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Epigenetics

Once upon a time, not so long ago, we believed that when we mapped the human genome we would be able to identify the kinds of people children would grow up to be. We hoped that understanding genetics would make it simple: Johnny has gene variants *xyz* so will grow up to be 190 centimetres tall; Mary has genes *abc* so will get breast cancer at age 35. The mapping of the first genome was completed in 2003 and scientists continue to work on cataloguing variations in the genome. It is hoped that with this detailed and growing knowledge, researchers will be able to develop processes to identify risk for developing various illnesses such as breast cancer, liver diseases and cystic fibrosis, and ultimately new ways of treating them.

However, with this new knowledge, it quickly became clear that our genetic make-up is not solely responsible for shaping our outcomes and does not tell us the whole story – our environment plays a crucial role too. This has led to the new science of epigenetics.

What is epigenetics?

The environment has a significant impact on shaping our development and our outcomes (our phenotype) – determining how long we will live, how healthy we will be and how we perform. In the past we used to think of this as a nature-nurture, gene-environment effect: the environment acted upon the underlying genetics to shape outcomes. More recently we are refocusing our thinking around the reverse: an environment-gene effect – the environment shapes the genome. This interplay between the genome and the environment is known as epigenetics.

Canadian researcher Michael Meaney defines epigenetics as "… a functional modification to the DNA that does not involve an alteration of sequence" (2010, p. 57). In other words, experiences (the environment) create chemical changes in the body that result in chemical changes around the DNA, which in turn alter the expression – but not the sequence – of the DNA. "The epigenome is innately plastic and can be programmed or reprogrammed by environmental experiences such as nutrition and stress" (Francis, 2009, p. S197).

Doctor Jeffrey Craig from the Murdoch Childrens Research Institute puts it like this: "Epigenetics refers to the chemical tags that stick to our DNA and act as thermostats to change the activity of our genes. These tags can be disrupted in disease but can also be changed by our environment, for example, diet, alcohol, pollution and stress. And there is evidence that this is more likely to happen very early in life, including when we are in the womb."

There is little, albeit tantalising, evidence about the transfer of these changes to the genome from one generation to the next, known as the 'transgenerational epigenetic inheritance'. Direct evidence from a handful of animal studies and circumstantial evidence from human studies suggests that the diet of mothers or fathers, long before they reproduce, can influence the health of the next generation.

Why the fuss?

Child and family health nurses know that the environment unquestionably influences the development of a child. Epigenetic research helps us develop a better understanding of how the outside world impacts on the biology and neurology of children and this helps us understand how best to intervene. This is important for children from all backgrounds, but it's especially significant because we know that children growing up in disadvantaged families and communities demonstrate poorer health, development and wellbeing outcomes over their life spans (Irwin, Siddiqi, & Hertzman, 2007; United Nations Educational Scientific and Cultural Organisation, 2010). Understanding the mechanisms that create this 'internal' disadvantage – which could possibly be transmitted to the next generation – can tell us much about the positive and negative external influences on children's development.

Much of the early work that helped develop our understanding has been undertaken with animals but researchers are now also beginning to undertake some investigations with humans.

Epigenetics and the physiology of stress

Our physiological response to stress from the outside world can have a detrimental effect on our bodies. Biologically, this is how it works: stressors activate the hypothalamic-pituitary-adrenal (HPA) axis, that, through evolution, has developed to shape metabolic and cardiovascular responses to enable coping. Basically, when triggered by a stressor, the human hypothalamus releases corticotrophin-releasing factor (CRF) which prompts the pituitary gland to release corticotrophin. Corticotrophin, in turn, prompts the adrenal gland to release gluccocorticoids which work with catecholamines to create lipolysis, glycogenolysis and protein catabolism resulting in increased blood glucose. These enable organs such as the heart and lungs to work faster, enabling the stressed human to become more alert and vigilant in order to manage the stressor. At the same time, a range of anabolic processes are suppressed and there is an impairment in insulin sensitivity, increased hypertension, amenorrhea, impotence, and impaired tissue repair and cognitive functioning.

