CRITICALLY APPRAISED TOPIC

FOCUSED CLINICAL QUESTION

In infants born preterm (<37 weeks), does hospitalization (I) predict dolichocephaly, plagiocephaly, or head preference at term equivalent age (O), compared to full term infants(C)?

AUTHOR

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CLINICAL SCENARIO

Since the introduction of the "Back to Sleep" campaign, which encourages a supine sleeping position for infants, to reduce the incidence of sudden infant death syndrome (SIDS), non-synostotic head deformities have become increasingly prevalent. Positional head deformities are associated with motor and cognitive deficits later in life.[1,2] This includes an increased risk of developmental delay diagnosis.[1] Motor deficits can persist into school age. While positional head deformities do not cause development delays, they are important predictive factors of future issues.[3]

This is even more important to consider in preterm infants, who are already at a high risk of cognitive and motor impairments. This includes increased risk of cerebral palsy and difficulties with motor planning and coordination.[4] There is, however, a lack of understanding of the prevalence of and risk factors associated with head deformities among preterm infants. Preterm infants have a high risk of developing head deformities. They tend to display lower tone and difficulty moving against gravity, resulting in prolonged periods spent in one position.[5] Dolichocephaly, specifically, is not well studied, but tends to occur most often in preterm infants, due to difficulty maintaining the head in midline against the effects of gravity. This results in the infant resting with the head rotated to either side, causing flattening of the lateral skull bilaterally.[6] Preterm infants are also more likely to develop a head turn preference, which is associated with asymmetrical movements and difficulties with visual orientation. Preterm infants are often subjected to medical interventions, such as endotracheal intubation, which result in prolonged positioning with the head rotated to one side. Head turn preferences can then result in positional head deformities.[7]

Based on my clinical rotation and research experiences in the NICU, I wanted to better understand the effect that hospitalization has on the development of head turn preference and positional head deformities, such as plagiocephaly and dolichocephaly. These issues are associated with further motor deficits as the infant develops, due to asymmetrical movement patterns. As we understand how hospitalization affects the development of these issues, we can better understand what preventative measures can be taken to reduce these impacts.

SUMMARY OF SEARCH
[Best evidence appraised and key findings]

There were 8 studies that met the inclusion and exclusion criteria, all of which were observational studies.

- There is a high prevalence of both symmetric and asymmetric positional head deformities, such as plagiocephaly and dolichocephaly among preterm infants at term equivalent age (TEA).[5,6,8,9]
- Medical factors related to hospitalization in the NICU may be associated with development of head turn preference and positional head deformities in preterm infants.[5,7]
- Head turn preference and positional head deformities may be predictive of abnormal or asymmetric movement patterns later in development.[7,10]

CLINICAL BOTTOM LINE

Hospitalization predicts head deformities and head turn preferences in preterm infants at term equivalent age. There is an increased prevalence of head turn preference and positional head deformities, such as plagiocephaly and dolichocephaly in preterm infants at TEA, compared to term infants. Medical factors in the NICU are associated with increased risk of head turn preferences and head deformities.

This critically appraised topic has been individually prepared as part of a course requirement and has been peer-reviewed by one other independent course instructor

The above information should fit onto the first page of your CAT

SEARCH STRATEGY

Terms used to guide the search strategy			
Patient/Client Group	**I**ntervention (or Assessment)	**C**omparison	**O**utcome(s)
Preterm infant Extremely preterm infant Premature infant Neonat* Prematur*	Neonatal intensive care unit NICU Hospital*	Full term infant Term infant	Dolichoceph* Plagioceph* Brachyceph* Scaphoceph* Head turn preference Head preference Head deformities

Final search strategy (history):

Show your final search strategy (full history) from PubMed. Indicate which "line" you chose as the final search strategy.

