Question: The effect of different CPAP machines on preterm infant cranial molding and frequency of positioning in the NICCU.	
(1) Title/Author/Year	**Prevalence of head deformities in preterm infants at term equivalent age. Ifflaender, 2013**
Article overview	Subjects: 195 patients divided into 3 groups by gestational age (Very preterm (>32 wk), Preterm (32-36 wk), and at term (37-40) weeks.) Intervention/Outcomes: no interventions were used. Instead, this was a study assessing risk factors and common patterns in infants with head deformities. Cranial index and Cranial Vault Asymmetry index (CVAI) were assessed in all infants. Results: CVAI was significantly higher in the very preterm infant group when compared to the other groups. 15% of term infants, 18% of preterm infants, and 38% of very preterm infants developed moderate or severe plagiocephaly. Cranial index (CI) was also significantly lower in very preterm infants and they were more likely to develop dolichocephaly Conclusions: Preterm birth and duration of total respiratory support (particularly CPAP) were significantly associated with the development of abnormal cranial molding. (Brachycephaly dolichocephaly, and plagiocephaly)
Comments	This article looked at the same population as our research study. It provides a connection between preterm infant, the need for respiratory support, and development of abnormal cranial molding. Preterm birth and use of and increased duration of respiratory support are individually risk factors of abnormal cranial molding.

(2) Title/Author/Year	**Effects of positioning on breathing pattern of preterm infants. Heimler, 1992.**
Article Overview	Subjects: 14 stable preterm infants, born 26-32 weeks' gestation with a recent episode of clinical apnea. Intervention/Outcomes: Positioning in supine and prone was used as the intervention. Breathing pattern via cardiorespirogram and oxygenation via SpO2 were assessed as outcomes. Administrators also monitored infants for apneic episodes. Results: Significant increase in apnea density in supine versus prone (p=0.01). Supine resulted in a 77% increase in periodic breathing (p = 0.015). Significant Increase in postprandial apnea during nights in supine. Conclusions: Prone is beneficial for respiration and preventing apneic episodes in spontaneously breathing preterm infants.
Comments	Positioning is often used as an intervention in the NICU to improve vitals in preterm infants. Use of respiratory support can affect the frequency of positioning changes and use in preterm infants. Respiratory support may decrease frequency of prone positioning despite prone being beneficial for improving oxygenation.
(3) Title/Author/Year	**Positioning for acute respiratory distress in hospitalized infants and children. Gillies, 2012**
Article Review	Subjects: systematic review containing 24 studies, a total of 581 participants. Most participants, but not all, were ventilated preterm infants. Intervention and Outcomes: interventions varied by studies, but

	all studies included some form of assessing supine placement vs prone positioning. Main outcomes were oxygen saturation, arterial oxygen content, and episodes of hypoxemia. Results: Prone positioning was significantly more beneficial than supine for oxygen saturation, arterial oxygenation, and episodes of hypoxemia Conclusion: Prone positioning was significantly superior to the supine in terms of oxygenation, and most of the data extracted was from preterm infants on ventilation.
Comments	This article is one of many that supports the use of prone positioning. It connects the use of positioning and respiration. Prone positioning is relevant to the preterm infant population and has statistically significant synthesized data from multiple studies indicating it's benefits over supine. However, tubing from CPAP may prevent positioning in prone.
(4) Title/Author/Year	**Prevalence and predictors of idiopathic asymmetry in infants born preterm. Nuysink, 2012**
Article Review	Subjects: Retrospective, longitudinal study assessing 192 infants born preterm. Intervention and Outcomes: There were no interventions applied as this was a retrospective study aiming to identify predictors of idiopathic asymmetry. Results: At term equivalent age the prevalence rate of positional head preference was 44.8%, and 10.4% of infants had developmental plagiocephaly. At 6 months corrected age none had a positional preference by 13% had developmental plagiocephaly. Chronic lung disease was significantly associated

