature review • Electronic alerts of relevant literature	• Review and critically appraise neonatal medicine, neonatal nursing and paediatric physiotherapy literature and incorporate findings into practice where appropriate. • Identify mechanisms to effectively disseminate selected current research related to neonatal physiotherapy to NNU staff and families. • Apply research and evidence-based practice literature into caregiving plans and interventions. • Utilise current evidence to challenge existing clinical practice and in the development of clinical protocols. • Support or participate in research involving infants, parents, or caregivers in neonatal care units: • Create research questions on neonatal topics for clinical researchers. • Review the literature to identify related studies, establish a basis for the research questions and potential measurement methods,

		and evaluate designs and statistical methods used in similar studies. • Formulate testable hypotheses. • Establish and define independent and dependent variables. • Determine the research design and methods best suited to answer the research question. • Establish reliability in the use of the instruments chosen for data collection. • Analyse and interpret data. • Establish conclusions and clinical implications from the data. • Identify limitations of the study and suggestions for future research. • Disseminate the results of the research.

Physiotherapy guide to intervention for pre-term infants (<37 weeks gestation)

Physiotherapy treatment options

Problems responsive to physiotherapy intervention

Volume loss identified by:
- CXR (collapse, atelectasis)
- Ventilator parameters (e.g. PIP, TV)
- Auscultation/palpation

Secretion retention identified by:
- CXR (collapse, consolidation)
- Ventilator parameters (e.g. PIP, TV)
- Auscultation/palpation
- Suction yield (consistency/colour/volume)

Positioning
- Variety is most important for maximising ventilation distribution (Hough 2012, 2016) therefore change positions frequently (balanced with need for sleep). Prioritise frequent turning where there is clear evidence of volume loss or excess secretions.
- Consider all positions (unless contraindicated), including prone or semi-prone, and kangaroo care.
- Dependent regions are prone to atelectasis and collapse (Hough 2014), therefore avoid spending long periods in one position.
- Consider 24-hour plan for positioning not positions in isolation.
- Contact physiotherapy team for guidance

Percussion (By experienced physiotherapist only)
- Stabilise head with one hand at all times
- Ensure whole circumference of the percussor makes contact with baby's chest, ideally directly on baby's skin
- Ideal rate approximately 3/sec
- Use short percussion episodes according to baby's stability/tolerance/gestational age
- Maximum of 1–2 min (up to 2–3 min for more robust babies)
- Address signs of stress by pacing baby or giving time-out/comfort holding
- Treat only when clinically indicated and a maximum of 4-hrly, except when an acute deterioration necessitates additional treatments
- Use a maximum of 2 positions in one session
- Avoid using excessive force by moving just the wrist and fingers, not the whole forearm
- Suction following percussion

(Hough PhD 2008)

Mucoactives
The role of Mucoactives in the neonatal population is uncertain.
Where collapse/ consolidation persists, consider discussing mucoactives with colleagues.
Mucoactives include:
- DNase
- Hypertonic saline

(De Luca 2011)

Change in ventilation
Consider cause of the problem and optimise ventilation. Aim Tidal Volume 4-6ml/kg (Bedside Clinical Guidelines Partnership 2017) 7mls/kg in BPD (Hunt 2019). MHI is not a valid therapeutic treatment for neonates due to:
- High and poorly restricted volumes and pressures it has the potential to deliver.
- Detrimental effects on cerebral blood flow
- The physiology of the pre-term does not support proposed mechanisms of action.

(parker 1993, Aversa 2016, Chitty 2015, Price & Ronan 2014)

Always optimise:
Humidification
- Ensure humidifier set up and working correctly, minimise rain-out
- Ensure appropriate fluid balance for patient
- Ensure appropriate mouth care

Sedatives/paralysing agents
- Review regularly to ensure baby not over sedated/paralysed unnecessarily

Optimise Suction technique
- Optimise ETT and catheter size (Goncalves 2015)
- Suction pressure (6-13kPa) (Gardner 2009)
- Measured length (ETT length +adapter +0.5cm) (Morrow 2008)
- Quick pass down, slow and steady up
- Minimise number of passes (Goncalves 2015)
- Saline ONLY if indicated (0.2-0.5 ml)

If secretions not moving up the catheter:
- Use saline 0.2-0.5ml
- Temporarily increase suction pressure rather than increasing catheter size.