1. (preterm OR prematur* OR neonat*) AND (dolichoceph* OR scaphoceph* OR plagioceph* OR brachyceph* OR head preference OR head deformities) AND (CPAP or continuous positive airway pressure)
2. (preterm infant OR prematur* or neonat*) AND (dolichoceph* OR scaphoceph* OR plagioceph* OR brachyceph* OR positional deformity OR head turn preference OR head preference) AND (nicu OR neonatal intensive care unit)
3. (preterm infant OR prematur* or neonat*) AND (dolichoceph* OR scaphoceph* OR plagioceph* OR brachyceph* OR positional deformity OR head turn preference OR head preference) AND (nicu OR neonatal intensive care unit) NOT craniosynostosis
4. (preterm OR prematur* OR neonat*) AND (head deformity OR plagiocephaly OR brachycephaly OR dolichocephaly OR scaphocephaly) AND (nicu or "neonatal care intensive unit" OR hospital*) NOT (craniosynostosis OR congenital)
5. **(preterm OR prematur* OR neonat*) AND (head turn preference OR head deformity OR plagiocephaly OR brachycephaly OR dolichocephaly OR scaphocephaly) AND (nicu or neonatal care intensive unit OR hospital*) NOT (craniosynostosis OR congenital)** Filters: **Humans, Newborn: birth-1 month, Infant: birth-23 months, English**

In the table below, show how many results you got from your search from each database you searched.

Databases and Sites Searched	Number of results	Limits applied, revised number of results (if applicable)
PubMed	**508**	**Subjects: Humans** **Age: Newborn: birth-1 month, Infant: birth-23 months** **Language: English**
CINAHL	**13**	**Language: English** **Age: All infants**
PEDro	**15**	**Body part: head or neck** **Subdiscipline: pediatrics**

INCLUSION and EXCLUSION CRITERIA

Inclusion Criteria
• Randomized controlled trial, systematic review, meta-analysis, observational study, review • Study subjects must have been born preterm • Study subjects must have been hospitalized in the NICU • Study subjects must have non-synostotic/positional head deformities
Exclusion Criteria
• Non-human studies • Studies published in non-English language • Adult population, children age greater than 2 • Infants born full term

RESULTS OF SEARCH

Summary of articles retrieved that met inclusion and exclusion criteria

For each article being considered for inclusion in the CAT, score for methodological quality on an appropriate scale, categorize the level of evidence, indicate whether the relevance of the study PICO to your PICO is high/mod/low, and note the study design (e.g., RCT, systematic review, case study).

Author (Year)	Risk of bias (quality score)*	Level of Evidence**	Relevance	Study design
Dunsirn et al. (2016)[7]	**Low Risk – AXIS (15/20)**	**Level 3**	**High**	**Cross-Sectional / Prevalence Study**
Ifflaender et al. (2013)[5]	**Low Risk – AXIS (16/20)**	**Level 3**	**High**	**Cross-Sectional Prevalence Study**
Nuysink et al. (2012)[8]	**Low Risk – AXIS (15/20)**	**Level 3**	**High**	**Cross-Sectional / Prevalence Study**
Yang et al. (2019)[9]	**Low Risk – AXIS (16/20)**	**Level 3**	**High**	**Cross-Sectional / Prevalence Study**
McCarty et al. (2017)[6]	**Moderate Risk – JBI Prevalence Tool (6/10)**	**Level 3**	**High**	**Retrospective Prevalence Study**
Willis et al. (2019)[11]	**Low Risk – AXIS (15/20)**	**Level 3**	**Moderate**	**Cross-Sectional / Prevalence Study**
Nuysink et al. (2013)[10]	**Moderate Risk – JBI Prevalence Tool (6/10)**	**Level 3**	**Moderate**	**Prospective Prevalence Study**
McCarty et al. (2018)[12]	**Moderate Risk – JBI Cohort Study Tool (7/11)**	**Level 3**	**Low**	**Prospective Observational Study (similar to cohort study)**

*Indicate tool name and score

**Use Portney Table 36-1: Summary of Levels of Evidence (2020). If downgraded, indicate reason why.

BEST EVIDENCE

The following 2 studies were identified as the 'best' evidence and selected for critical appraisal. Rationale for selecting these studies were:

- **Ifflaender (2013): This study was scored as a low risk of bias, based on the Appraisal Tool for Cross-Sectional Studies (AXIS), with a score of 16/20. Additionally, this study had high relevance to the research question as it looked at both symmetrical head deformities (such as dolichocephaly) and asymmetrical head deformities (such as plagiocephaly). While this was Level 3 evidence, the study had a strong design, including having a control group included in the study. This allows for comparison between pre-term and term infants.**
- **Dunsirn (2016): This study was also scored as a low risk of bias, based on the AXIS tool, with a score of 15/20. This study is also highly relevant to the research question and is one of the few studies that examined the effect of hospitalization in the NICU on head turn preference. This was Level 3 evidence, as it was a prospective observational study.**