While our body's responses are adaptive at times of stress, chronic activation of these responses (when our body is under continual stress) leads to an increasing allostatic load on the HPA axis, and ultimately increased vulnerability to poor health (Francis, 2009; Meaney, 2010). In short, our body cannot withstand chronic periods of stress without it taking its toll – too much stress is detrimental to our health.

However, research is showing that nurturing experiences in the early years can lessen the biological impact of stress. This means that positive, nurturing environments and secure attachments between an infant and caregivers, play a protective role in children's health. But infants under chronic stress from their environment (for example, unstable home environments, insecure attachment and poor diet) are more likely to have poorer health outcomes.

Epigenetics and our work with children and families?

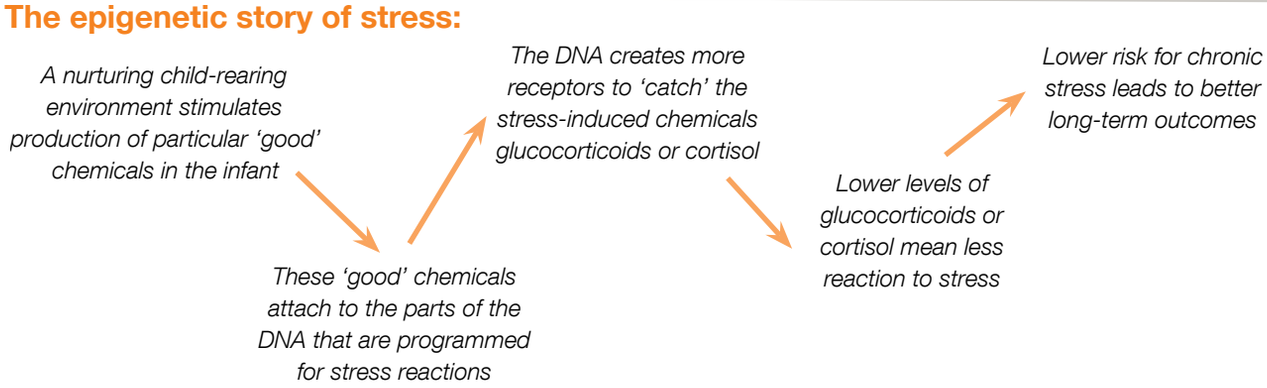
Epigenetic research shows us that although an infant is born with certain genetic predispositions to physical attributes and disease or illness, external factors also play an important role in determining health outcomes. For nurses and other health professionals this means considering how these external factors impact on the children and families we care for, and how we can intervene early to improve the health and development of children now as well as future generations.

The importance of secure attachments

As child and family health nurses, we understand that the attachment relationships between children and their caregivers are crucial. Infants who establish secure attachments with their caregivers demonstrate more positive long-term outcomes across a range of health and developmental measures (Sims & Hutchins, 2011). These children are physically and mentally healthier, do better at school, and are more sociable and emotionally stable. There is evidence that children who experience multiple, equal attachments are also advantaged in that they are less at risk should one relationship not work effectively (Hrdy, 2009; Sims & Hutchins, 2011).

Neurologist Bruce Perry has developed a therapeutic model of intervention for children who have been maltreated and/or traumatised that depends on the concept of multiple attachment (Perry & Hambrick, 2008).

The epigenetic story of stress:



He argues that "… the primary therapeutic implication is the need to increase the number and quality of relational interactions and opportunities for the high-risk child" (p.46).

Child and family health nurses working with children and families can help to prioritise the development and maintenance of caring, nurturing relationships between carers (parents, extended family, such as grandparents, and others including early childhood education and care professionals and teachers) and children.

