Infant Pain and Brain Development

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Nurses and other health care professionals are taught that pain is what a patient tells you it is. What about the patients who are unable to verbalize their pain? Infants cannot communicate their pain verbally and although this statement is obvious, its implications to nursing practice and how infants are cared for should be considered. According the National Center for Infants, Toddlers, and Families (2014), much of an infant’s brain development happens in the first two years of life. The cerebral cortex produces all of its neurons before birth, but the synaptic connections are poor. The cerebral cortex produces two million new synapses every second and by two years of age, a toddler’s cerebral cortex contains over a hundred trillion synapses. These changes occur in the visual cortex and primary touch area. The synapses are creating better connections due to a process called myelination, where myelin, a dense impermeable substance coats the brains cells and allows for efficient electrical transmission (Citation, 2014).

With the extensive amount of brain development in early life, one should consider if there is any evidence that certain experiences could alter or affect these processes. Without the knowledge of evidence based practice pertaining to this subject, nurses and health care professionals may not be providing the best quality care. The goal of this literature review is to answer the following question: “In infants, what is the effect of pain related to procedures, accident, injury or hospitalization on brain development?” Infants are defined as birth to two years old and brain development is any physical, structural or chemical change to the brain that takes place.

If pain experienced in infancy does effect brain development, nurses can use this information to create practices for reducing infant pain in any measure. Although it is the hope that any health care professional would strive to eliminate pain, such knowledge may open the
doors for research on better assessing infant’s pain. In an article by the National Institute of
Health, researches discussed “As a result of infants’ inability to give a self-report of their pain
experience, caregivers play a crucial role in assessing the pain and taking appropriate action to
manage it (Riddell, 2009).

**Literature Search**

The literature search process included databases such as Medline, Cinhal, Science Direct
and PubMed. The most common key words used in the search were “infancy”, “pain”, and “brain
development.” Using these terms with Medline produced 51,618 hits for “infancy”, 692 hits for
“pain” and 12 hits for “brain development.” Although many articles found addressed these terms,
only six articles were considered when creating the rough-draft paper review. In the final version
of the paper, four articles were included as the basis for support of the research question. These
articles were selected on the basis of: (a) key terms used; (b) the population sampled; (c) the
focus on brain development and (d) infant pain assessment. Although this selection may have
limited the amount of resources utilized, these concepts were considered because of their
relevance to the research question and how it impacts the field of nursing. Some of the studies
found addressed pre-term infants which was not ideal with the population at hand, however, the
studies were included to give the current broadest findings in this field. Studies omitted in the
literature review included those that did not specifically address changes in the brain as a result
of infant pain.

**Key Findings**

**Physical Brain Developmental Changes**

Pain experienced in infancy can cause physical changes to the infant’s brain. Ranger, et al
(2013) found that greater neonatal pain related stress is associated with significantly thinner
cortex in 21/66 cerebral regions. This happens mostly in the frontal and parietal lobes (Ranger, 2013). These lobes are responsible for cognitive and emotional processing and in many neuropsychiatric disorders, these are the parts of the brain that are involved (Rubenstein, 2011). Research in regards to thinning of the cortex as it relates to this topic is not conclusive, but may indicate that there are significant physical brain related changes that occur in an infant due to experiencing pain. This study examined infants who were born preterm and were tested at a mean age of 7.9 years to determine physical change on the brain. The evidence provides knowledge that higher exposure to neonatal pain contributes to altered brain development at a young age and later in school aged children (Ranger, 2013). These findings are crucial in understanding the negative effects that pain can have on an infant and the changes that may alter the cognitive functioning of an individual as they age.

Although nurses take extreme measures to ensure the safety of neonates in the neonatal intensive care unit (NICU), understanding the physiology of the change may indicate that certain interventions take place. For example, if an infant is to undergo a procedure, the benefits of the procedure should be measured against the risks of developmental effects. This may change the timing of certain procedures depending on where an infant or child is in their brain development stage.

Many infants born preterm are said to have developmental delays. However, understanding all the factors that may contribute to the brain development will help nurses understand how to better provide for this population. In a study by Bentley (2012), it was concluded that infants born preterm are more susceptible to pain related procedures which may interfere with normal growth and development. These infants had reduced weight gain and larger
head circumference (Bentley, 2012). Although the implications to these finding remain unclear, they are significant enough to consider for health care and patients within this population.