SUMMARY OF BEST EVIDENCE

(1) Description and appraisal of (Prevalence of head deformities in preterm infants at term equivalent age) by (Ifflaender et al., 2013)[5]

Aim/Objective of the Study/Systematic Review:
The aim of the study by Ifflaender et al. was to determine the prevalence of both symmetrical and asymmetrical head deformities among preterm infants at TEA and explore possible risk factors.
Study Design [e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant] Note: For systematic review, use headings 'search strategy', 'selection criteria', 'methods' etc. For qualitative studies, identify data collection/analyses methods.
This was an observational, cross-sectional study. Infants in the study underwent weekly head shape scans, as part of their standard care. In this study, the last scan taken prior to discharge was analyzed, if the infant was at TEA at the time of the scan. The head shape scan was used to calculate Cranial Index (CI) and Cranial Vault Asymmetry Index (CVAI). The data were analyzed using GraphPad Prism version 5.0 and Microsoft Excel 2011. Mann-Whitney tests were used to compute and display medians, interquartile range (IQR), minimum, and maximum of CI and CVAI. The data were displayed in boxplot diagrams. Statistical significance was set at $p<0.05$. Contingency tables and Fisher's exact test with two-tailed p-value were used to compare categorical data. Risk factors for plagiocephaly and dolichocephaly were analyzed by categorizing preterm infants as controls (if they had mild to no deformity) or cases (if they had moderate or severe head deformities). Additionally, Fisher's exact test was used to calculate Odds Ratio (OR) and p-values.
Setting [e.g., locations such as hospital, community; rural; metropolitan; country]
Data collection took place at an intermediate care unit of a tertiary neonatal clinic in Dresden, Germany.
Participants [N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up] Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article.
There were 195 infants that were included in the study. These infants were screened from a convenience sample of all infants who were treated within the unit between April 2011 and January 2013, who had undergone weekly three-dimensional head shape scans during their hospitalization. Infants were excluded if they had a peripheral IV at the scalp or required supplemental oxygen at the time of the measurement. During this time period, 1240 patients were treated on the unit, and 758 had at least one head shape scan. Patients were excluded if they had not had a scan at TEA, due to discharge before 37 weeks or after 40 weeks of gestation. The final cohort included 101 males and 94 females. The mean age of the cohort was 34.0±4.1 weeks. They had a mean birthweight of 1996±873 grams. The mean post-menstrual age (PMA) of the group at the time of the scan was 38.4±0.9 weeks. The cohort was categorized into three groups based on gestational age at birth: 1) Very preterm (<32 weeks gestation), 2) Late preterm (32 to 36+6 weeks), and 3) Term (37 to 40 weeks). There were 55 very preterm infants, 85 late preterm infants, and 55 term infants.

Intervention Investigated

[Provide details of methods, who provided treatment, when and where, how many hours of treatment provided]

Control

This study was a cross-sectional observational study. There was not a defined experimental and control group. All participants in the study received standard care and underwent the same head shape scan. However, since the main focus of the study was to evaluate head deformities in preterm infants, the term infants in the cohort could be considered a control group. Preterm infants were compared to the term infants during statistical analysis.

Experimental

This study was a cross-sectional study in which preterm infants were compared to term infants. There was not a specific intervention that was provided, outside of standard neonatal intensive care which all infants received. This included weekly head shape scans, using a STARScanner.

All measurements were conducted at the same site in which the infants were hospitalized. Patient data, perinatal data, and information on neonatal morbidity were obtained from the medical records.

Outcome Measures

[Give details of each measure, maximum possible score and range for each measure, administered by whom, where]

Head Shape Data:

Cranial measurements were done using a STARScanner, a non-invasive laser shape digitizer, as part of weekly head scans that all patients in the unit underwent. Patients were placed in the scanned for 20 seconds, and scans took about 3 seconds. The scans of the cranium were divided into 12 cross sections, which were used to measure biparietal diameter (BPD), fronto-occipital diameter (OFD), and 30^{o} diagonals.