NOTE: Saline use not supported in literature (Gardner 2009, Myers 2017)

Contraindications and precautions to physiotherapeutic interventions for pre-term infants

	MHI	Percussion	Position change	Suction	Saline
Precautions	MHI is contraindicated as a therapeutic technique in preterm infants. (Price & Ronan 2014) MHI has a detrimental effect on cerebral blood flow and has a high risk of pulmonary complications. (Price & Ronan 2014) In infants closer to term age it may be discussed, but consider the mechanisms behind action and whether the intervention will have the desired effect. Chakraporty (2010)	• Poor skin integrity • Platelet count <100 x 109/L • Avoid chest drain sites and Broviac lines/proximity of wounds/stomas • Effectiveness reduced in chest wall oedema • Distended abdomen	• Follow any surgical instructions (e.g. Abdominal surgery, myelomeningocele) • Care with lines e.g. umbilical • Consider optimising position for both respiratory function and long-term neurodevelopment • Ensure no condensate in tubing prior to turns (Weber 2016)	• Follow any surgical instructions e.g. in TOF (Tracheo-oesophageal Atresia) • Consider analgesia (breast milk or sucrose) • Position for reduced stress and pain. Use facilitated tucking (Alinejad-Naeini 2014) and 2Xcarers (Cone 2013) • Do not suction routinely	The research does not support the use of saline. In fact, saline can cause numerous deleterious effects including immediate (e.g. vagal response) and subsequent (e.g. VAP secondary to washing URT bacterial colonies to the LRT) The only rationale for use is to lubricate the catheter to allow viscous secretions to move along the catheter, thus relieving obstruction. Saline should only be used if absolutely indicated, and not routinely, and in small doses. (Goncalves 2015, Morrow 2015, Gardner 2009)
Contraindications	• Cardiovascular instability • Air leaks (including: Pneumothorax, PIE (Pulmonary Interstitial Emphysema), Bullae, Surgical Emphysema) • Acute pulmonary haemorrhage • Intraventricular haemorrhage (IVH) within 48 hr • Prematurity <37 weeks see above	• Cardiovascular instability • Air leaks (including: Pneumothorax, PIE (Pulmonary Interstitial Emphysema), Bullae, Surgical Emphysema) • Acute pulmonary haemorrhage • Metabolic bone disease/fractured ribs • Intraventricular haemorrhage (IVH) within 48 hr • Extreme prematurity (<1500 g/<26 weeks' gestation) in first week of life • Platelet count <50 x 109/L and/or prolonged clotting and/or active bleeding (Hough PhD 2008)	• Head down tip contraindicated (Price & Ronan 2014)	• Do not suction ETT for 8 hrs following surfactant instillation • Suction is contraindicated in Surfactant-deficiency disease for 48 hrs (Bedside clinical Guidelines Partnership 2017) When indicated, there is no absolute contraindication to ET suction (AARC 2010).	

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CHAPTER 7: Neonatal Follow-up

Introduction

Due to the increased risk of developmental sequelae, it is recommended that vulnerable preterm infants and high-risk term infants need specific follow-up (NICE, 2017). A structured approach to follow-up is essential in order to screen for early signs of developmental difficulties and to facilitate early intervention strategies and timely onward referral to appropriate professionals. The specific format of each developmental follow up clinic may vary in different locations depending on local resource and expertise. The follow up clinic may include one of a range of standardised assessments or something less formal involving comparison of an infant's abilities against the expected developmental milestones for a particular gestational age. The Scottish Perinatal Network (2019) have published guidance regarding provision of neonatal follow up including an proposed pathway based on existing evidence and recommendations which may be helpful in considering service design or service improvement. This chapter will discuss which babies should receive developmental follow-up, at what gestational ages and present examples of assessment tools that may be used.

*The NICE Guidelines (2017) for Developmental follow-up of children and young people born preterm provide *minimum* standards for neuro-developmental follow up for preterm and high-risk term infants

Assessment of preterm and high-risk term infants after discharge home		
Assessment	**Foundation**	**Advanced**
Subjective	Must be able to identify infant risk factors that indicate the need for neurodevelopmental assessment and follow-up. See NICE Developmental follow-up of children and young people born preterm (2017). https://www.nice.org.uk/guidance/NG72 (see appendix 1) Understanding of family-centered principles and how they could be applied within neonatal physiotherapy assessment e.g. involving	Interpret perinatal and medical history along with results from medical investigations (such as cranial ultrasound scan) to identify specific developmental risks Identify risks to normal development based on social and environmental context Awareness of safeguarding risks and (how this might impact on an infant's 'journey') Awareness of bonding and interaction between career and infant Individualise management approach based on parental confidence