Holistic approaches to addressing health inequalities

We are beginning to understand that effective interventions aimed at addressing inequalities in health need to include understandings from neuroscience, molecular biology and childhood roots of health disparities (Francis, 2009, p. S201). Interventions need to be holistic and we can no longer operate in isolation; we need to work with others to ensure that we address the full range of disadvantages impacting on families.

Interventions proven to be effective are identified on the Promising Practices Network (www.promisingpractices.net/programs_topic.asp) and include Nurse Family Partnerships (Olds, Hill, & Rumsey, 1998), Parent-Child Centres (Reynolds & Ou, 2011) and Early Head Start (Vogel, Yange, Moiduddin, Kisker, & Carlson, 2010).

Interventions also need to begin very early in children's lives; the earlier the better. We now know that disadvantage has a cumulative effect not only on outcomes, but on the biology of each human experiencing it. This means it is necessary to develop and deliver interventions that target families with very young children, including pregnant women and even women before they become pregnant if possible. Child and family health nurses have a key role in supporting women to establish and maintain healthy lifestyle choices that support the development of a positive inter-uterine environment. In addition, child and family health nurses need to be aware of the importance of establishing early interventions, as the earlier interventions are offered the more opportunities there are to prevent or significantly attenuate the cumulative effects of social disadvantage that we know emerge over the lifespan (Francis, 2009, p. S200).

Integrated service delivery in early childhood, in which early intervention support is offered targeting health, wellbeing, child development and family support, is becoming more popular and evaluations of the impact of such services are beginning to demonstrate positive results. For example, long-term evaluations of Sure Start, an initiative in the UK working to improve outcomes for children, especially those living in areas of high socioeconomic deprivation, demonstrate better outcomes as time passes and services become more efficient and effective. Children growing up in Sure Start areas were, by age three, more likely to show better social development and their mothers were less likely to demonstrate negative parenting (Melhuish, Belsky & Barnes, 2010). By age five, the children were more likely to be physically healthy and their mothers were more likely to provide a stimulating home learning environment (The National Evaluation of Sure Start Team, 2010). Child and family health nurses who are able to link families to integrated early childhood programmes maximise opportunities for families to develop and maintain the environmental conditions necessary for positive long-term outcomes.

What are the broader implications of epigenetics research?

Epigenetic research supports what many child and family health nurses have known for years: good attachments are critical for babies and have a significant impact on children's future developmental outcomes. Science tells us that not only do the early years of a child's life affect their entire life, but we can speculate that they could also go on to impact future generations.

By supporting mothers and families from birth, and where possible, pre-natally, child and family health nurses can continue to support children to have the best start in life. Our growing understanding of epigenetics, the transgenerational epigenetic inheritence and the complicated interplay of a multitude of factors in the early years can be used to support and motivate change. This new understanding can be applied across policy development and implementation in community health, social work, clinical psychology, education and medicine to address health disparities early and holistically. In their work, child and family health nurses are not only impacting on the lives of children and families today, but on the lives of the children of the future. We can, in time, make a difference.

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Oral health

Oral health care can often be seen as an issue for older, school-aged children, but in fact it is a critical part of infants' and young children's health. Primary teeth (also known as milk, baby or deciduous teeth) set the pattern for adult tooth development and any dental caries or tooth decay early in life can lead to painful and expensive dental treatment later. High rates of tooth decay – or early childhood caries – are a significant issue for preschool-aged children and their families (Dental Health Services Victoria, 2011). A school dental service survey in 2002 showed that 42 per cent of five-year old children experienced dental decay, 75 per cent of which was untreated (Dental Health Services Victoria, 2003).

In a child's first years of life, they are more likely to see a child and family health nurse than a dentist, so it's crucial for nurses to be aware of the early signs of tooth decay, poor oral health practices and the need to educate parents on oral health. It is recommended that infants' teeth are checked by a nurse or oral health professional, such as a dental therapist, when they're under two years of age. These early checks can help identify children who need to be referred to a paediatric dentist.