Cranial Index (CI) was calculated as [BPD/OFD x 100] and used to determine symmetrical head deformities (brachycephaly and dolichocephaly). Cranial Vault Asymmetry Index was calculated as [(diagonal A − diagonal B) / diagonal A) × 100, where diagonal A > diagonal B] and used to determine asymmetrical head deformities (plagiocephaly).

Ifflaender et al. utilized normative data from a previous study by Wilbrand et al.[13] Severity levels were defined as the 75th (mild), 90th (moderate) and 97th (severe) percentile of CVAI (plagiocephaly) and CI (brachycephaly), at 0-3 months, respectively.

Dolichocephaly severity levels were defined as mild (CI = 10th-25th percentile), moderate (CI = 3rd to 10th percentile) and severe (CI <3rd percentile) dolichocephaly at 0–3 months.

Main Findings

[Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided; you may calculate your own values if necessary/applicable. You may summarize results in a table but you must explain the results with some narrative.]

Table 1: Asymmetrical Head Deformities (Plagiocephaly)

Severity	Total	Very Preterm	Late Preterm	Term
Mild	37 (19%)	9 (16%)	17 (20%)	11 (20%)
Moderate	27 (14%)	10 (18%)	12 (14%)	5 (9%)
Severe	17 (9%)	11 (20%)	3 (4%)	3 (5%)
Moderate/Severe	44 (23%)	21 (38%) p=0.005 (compared to term infants)	15 (18%)	8 (15%)

When compared to term infants, very preterm infants had a higher risk of moderate to severe plagiocephaly, (OR 3.75, 95% Confidence Interval 1.48-9.46, p=0.005). Furthermore, CVAI was significantly higher (4.1% IQR 1.9-5.6%) in the very preterm group compared to late preterm infants (2.7%, IQR 1.1-4.6%) and term infants (2.4%, IQR 0.7-4.0%).

Risk factors for asymmetrical head deformities were evaluated. Intracranial hemorrhage grade II-IV was significantly associated with moderate or severe plagiocephaly at TEA (p<0.001). Additionally, medical interventions received in the NICU were associated with asymmetrical head deformities. The cases had a significantly higher median duration of total respiratory support (continuous positive airway pressure (CPAP) and invasive mechanical ventilation (IMV)) (372 hours, IQR 16-650 h, p=0.008), compared to controls (64 h, IQR 0–297 h). Additionally, duration of CPAP therapy was longer in cases (207 h, IQR 16–486 h, p = 0.018) compared to controls (24 h, IQR 0–246 h).

Table 2: Symmetrical Head Deformities (Dolichocephaly)

Severity	**Total**	**Very Preterm**	**Late Preterm**	**Term**
Mild	46 (24%)	8 (15%)	23 (27%)	15 (27%)
Moderate	33 (17%)	15 (27%)	13 (15%)	5 (9%)
Severe	37 (19%)	25 (45%)	11 (13%)	1 (2%)
Moderate/Severe	70 (36%)	40 (73%) p<0.0001 (compared to term infants)	24 (28%) p=0.02 (compared to term infants)	6 (11%)

Both very preterm (OR 21.78, 95% CI 7.74-61.61, p<0.0001) and late preterm infants (OR 3.21, 95% CI 1.22-8.48, p=0.02) had a significant risk of moderate to severe dolichocephaly compared to term infants. Additionally, in the very preterm group, CI at TEA was significantly lower (indicative of dolichocephaly) (71.4%, IQR 68.7-74.6%), compared to late preterm infants (77.2%, IQR 73.2–80.7%) and term infants (80.0%, IQR 75.5–83.3%).

Significant risk factors for dolichocephaly were female sex (OR 2.73, 95% CI 1.38-5.44, p=0.004) and Cesarean section delivery (OR 4.27, 95% CI 1.30-11.37, p=0.003). There was also an association between respiratory support and dolichocephaly. Dolichocephalic infants had a significantly higher median duration of total respiratory support (281 h, IQR 51–622 h, p<0.0001) compared to controls (13 h, IQR 0–235 h). Additionally, these infants had a longer duration of CPAP therapy (214 h, IQR 26–499, p<0.0001) compared to controls (9 h, IQR 0–168 h) and a longer median duration of IMV (29 h, IQR 0–134 h, p=0.04) compared to controls (0 h, IQR 0–89 h).