	and empowering parents (Pineda, Bender et al. 2018) Understanding how infant/carer bonding and interaction can influence infant development Consider how the home environment could impact on developmental ability	
Objective	Neonatal developmental assessment should consider: • Motor observation (posture, quality and quantity of movement) • Neurological (muscle tone, reflexes, cranial nerves and abnormal signs) Behavioural observation (regulation, attention and attachment) (Shah, Clements et al. 2011) Be able to plot growth and head circumference accurately on a standardised growth chart as part of developmental follow-up General attainment of developmental milestones - using a suitable scale. Consider use of AIMS within an assessment pathway as an efficient tool to enable discrimination of motor delay and triaging for intervention. Knowledge of typical neuromotor behaviour including detection of asymmetries, tone and	Adopt a holistic approach to developmental follow-up of preterm infants including use of multiple tests and measures used to assess an infants' abilities over time (Johnson and Marlow 2006; Walker et al, 2012; Orton, 2018,) Refer to Novak et al (2017) *Algorithm for Early Diagnosis of Cerebral Palsy or High Risk of Cerebral Palsy* (Appendix 1) for a systematic and evidence-based approach to early prediction of cerebral palsy and other neurodisability. Establish which infants are at high risk of cerebral palsy and require immediate referral to early intervention. Advanced neonatal physiotherapists should consider training and implementation of service delivery structure using the General Movements Assessment (Prechtl) (Novak, Morgan et al. 2017). Consider use of the Hammersmith Infant Neurological Examination (3 months to 18 months) as a predictive assessment for CP. Consider use of Bayley Scale for Infant Development with MDT as a comprehensive developmental assessment, to identify areas of developmental delay. Recognise the emergence of early signs of adverse behavioural developmental difficulties (such as autism or other sensory processing disorders) to be able to refer appropriately. Be able to identify global developmental delay (potential learning difficulty rather than specific motor disability) by using

	posture abnormalities and poor-quality movement	standardised assessments to assess progression of infant ability over time.
Communication	Ability to communicate key findings from specialist assessments with MDT	Consider how best to share results of developmental assessments with parents taking into consideration parental preference and understanding. Identify infants requiring referral to community service or MDT Sensitively discuss the risk of emerging signs of disability within a supportive MDT environment (supportive for parent and clinician)
Training and Development	Physiotherapists inexperienced in neonatal assessment will require a structured and supportive supervision programme to develop skills of appropriate approach and handling within assessment. Know the NICE criteria and what their own unit/NHS criteria is and why it may be different Know why each criterion is significant	Experienced neonatal and paediatric physiotherapists will require regular opportunity to attend advanced training courses. Experienced neonatal and paediatric physiotherapists will require regular opportunity for peer review with other experienced therapists. Be able to set and justify own neonatal therapy criteria and if it differs from the NICE guidelines be able to justify this Know implications of each criteria and which assessment maybe appropriate and justification for using that particular assessment. Examples could be the HINE, General Movement assessment, Bayley III, AIMS, SOGS. Collate results of all standardized assessments/milestones used and record this on a database. Be aware of the importance of clinical research and what studies are going on in the neonatal unit and why. Be aware of the changing NICE guidelines and where possible become involved seek opportunity to comment on any relevant draft guidelines.

		Be confident in approaching managers locally and at network level with relevant guidelines and be able to demonstrate how this can influence your service.

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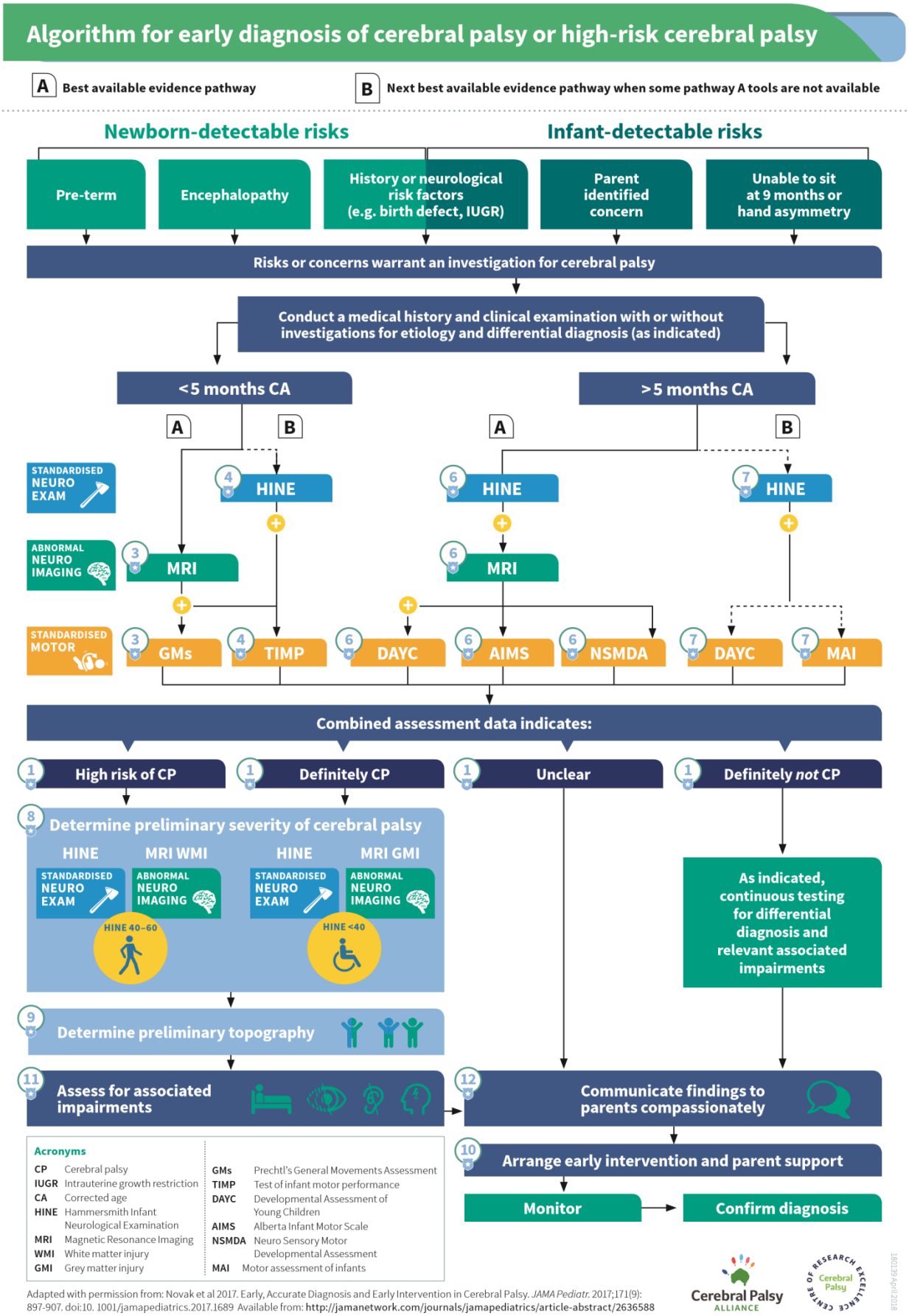