	with positional preference and developmental plagiocephaly at term equivalent age (TEA.) Conclusion: At 6 months DP is observed in 13% of infants. In 5.2% the plagiocephaly was resolved. Only chronic lung disease increased the odds of having plagiocephaly at TEA but not at 6 months corrected age.
Comments	Chronic lung disease was associated with development of developmental plagiocephaly in the premature stages of development. This means that respiratory support predisposes patients to developing plagiocephaly. This connects the need for mechanical ventilation and development of positional plagiocephaly.
(5) Title/Author/Year	**Musculoskeletal implications of preterm infant positioning in the NICU. Sweeney, 2002**
Article Review	Subjects: This was a narrative review summarizing the different musculoskeletal implications of preterm infant positioning. There were no set subjects as the review included many studies. Interventions and Outcomes: No set interventions as this was a narrative review. Results: Gentle pressure, if applied persistently, can cause deformity, particularly in the malleable skulls of infants. Preterm infants are predisposed to developing two skull deformities: scaphocephaly and plagiocephaly. Scaphocephaly, described as boat-shaped or elongated in the anterior-posterior axis, occurs from skull flattening during side-to-side head positioning during the inpatient period.

	Conclusions: Asymmetrical occipital flattening results from combined with caregiving practices emphasizing supine sleeping position, overuse of infant seats, and absence of prone play activities.
Comments	This review assessed the implications of abnormal cranial molding in preterm infants. Particularly it combined both morphological risk factors and care risk factors for the development of abnormal cranial molding.
(6) Title/Author/Year	**Head growth trajectory and neurodevelopmental outcomes in preterm neonates. Raghuram, 2017**
Article Review	Subjects: Retrospective cohort study of 1973 infants. All infants were born at <29 weeks gestational age and admitted to a level III NICU. They all received follow-up assessments at 16-36 months. Interventions and Outcomes: No interventions were used since this was a retrospective study assessing characteristics associated with poor head growth during time in the NICU and after discharge. The main outcome measure was head circumference and head circumference Z-score. Results: Poor head growth (HG) was more frequent during infants NICU stay compared with post-discharge. Infants with the poorest HG displayed the longest duration of mechanical ventilation and poorest weight gain during the NICU admission. Conclusions: Poor head growth, while multi-factorial, can be tied to extended stays in the NICU, time on mechanical ventilation. Neonates with the poorest head growth also received more mechanical ventilation at all times.

Comments	Extended NICU stay, and particularly mechanical ventilation, is strongly correlated with poor head growth and poor weight gain in preterm infants. Since extended stay is often used associated with complications such as respiratory issues that require ventilation.
(7) Title/Author/Year	**Effects of Multiple Ventilation Courses and Duration of Mechanical Ventilation on Respiratory Outcomes in Extremely Low-Birth-Weight Infants. Jensen, 2015**
Article Review	Subjects: Retrospective cohort study of 3343 extremely low birth weight infants, 2867 survived to discharge. Interventions and Outcomes: Retrospective study assessing duration of mechanical ventilation on development of extremely low-birth weight infants. From birth to NICU discharge duration of ventilation was treated as a continuous variable. Outcomes included development of bronchopulmonary dysplasia, death, continued supplemental oxygen use, and number of distinct ventilation courses. Results: Long term, multiple courses of mechanical ventilation are common. The duration of mechanical ventilation was the strongest predictor of risk of BPD and of supplemental oxygen use at discharge. Conclusion: Duration of mechanical ventilation is a strong risk factor for development of bronchopulmonary dysplasia, cranial abnormalities (plagiocephaly, etc.) and continued use of oxygen at discharge.
Comments	This was another study concluding the detrimental effect of length ventilation on growth and correlation with development of head deformation. Longer duration and multiple rounds of

	mechanical ventilation indicate continued use of mechanical ventilation, which may lead to further deformation of head and poor head growth.
(8) Title/Author/Year	**Prolonged ventilation and postnatal growth of preterm infants.** **Williams, 2019**
Article Review	Subjects: 55 preterm infants born at less than 28 weeks gestation. All subjects failed to stabilize with CPAP use and had to be intubated. Interventions and Outcomes: Mechanical ventilations was used as the intervention and the study compared mechanically ventilated infants and non-ventilated infants. Outcome measures included weight, head circumference, admission of corticosteroids, duration of non-invasive mechanical ventilation, and ventilation post extubation. Weight and age at discharge was also assessed. Results: The difference in weight z-score and HC z-score from birth to discharge was significantly negatively related to the number of days on ventilation. Conclusion: Growth of extremely premature infants is significantly negatively associated with weight gain, head growth, and general growth. An increase severity of respiratory illness is associated with an increase in duration of mechanical ventilation.
Comments	There is a significantly negative association between prolonged ventilation and postnatal growth in extremely premature infants. This includes head circumference.
(9) Title/Author/Year	**From Surviving to Thriving: The Impact of Cranial Deformation**