Finally, there was 20 patients (10% of the cohort) who exhibited moderate to severe plagiocephaly and moderate to severe dolichocephaly. Very preterm infants had a higher risk of having both asymmetrical and symmetrical head deformities at TEA (27%, OR 15.0, 95% CI 1.91-117.6), compared to term infants.

Original Authors' Conclusions

[Paraphrase as required. If providing a direct quote, add page number]

There is a high prevalence of both symmetrical and asymmetrical positional head deformities in preterm infants at term equivalent age, especially those born very preterm. There has been an increase in nonsynostotic head deformities in infants in recent years, with promotion of supine sleep positioning. This study demonstrates the high prevalence of these issues in preterm infants as well as the risk factors associated with their development.

Critical Appraisal
Validity [Summarize the internal and external validity of the study. Highlight key strengths and weaknesses. Comment on the overall evidence quality provided by this study.]
This article by Ifflaender et al. has a low risk of bias, based on the Appraisal tool for Cross-Sectional Studies (AXIS), with a score of 16/20. This study had several strengths. First, the study compared preterm infants with term infants, which strengthened the specific conclusions that were being made about preterm infants. Additionally, in a previous study by Geil et al. the scanner used to make cranial measurements and identify head deformities in the patients was found to be both accurate and reliable, when compared to traditional measurement methods.[14] Additionally, the methods of both data collection and data analysis were well described, which would allow the methods to be repeated. This study has Level 3 evidence, as it is an observational study. This is one of the major weaknesses of the study. However, since the "intervention" that is being studied is hospitalization in the NICU, it would not be possible to conduct any kind of experimental study on the subject. It would not be ethical to subject healthy infants to hospitalization, nor would it be ethical to deny preterm infants the necessary medical care. An additional weakness is that the study utilized a convenience sample of patients at one medical center. This impacts the generalizability of the study to other groups of preterm infants. The results of this study could be attributed to hospital-specific practices, such as the use of positioning devices, head shape screening procedures, or availability of physical therapy services. Additionally, this study had a small sample size of 195 patients.
Interpretation of Results [This is YOUR interpretation of the results taking into consideration the strengths and limitations as you discussed above. Please comment on clinical significance of effect size / study findings. Describe in your own words what the results mean.]
Based on the results of this study, it is highly likely that hospitalization is predictive of plagiocephaly and dolichocephaly in preterm infants at TEA. Very preterm infants had a significantly higher risk of moderate to severe plagiocephaly, compared to term infants at TEA and significantly higher risk of moderate to severe dolichocephaly, compared to both late preterm and term infants. Furthermore, both plagiocephaly and dolichocephaly were significantly associated with medical interventions received in the NICU, especially respiratory support. Infants born very preterm tend to have longer periods of hospitalization, requiring more significant medical interventions. This supports the idea that hospitalization plays a role in the development of positional head deformities, in addition to factors such as low tone, difficulty maintaining midline, and malleable cranial bones seen in preterm infants. Although the sample size in this study is small, the results are both statistically and clinically significant.
Applicability of Study Results [Describe the relevance and applicability of the study to your clinical question and scenario. Consider the practicality and feasibility of the intervention in your discussion of the evidence applicability.]
This study is highly applicable and relevant to the clinical question and scenario. There is limited evidence related to non-synostotic head deformities in preterm infants and the risk factors that are associated with these deformities. This study was able to demonstrate clear associations between preterm birth and both plagiocephaly and dolichocephaly at TEA. Additionally, the understanding of risk factors, such as Cesarean section delivery or respiratory support is important. If we know that a preterm infant is at an even higher risk of developing a head deformity, due to the presence of one of these risk factors, additional preventative measures can be taken.