Visits to the dentist

At or by two years of age, children should see a paediatric dentist to discuss early diagnosis and prevention of oral diseases. Paediatric dentists have specific training in working with infants and very young children. Dental Health Services Victoria advises parents to take their baby to see a paediatric dentist or other oral health professional for a check-up as soon as the first tooth appears and no later than two years of age. Once children have reached school age, regular check-ups with a general family dentist are advised to manage good oral health.

Tooth development

Primary teeth are important in guiding the growth and development of permanent teeth. These first teeth appear at varying times, usually between six months and three years. Most children will have a full set of 20 primary teeth by the time they are three. If there is a concern about the timing or pattern of tooth eruption, nurses should refer the child to a specialist paediatric dentist.

Tooth decay

Tooth decay is caused by certain pathogenic oral bacteria growing on the tooth surface producing lactic acid that causes damage to the tooth structure. One of the first signs of tooth decay is small white lesions running along the gum line, called enamel white spots or decalcification. This indicates that the tooth enamel is being demineralised, while the surface remains intact (Community Paediatric Review, 2006).

The presence of bacteria in the oral cavity (in the form of soft white or pale yellow debris known as plaque) can metabolise carbohydrates from food (mainly sucrose) into lactic acid. In turn this acid breaks down the hard surface of the tooth, creating holes or cavities (Raising Children Network, 2009). Early childhood caries can occur in children as young as nine to 12 months of age. In infants, the upper four front teeth (incisors) are the most commonly affected.

It's important to educate parents that children are not born with the pathogenic bacteria that cause dental caries. Rather, the bacteria are mainly transmitted by the primary caregiver, usually the mother. If the mother, for example, has high levels of the bacteria that cause tooth decay in her mouth, then sharing utensils or cups, cleaning a dummy, even kisses can transmit these bacteria. This means it's important for the whole family to have good oral health hygiene and regular dental check-ups.

Developing good oral health practices

Cleaning, brushing and toothpaste

Even before teeth appear, it is recommmended that babies' gums and tongues are cleaned with water and a washcloth, twice a day or after each feed. As soon as the first tooth appears, a soft toothbrush (designed for children under two years of age) can be used. Very young children (under 18 months) do not need toothpaste; a thin smear of a low-fluoride child's toothpaste can be introduced when children are 18 months. Until about the age of eight, children will need some assistance cleaning their teeth. (A good measure for parents is if their children can tie their shoelaces alone, they can generally manage cleaning their teeth as well.)

Diet and nutrition

Diet and feeding practices are also important for children's oral health. Research shows that the frequency of sugar intake, rather than the amount of sugar consumed, is important in predicting dental caries (Gussy et al., 2006). Also, the longer food and drink stays in the mouth, the more chance there is for acid to develop, so food and drinks that are nibbled or sipped over longer periods of time are more likely to cause tooth decay (Raising Children Network, 2009).

Food and drinks that contain added sugars should be limited, especially between meals. Having regular snack and meal times, and putting food away when snack or meal time is over, can help parents to encourage healthy eating habits.

Parents should also be reminded not to settle their infant with a bottle – the natural sugars in milk (mainly lactose which can be metabolised into lactic acid) can pool around the teeth and lead to dental caries (Raising Children Network, 2009). After six months of age, infant feeding cups rather than bottles are preferred for drinks other than formula or breast milk (Australian Dental Association, 2011).

Children should be encouraged to drink clean, safe tap water where available, and if possible, avoid bottled water. There is evidence that decay rates are rising in younger children who have had more exposure to bottled water and therefore missing out on the fluoride present in Australian tap water. People living in non-fluoridated areas or using tank water should ask a dental professional for advice on alternative ways to get the benefits of fluoride. These options could include more frequent use of toothpaste; introducing toothpaste at a younger age; or introducing adult strength toothpaste earlier than usual (Government of Western Australia, 2010).

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Community Paediatric Review supports child and family health nurses in caring for children and their families through the provision of evidence-based information in relation to current health issues.

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