	and Pressure Ulcers in the Hospitalized Infant. Neonatal Intensive Care. Hutchinson G, Wayne R. 2016
Article Review	Subjects: no subjects, as thus was a review of the impact of cranial deformation on NICU infants. Interventions and Outcomes: No interventions were mentioned as this is a commentary review about the impact of cranial deformity on NICU infants. The outcome assessed was the presence of "severe skull deformity" at birth and throughout NICU care. Results: The prevalence of plagiocephaly or brachycephaly was 19.7% at four months. Very preterm infants have an even greater incidence of plagiocephaly, 38% compared to normal 23%. This can lead to cosmetic issues, disturbed auditory function, delayed development. Conclusions: Prolonged pressure is known to affect cranial shape in the very young and can lead to more serious deformities that are associated with significant treatment costs. Additionally, emerging evidence continues to indicate that the effects may substantially impact quality of life, cognition, and development.
Comments	In the case of positional plagiocephaly, evidence continues to accumulate that cranial deformities can negatively impact quality of life, including appearance, inappropriate neuronal mapping secondary to anatomical anomalies, and delayed developmental milestone. Positional plagiocephaly is another known risk factor associated with prolonged exposure to extracranial pressure in infants. This can include pressure from prolonged positioning and CPAP

	machines.
(10) Title/Author/Year	**Evaluating the effectiveness of gel pillows for reducing bilateral head flattening in preterm infants: a randomized controlled pilot study. Schultz AA. 2008**
Article Review	Subjects: Literature review of effectiveness of gel pillows in reducing abnormal flattening in preterm infants. Included studies with infants who weighed less than 1500g or were less than 34 weeks gestational age. Interventions and Outcomes: The intervention was the use of a gel midliner pillow versus a standard mattress during NICU care. The outcomes assessed varied by study but most assessed cranial index. Results: The two groups were equivalent for uncontrollable factors. The use of the gel pillows did not significantly reduce the degree of bilateral head molding as measured by CI. Conclusions: While this article more specifically assesses a positional device on head shape, it acknowledges that a regimented positional protocol further reduces head molding and is needed for preterm infants.
Comments	Deformational bilateral head molding can occur from prenatal and postnatal constraints or cranial molding abnormalities. This includes postnatal constraints that restrict movement or changing of positioning. Constraints can include straps and apparatuses that are used to adhere CPAP tubing to the infant cranium.
(11) Title/Author/Year	**Clinical course of asymmetric motor performance and deformational plagiocephaly in very preterm infants. Nuysink**

	J. 2013
Article Review	Subjects: Infants born in a level II NICU before 30 weeks gestational age or with a birthweight of <1000g. All subjects visited a clinic for follow-up at term equivalent age. Interventions and Outcomes: No interventions were used; the article assessed the development of preterm infant and associated risk factors. Outcomes included positional preference (defined head turned to one direction 75% of time or more), deformational plagiocephaly, restricted active movement, and inability to maintain passive rotation. Results: At 6 months corrected age 23.3% of all infants had a deformational plagiocephaly with ear deviation (severe). 36.7% had deformational plagiocephaly without ear deviation (minor.) Duration of intubation and diagnosis of chronic lung disease were moderately to highly correlated with development of plagiocephaly. Conclusion: Sleeping in supine was most predictive of an asymmetric motor performance at 6 months Chronic lung disease or slow gross motor maturation at 3 months predicted the persistence of deformation plagiocephaly.
Comments:	Very preterm infants have higher rate of occurrence à related to immature postural control. Subjected to extrauterine gravity at an earlier stage in motor maturation shows.
(12) Title/Author/Year	**Use of a midliner positioning system for prevention of dolichocephaly in preterm infants. McCarty DB. 2018**