(2) Description and appraisal of (Defining the nature and implications of head turn preference in the preterm infant) by (Dunsirn et al., 2016)[7]

Aim/Objective of the Study/Systematic Review:
The aim of the study by Dunsirn et al. was to evaluate the association between head turn preference in preterm infants with perinatal medical factors, neonatal neurobehaviors, and infant neurodevelopmental outcomes.
Study Design [e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant] Note: For systematic review, use headings 'search strategy', 'selection criteria', 'methods' etc. For qualitative studies, identify data collection/analyses methods.
This study was a cross-sectional prevalence study. Infants were previously enrolled prospectively into a longitudinal study of neurodevelopment of preterm infants. Part of the study involved a videotaped neurobehavioral assessment, which was used to perform a head turn preference assessment. All participants also had an MRI done as part of the overarching longitudinal study. Participants also underwent developmental testing at a 2-year follow-up. Lastly, a medical chart review was conducted to determine medical factors that may be associated with head turn preference. There were several statistical methods used for the different outcomes. For associations between early medical factors and Head Turn Preference Scale (HTPS) score, chi-square analysis and logistic regression were used, with $\alpha = .05$. For associations between HTPS and developmental outcomes (as determined by NICU Network Neurobehavioral Scale summary scores and composite and subscale scores on the Bayley-III at age two years), logistic regression models were used. Associations between head turn preference and developmental outcomes were also evaluated using a multivariate model which controlled for clinical factors which are related to head turn preference and may affect development.
Setting [e.g., locations such as hospital, community; rural; metropolitan; country]
This study took place at St. Louis Children's Hospital, in the level III-IV NICU.
Participants [N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up] Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article.
There were 70 patients total in the study. Infants in the study were all born at ≤30 weeks estimated gestational age (EGA) during a 3-year period, were free of congenital anomalies, and were enrolled within the first 72 hours of life. There were 38 patients deemed to have a severe head turn preference and 32 patients without a severe head turn preference. The two groups had similar ages, birthweight, and gender. They also had a similar number of days spent on ventilation and CPAP. When these characteristics were compared between groups, the p values were >0.05, indicating that they were not significantly different. The EGA of the overall group was 26.3 ±1.8 weeks. They had a mean birth weight of 929 g (±247.5) and had a median length of stay of 90.5 days (50.0-232.0 days).

Intervention Investigated

[Provide details of methods, who provided treatment, when and where, how many hours of treatment provided]

Control

This was an observational, cross-sectional study, which was evaluating the prevalence of head turn preference. There was no control group included in the study cohort.

Experimental

As this was an observational study, there was no experimental group. All of the participants were part of a longitudinal study of neurodevelopment of preterm infants, and were enrolled into the study at birth, if they were born at ≤30 weeks estimated gestational age. All participants received standard neonatal intensive care in the hospital. They also underwent neurobehavioral testing at 34 weeks gestation and again at TEA, all done by one examiner and recorded on video. Videotapes of the neurobehavioral testing were used to evaluate head turn preference and score it. Lastly, the infants returned for developmental testing at age 2.

Outcome Measures

[Give details of each measure, maximum possible score and range for each measure, administered by whom, where]

To determine head turn preference, the researchers developed a scale for quantifying preferences. The Head Turn Preference Scale ranged from 0 to 10, with higher scores signifying more severe head turn preference. The severity was categorized as follows: none (score of 0), minimal (scores 1-3), moderate (scores 4-6), and severe (scores 7-10). Head turn preference was determined based on the following criteria: 1) whether the infant displayed head turn preference at rest, 2) the severity of head turn preference based on the force required to move out of the position, and 3) passive cervical range of motion restrictions. Head turn preferences were determined by 4 trained occupational therapists.

Neurobehavioral testing was also conducted, using the NICU Network Neurobehavioral Scale (NNNS) at 34 weeks PMA and again at TEA (37-41 weeks PMA). All NNNS testing was conducted at each patient's bedside by one certified examiner. The NNNS evaluates 13 categories: measures of habituation, orientation, arousal, self-regulation, hypertonia, hypotonia, stress, lethargy, excitability, sub-optimal reflexes, asymmetry, quality of movement, and tolerance of handling.

Medical factors were determined by researchers using information from electronic medical records. These included EGA at birth, birth weight, number of days on mechanical and high frequency oscillatory ventilation, number of days on continuous positive airway pressure (CPAP), hours of oxygen use (ventilation, CPAP, or oxygen delivered by nasal cannula), oxygen requirement at 36 weeks, hours of inotrope use, Clinical Risk Index for Babies score, number of days on total parental nutrition, patent ductus arteriosus (treated with indomethacin or surgical ligation), necrotizing enterocolitis (all stages), cerebral injury, and postmenstrual age (PMA) at discharge.