Along with physical brain development, chemical changes in the brain also take place due to pain. Pattinson and Fitzgerald (2004) conducted a study on rats whose ages correlated with that of infants. They found that there is a structural and functional change to glutamate, GABA and glycine receptors which are excitatory and inhibitory transmitters activated by pain input (Pattinson and Fitzgerald, 2004). These finding suggest that pain transmission is altered in the infants brain which could lead to better development of specific analgesia agents used to treat pediatric pain. Understanding pain transmission in the infants brain may lead to better treating pain and therefore controlling pain effects on brain development.

**Infant Pain Assessment**

In a study conducted by Fuller (1998), researchers discussed the importance of knowing how to properly assess infant pain. With the data collected, they created six domains or categories that nurse are using when assessing infant pain. The categories included: (a) acknowledging the infant’s distress signals (b), hypothesizing about the case of the distress (c), considering clinical data and judgments (d), comfort measure testing (e), applying the principle of consolability and (f) assessing the level of pain. With this data, a pain assessment model emerged and is used in education of nursing students and novice pediatric nurses (Fuller, 1998).

Understanding the factors included in infant pain assessment may create more insight into research on the physiological changes that occur with pain. Learning how to properly assess infant pain will create better preventive measures because nurses will be able to identify pain more rapidly and readily. The early detection could lessen the severity of pain infants’ experience and altogether prevent changes to brain development.
Limitation of the Current Research

In the studies discussed above, limitations to the research were present as they are in any study. However, on the topic of infant pain development, the largest limitation is that this topic doesn’t have a whole lot of research which could limit the way researches or health care providers may view this topic. In the studies that were discussed, the sample sizes tended to be smaller which doesn’t show the best representation of the population. Also, the studies were done in one particular area such as one hospital. The limitations on sample size and demographics decrease the quality of data that a study may produce and therefore could affect the way researches consider the data found. The studies that were discussed found that there are brain developmental changes due to infant pain but do not support to what extent pain-related stress alters cognitive, motor, and behavioral outcomes. It would be useful for researches to further investigate the effects of stress on an infant as they proceed into childhood and adulthood. The knowledge of this information would provide better evidence for future practice.

Discussion

There are definitely effects on brain development caused by infant pain and the more nurses understand how infants are affected by pain, the better preventative measures can be taken to limit infant exposure. Research on this topic may open the door into better assessing infant pain and providing specific pediatric pain medication. The better nurses understand the population at hand, the more effective treatment and service to patients may be. According to Riddell, “research with stringent experimental controls on the infant assessment stimuli has shown that infant pain assessment is heavily influenced by what caregivers bring into the judgment context” (Riddell, 2009). Nurses are responsible for advocating for patients and keeping their best interest in mind. When a nurse doesn’t understand how pain can affect infants,
their judgment may be skewed in terms of the best way to care for that infant. To fully understand how pain in infancy affects brain development will allow for better assessing, diagnosis, intervention, planning and implementation in caring for this special population. The nursing process can only improve as much as evidence suggests it should. Further research into this topic will produce better nurses and better patient outcomes.
References

Bentley, J. (2012). Babies born before 32 weeks are susceptible to pain and development can be impaired. *Nursing children & Young People, 24*(9): 11.