Article Review	Subjects: Prospective study of 31 infants compared to 65 infants from previous retrospective study. All infants in this study had a body weight less than 1500G, gestational age less than 31 weeks at birth and enrollment, were less than 3 weeks corrected age at time of enrollment and were stable on CPAP/nasal cannula/room air. Interventions and Outcomes: The intervention was use of midliner positioning system (MPS.) Positioning protocol to provide MPS use 24 hours a day and maintained at all times. Outcome measures included cranial Index (CI) determined by calculating the ratio of biparietal diameter (BiPD) over occipital diameter (OFD). Dolichocephaly was defined as CI less than 76%. Results: Gestational age, body weight, and post-menstruation age (PMA) at enrollment, days on CPAP and % of time in supine were not associated with development of dolichocephaly. CI vales at 32- and 34-weeks PMA were greater in the midliner group. Conclusion: Infants who used MPS had better cranial molding outcomes than infants who received standard-of-care interventions.
Comments	This article is an assessment of future care directions and interventions that may be used to counteract the effects of prolonged mechanical ventilation and extrauterine pressures on the infants cranium. The use of MPS resulted in less cranial molding compared to standard care. It led to more stable CI measures throughout the study period. This indicates MPS may be a good option for cranial molding prevention protocols.

(13) Title/Author/Year	**Dolichocephaly in Preterm Infants: Prevalence, Risk Factors, and Early Motor Outcomes. McCarty DB. 2017**
Article Review	Subjects: 65 preterm infants who had a body weight <1500g or PMA <32 wks. and were stable on room air/nasal cannula/or CPAP at initial evaluation. All infants had 2/3 cranial index measures (initial eval, reevaluation, or discharge) were recorded during study period. Interventions and Outcomes: No interventions were used, instead this study assessed factors and early outcome measures of preterm infants who developed dolichocephaly. The main outcome measure was cranial index. Results: 54% of infants developed dolichocephaly at some point during the hospital stay. The highest incidence was noted between 32-34 post-menstruation age(PMA.) Younger gestational age at birth and corrected age at OP follow-up was associated with lower CI measurement. Infants with dolichocephaly at 32-34 weeks PMA were more likely to present to OP follow-up with dolichocephaly. Conclusion: Dolichocephaly post prevalent at 32-34 weeks and can lead to decreased developmental stages in outpatient PT Supine is best position to limit dolichocephaly but not great for developmental care and secondary conditions.

Comments	Preterm infants are more likely to develop dolichocephaly, especially during 32-34 weeks PMA.
(14) Title/Author/Year	**Impact of prolonged mechanical ventilation in very low birth weight infants: results from a national cohort study. Choi, 2018**
Article Review	Subjects: 3248 very low birth weight infants born between January 1, 2013 and December 31, 2014. All infants had a birth weight of <1000g. Interventions and Outcomes: No interventions, instead the study assessed the effects of the following on growth: GA, cumulative duration of invasive mechanical ventilation, and length of hospital stay. The primary outcome was survival to discharge or death. Secondary outcomes included duration of hospital stay, duration of parenteral nutrition, weight, height, and head circumference at birth and at discharge. Results: Lower gestational age and birth weight were predisposing factors to prolonged mechanical ventilation. Longer durations of mechanical ventilation were associated with smaller Z scores for weight, height, and head circumference after adjusting for gestational age and weight. Conclusion: Prolonged exposure to mechanical ventilation is associated with multiple poor outcomes. Prolonged mechanical ventilation affected poor physical growth, including head circumference.

Comments	This study aligns with others, agreeing on the effects of mechanical ventilation on head growth. Mechanical ventilation is associated with poor health outcomes, and prolonged mechanical ventilation is negatively associated with proper head growth.
(15) Title/Author/Year	**Growth in high-risk infants <1500g birthweight during the first 5 weeks. Loui, 2008**
Article Review	Subjects: 46 infants all of whom had a birth weight of <1500g. 22 of these infants were ventilated. Interventions and Outcomes: Intervention was considered the use of mechanical ventilation or regular room air. Outcomes included body weight, body length, and head growth. Results: Ventilated infants had retarded growth and weight gain compared to unventilated infants. Head growth was 0.45 vs 0.60 cm/wk. and lower than the typical infant avg of 0.90-1.04 cm/week. Conclusion: Duration of artificial ventilation was a predictor of weight gain and head growth.
Comments	Preterm and very underweight infants are already predisposed to retarded head growth. This increases with use of and increased duration of mechanical ventilation.

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