At two years of age, participants underwent follow-up developmental testing, using the Bayley Scales of Infant and Toddler Development-Third Edition (Bayley-III). The scoring includes cognitive, language, and motor outcomes, and subscales for expressive and receptive language and fine and gross motor outcomes.

Main Findings

[Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided; you may calculate your own values if necessary/applicable. Use a table to summarize results if possible.]

Table 1: Head turn preference

Head Turn Preference	**Number of Participants (% of total)**
Mild	15 (21%)
Moderate	17 (24%)
Severe	38 (54%)
Total	70 (100%)

All of the participants displayed some level of head turn preference, with 21% having a mild preference, 24% having a moderate preference, and 54% having a severe head turn preference, based on the Head Turn Preference Scale. Furthermore, 51 (77%) had a preference for turning towards the right and 15 (23%) had a preference for the left. The remaining 4 participants had difficulty with maintaining their head in midline, resulting in both right and left head turns during the assessment.

Table 2: Medical factors

Medical Factor	Mean (±SD) OR N (%) among participants with severe head turn preference	Mean (±SD) OR N (%) among participants without severe head turn preference	P value
Hours on inotropic medications	68.5 (±126.0)	9.1 (±26.5)	p=0.02
Oxygen required at 36 weeks PMA	27 (71.1%)	15 (46.9%)	p=0.03

Of the medical factors which were evaluated, there were 2 factors which were associated with severe head turn preference, as indicated by higher Head Turn Preference Scores. First, patients with higher scores required more hours on inotrope medications (p=0.02). Additionally, higher scores were associated with oxygen requirement at 36 weeks PMA (p=0.03). The other medical factors did not have any significant associations with Head Turn Preference Scale scores.

Neurobehavioral Outcomes:

There were several associations found between early neurobehavior and head turn preference at TEA. Higher HTPS scores, indicating severe head turn preference, was associated with worse self-regulation (p=0.007) and more suboptimal reflexes (p=0.006) at 34 weeks PMA. There were no other significant associations that were found, including when the direction of head turn preference and PMA at time of testing were controlled.

Developmental Outcomes:

Higher HTPS scores were associated with lower Bayley-III fine motor (p=0.016) and expressive language scores (p=0.049) scores when developmental testing was conducted when participants were 2 years of age. The other sections of the Bayley-III did not show any associations with HTPS scores.

Original Authors' Conclusions

[Paraphrase as required. If providing a direct quote, add page number]

There were 3 major conclusions from this study. First, there is a high prevalence of head turn preference in preterm infants at TEA, especially turning towards the right side. Additionally, head turn preference is associated with several medical factors, related to care required in the NICU. Lastly, head turn preference at TEA is a predictor for adverse developmental outcomes.

Critical Appraisal

Validity

[Summarize the internal and external validity of the study. Highlight key strengths and weaknesses. Comment on the overall evidence quality provided by this study.]

This study had a low risk of bias, based on the AXIS tool, with a score of 15/20. The study had clearly defined methods allowing for the study to be repeated. There were no conflicts of interest reported for this study. While the Head Turn Preference Scale was newly developed for this study, the researchers evaluated the reliability of the scale, using 4 trained occupational therapists. Interrater reliability was measured using Fleiss' Kappa statistics, and found to have a value of 1, as there was 100% agreement among the therapist in defining head turn preference. This contributed to the overall validity of the study. Additionally, the NNNS testing was conducted by one examiner, for all of the participants which improves the reliability of the neurobehavioral testing scores. Additionally, the NNNS and Bayley-III have good psychometric properties. The NNNS has been found to be predictive of medical and developmental outcomes through age 4.5[15] and has good internal consistency.[16] The Bayley-III also has excellent internal consistency and strong predictive reliability.[17] The use of these assessment tools was an additional strength of this study.

There were also several weaknesses. First, this is a Level 3 study, as it was observational. The study also did not include any controls, such as typically developing term infants, which could have served as a comparison point to the study participants who were hospitalized. Also, the participants were obtained using a convenience sample of those patients that were already enrolled in a longitudinal study and had recorded videos of the NNNS. This reduces the generalizability of the results. Furthermore, it would have been beneficial to directly evaluate the head turn preference of each participant, rather than using video, as this may be more accurate. As all the participants were patients in a NICU, receiving physical and occupational therapy, there was likely some confounding of results caused by their treatment. For instance, as part of standard care, therapists' recommendations may have been made for positioning in order to reduce the risk of head turn preference.