Topic: Pain and Development

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<th>Study</th>
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<td>Objective of the study: To determine whether pain experienced by babies born prematurely influences their postnatal growth.</td>
<td>Population and method of data collection: Population is infants that were born 32 weeks gestation or earlier and data collection was by way of the infants records on severity of illness, number of skin breaking procedures, number of days infant was reliant on mechanical ventilation, presence of infection and exposure to morphine and corticosteroids. Method of data analysis: Analysis of variance was used to determine the impact of variables on weight gain and head circumference within the three time frames established in the study.</td>
<td>Major Findings (include significance): Babies born before 32 weeks gestation are particularly susceptible to pain and their growth and development may be impaired by this early experience. Implications for practice: This reinforces practices that minimize pain experience, especially in this young age group and the reduce procedures to the minimum required to reach a diagnosis and insur infant health.</td>
<td>Strengths: This study factors in other variable such as severity of illnesses, number of skin-breaking procedures, number of days infant reliant on mechanical ventilation, presence of infection and exposure to morphine and corticosteroids. The incidence of these factors was taken account for and calculated across three time frames. Limitations: The infants were from one intensive care unit in Canada for this study. This limits the sample size. Level of evidence: Single prospective/Cohort Study- Level II for prognosis questions and Level II for some diagnosis questions.</td>
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<td>To create an infant pain assessment model by describing how pediatric nurses report assessing infant pain. They want to do this in hopes of making the process of infant pain more explicit.</td>
<td>The sample/population consisted of 40 currently practicing pediatric nurses whom all had at least a bachelor’s degree in nursing. Of this sample, 20 nurses had between 1-5 years of current experience in pediatrics and the other 20 nurses had between 5-20 years of current pediatric experience.</td>
<td>Six domains of categories were described by the nurses to assess the pain in infants. The categories where: 1. Acknowledging the infant’s distress signals 2. hypothesizing about the cause of the distress 3. Considering clinical data and judgements 4. Comfort measure testing 5. Applying the principle of consolability 6. Assessing the level of pain</td>
<td>This study addresses 4 components of trustworthiness in qualitative findings: credibility, transferability, dependability, and confirmability. These 4 components are used in the data analysis.</td>
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<td>Study Design:</td>
<td>Data collection: Each nurse was asked to watch 21-23 videotaped infants (ages 2 wks-12 mo) and assess their pain. They were given a 3 minute video tape of each infant also with info on the infant’s medical hx, diagnosis, medical-surgical status at the time of videotaping, parent’s comments, meds and nutritional records for the 48 hrs before taping. They were assessed to comment about certain factors and how they arrived at each assessment in a ‘research situation.’</td>
<td>Descriptive material about each domain was presented.</td>
<td>Limitations: The model that is created in this study does not fit all the instances of pain assessment. For example, if an infant is in pain and doesn’t give any ‘distress signals’, their pain could be overlooked and not addressed.</td>
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<td>Variables:</td>
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<td>Implications for practice:</td>
<td>Level of evidence:</td>
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<td>-How each nurse does his/her own assessment.</td>
<td>A pain assessment model emerged from the domains and their contents. The model permits the generation of testable hypotheses to guide future clinical research. The model also implies that the</td>
<td></td>
<td>Single In-Depth Qualitative Study Level II for Meaning/Process questions</td>
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<td>-The factors influencing how the nurse does their assessment like medical hx, diagnosis, medical surgical status, parents comments, meds and nutritional records.</td>
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They were then asked to describe the process they would use in assessing infant pain in ‘real world’ and how the experimental process constrained their normal ways of working and to explain what else they may consider in a ‘real world’ setting when assessing infant pain.

Method of data analysis:

The interviews were tapped and transcribed verbatim. The resulting transcripts were coded by two individuals to identify discrete parts of the assessment process using ethnographic analytic methods. The material collected was grouped together and given a code based on common meaning. The codes were grouped into related categories which then reflected a higher theoretical level of interpretation. When these categories were created, domains of certain meaning emerged and embodied certain concepts.

roles of comfort measure testing and principle of consolability can be used to further improve the infant pain assessment education of both nursing students and novice pediatric nurses.
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<td>To determine if greater neonatal pain stress is related to reduced cortical thickness.</td>
<td>Population is 42 right-handed children who were born preterm (24-32 wks gestation) who examined as neonates to a mean age of 7.9 years. These children had no severe brain injury or major motor/sensory cognitive impairment. As neonates, these children were all admitted to a level II NICU at British Columbia’s Woman’s Hospital between 200-2004. Out of 106 children who were seen at the age of 7 for follow up, only 42 participated in the study meeting the criteria for the research study.</td>
<td>Greater neonatal pain related stress is associated with significantly thinner cortex in 21/66 cerebral regions mostly in the frontal and parietal lobes. P-values ranged from 0.00001-0.014</td>
<td>Takes into consideration many cofounding variables such as gender differences and health history. Also, the study is very specific in their population; there are certain parameters and only used data in which fell into those. The population is clearly defined and influential variables are considered.</td>
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<td>Study Design:</td>
<td>Data collection: Data was collected on the infants/children that included birth weight, gestational age, # of days on ventilation, # of surgeries, presence of proven infection (by a culture), dose of morphine adjusted for body weight, and # of skin breaking procedures during stay at the NICU. MRI taken when children mean age of 7.9.</td>
<td>Implications for practice:</td>
<td>Limitations:</td>
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<td>Quantitative; Cross-sectional</td>
<td></td>
<td>This study can be used to further advance our understanding of the relationship between pain related stress and alterations in cortical development by further examining corticospinal tracts, white matter and gray matter.</td>
<td>The population is limited to one specific hospital. Also, the sample size is relatively small.</td>
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<td>Variables: If quantitative, specify independent and dependent variables</td>
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<td>Level of evidence:</td>
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<td>IV: neonatal pain related stress (defined by # of skin- breaking procedures)</td>
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<td>Single Cross-Sectional Study</td>
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<td>DV: cortical thickness</td>
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