Adapted with permission from: Novak et al 2017. Early, Accurate Diagnosis and Early Intervention in Cerebral Palsy. *JAMA Pediatr.* 2017;171(9): 897-907. doi:10. 1001/jamapediatrics.2017.1689 Available from: http://jamanetwork.com/journals/jamapediatrics/article-abstract/2636588

Glossary of Abbreviations:

AHP = Allied Health Professionals

AIMS = Alberta Infant Motor Scale

APCP = Association of Paediatric Chartered Physiotherapists

ATNR = Asymmetrical tonic neck reflex

BPD = Bronchopulmonary dysplasia

CDH = Congenital diaphragmatic hernia

CGA = Corrected gestational age

CHD = Congenital heart disease

CLD = Chronic lung disease

CP = Cerebral Palsy

CXR = Chest x-ray

EBM = Expressed breast milk

ETT = Endotracheal tube

FIC = Family Integrated Care

FINE = Family and Infant Neurodevelopmental Education

GA = Gestational age

GM = General movements (Prechtl's)

HIE = Hypoxic ischaemic encephalopathy

HINE = Hammersmith Infant Neurological Examination

HNNE = Hammersmith Neonatal Neurological Examination

HR = Heart rate

HSV = Herpes simplex virus

IPAT = Infant positioning assessment tool

IUGR = Intrauterine growth restriction

IVH = Intraventricular haemorrhage

LAPI = Lacey Assessment of Preterm Infants

LRT = Lower respiratory tract

MAS = Meconium aspiration syndrome

MDT = Multidisciplinary team

NAS = Neonatal Abstinence Syndrome

NBAS = Neonatal Behavioural Assessment Scale

NBO = Newborn Behavioural Observations

NCCR = Neonatal Critical Care Review

NEC = Necrotising Enterocolitis

NICE = National Institute for Health and Care Excellence

NICU = Neonatal Intensive Care Unit

NNAP = National Neonatal Audit Programme

NNU = Neonatal Unit

PAIS = Perinatal arterial ischaemic stroke

PDA = Patent ductus arteriosus

PHI = Periventricular haemorrhagic infarction

PHVD = Post haemorrhagic ventricular dilatation

PIE = Pulmonary interstitial emphysema

PIP = Peak inspiratory pressure

PPHN = Persistent pulmonary hypertension of the newborn

PVL = Periventricular leukomalacia

QI = Quality improvement

RDS = Respiratory distress syndrome

REM = Rapid eye movement

ROP = Retinopathy of prematurity

SCBU = Special Care Baby Unit

SIDS = Sudden infant death syndrome

SOGS = Schedule of Growing Skills

TOF (surgical) = Tracheo-oesophageal fistula

TOF (cardiac) = Tetralogy of Fallot

TV = Tidal volumes

URT = Upper respiratory tract

VAP = Ventilator acquired pneumonia

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