Interpretation of Results

[This is YOUR interpretation of the results taking into consideration the strengths and limitations as you discussed above. Please comment on clinical significance of effect size / study findings. Describe in your own words what the results mean.]

The results of this study indicate that hospitalization is likely to play a role in the development of head turn preference in preterm infants at TEA. There is a high prevalence of head turn preference among preterm infants. Additionally, there were several medical factors that were associated with head turn preferences. While these medical factors, including increased need for inotropic medications and oxygen requirement at 36 weeks PMA do not cause head turn preference, they are indicative of increased medical complexity. Furthermore, these results are clinically significant because head turn preferences at TEA are associated with poorer neurobehavioral outcomes while in the NICU, as well as developmental delays at age 2. This could result in further delays and poor outcomes later in life. This highlights the importance of identifying and preventing head turn preferences for preterm infants receiving care in the NICU.

Applicability of Study Results

[Describe the relevance and applicability of the study to your clinical question and scenario. Consider the practicality and feasibility of the intervention in your discussion of the evidence applicability.]

This study by Dunsirn et al. is highly relevant and applicable to this clinical question and scenario. This study demonstrated the high prevalence of head turn preference in preterm infants at TEA. Additionally, they were able to identify medical factors related to their hospitalization that were associated with head turn preference. While these medical factors, including increased need for inotropic medications and oxygen requirement at 36 weeks PMA do not cause head turn preference, they are indicative of increased medical complexity. For instance, these infants may have required additional respiratory support earlier in life, such as intubation, requiring their heads to be turned in a certain direction. While it is not possible to reduce the amount of time spent hospitalized or the medical interventions required, we can apply this information by considering other methods by which we can reduce head turn preference, such as nurse/provider education and positioning tools.

SYNTHESIS AND CLINICAL IMPLICATIONS

[Synthesize the results, quality/validity, and applicability of the two studies reviewed for the CAT. Future implications for research should be addressed briefly. Limit: 1 page.]

The two studies included in this CAT demonstrate that hospitalization predicts head turn preference and positional head deformities, such as plagiocephaly and dolichocephaly in preterm infants at term equivalent age. The first study included, by Ifflaender et al. included very preterm, late preterm, and term infants who were hospitalized in the same unit. This study was highly relevant to the clinical question as it evaluated both the prevalence of head deformities and medical factors in the NICU which were risk factors associated with these deformities. This study showed that there is a high prevalence of both symmetrical and asymmetrical head deformities in preterm infants, especially those born very preterm. Furthermore, medical interventions in the NICU, especially respiratory support increase the risk of developing plagiocephaly and dolichocephaly. This demonstrates the role that hospitalization plays in the development of positional head deformities. The study by Ifflaender et al. has a low risk of bias and includes both preterm and term infants, allowing for comparisons to be made between these groups.

The study by Dunsirn et al. evaluated the prevalence of head turn preference in preterm infants and perinatal medical factors affecting the development of a preference. This study was also very relevant to the clinical question as it focused on head turn preference at term equivalent age. This study included only preterm infants and found that all infants had a head turn preference, with the majority displaying a moderate to severe preference. Furthermore, head turn preference was associated with medical severity during hospitalization. This study also had a low risk of bias.

Future studies could be made stronger with larger sample sizes, in order to improve the generalizability of the results. Larger scale studies across multiple hospitals and in multiple countries could also reduce any risk of bias caused by medical practices within one institution or cultural differences. It would not be possible to have true control groups, who do not receive intervention, as the intervention in this clinical scenario is standard neonatal intensive care. However, studying infants who do not require hospitalization would allow for a better understanding of how hospitalization affects the development of head turn preference and head deformities.

Based on the studies by Ifflaender et al. and Dunsirn et al. I conclude that hospitalization is predictive of head turn preference and positional head deformities, such as plagiocephaly and dolichocephaly, in preterm infants at TEA. There is a high prevalence of both head turn preference and positional head deformities in preterm infants at TEA, and medical factors in the NICU can increase the risk of developing these issues. Due to the adverse effects of these outcomes, it is important that future studies also consider interventions for preventing head turn preferences and head deformities.

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