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UCT Department of Paediatrics and Child Health



Regul8

The role of the children's nurse in optimising autonomic regulation

The Regul8 framework

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Domains and evidence summaries

Supporting autonomic regulation in infants and children

In nursing infants and children, supporting regulation is key. Significant advances in various disciplines indicate that the process of supporting optimal autonomic regulation in infants and children is a different and more complex process than it is in adults.

Emerging evidence in human biology and neuroscience indicate eight key domains within which children's nursing practices support optimal autonomic regulation. These are:

1. Engaged mother to child interaction
2. No needless pain
3. Hydration
4. Nutrition
5. Managing the microbial load
6. Skin and mucosal integrity
7. Developmentally supportive care
8. A system of action

Rationale

The Regul8 framework is built on Florence Nightingale's 1860 assertion that *"What nursing has to do ... is to put the patient in the best place for nature to act"*.¹

The rationale at the heart of this approach is that **optimal autonomic regulation** is this best place and that there is good evidence that these 8 key domains **are fundamental to children's nursing care that intentionally supports regulation**. Within these domains, nursing activities include assessing, anticipating change, preventing deterioration and injury, planning care in anticipation of discharge planning and providing an intentionally supportive environment.

Observing regulatory function

Autonomic regulatory function is observable through activities that nurses routinely track and monitor, including:

Vital signs

- thermoregulation
- respiratory rates and efficiency of breathing
- cardiovascular regulation measured by cardiac rate and force
- blood pressure, **including** arterial pressure and central venous pressure

Other observations

- Blood glucose maintained within normal glycaemic range
- Comfort
- Emotional and behavioural regulation
- Sleep-wake rhythms

1 Nightingale, F., (1865). *Notes on Nursing: What it is and what it is not & notes on nursing for the labouring classes*. Reprint, New York: Springer Publishing Company, 2010.



Engaged Mother Child Interaction ... and autonomic regulation

This domain centres around the importance of the engaged presence of the mother to mediate the distress of illness, injury and healthcare interventions. Infants and children should never be left alone in clinical settings. The presence of the mother with the child is encouraged and supported at all times.

Evidence summary

- Research in human biology and neuroscience reveals a clear link between autonomic regulation in infants and children and the presence of the mother.
- There is evidence that children and care-givers physiologically regulate one another through social interaction, affecting both immediate physiological status and longer-term brain structure.
- Studies in neonates have confirmed the validity of using objective autonomic nervous system parameters to assess stress. In the paediatric ICU, measuring heart rate variability as a stress indicator confirms that mothers' intervention during procedures results in a faster recovery.
- There is also evidence that the quality of the interaction between the mother and the child is linked to long term health outcomes.
- In addition, the field of reproductive biology confirms that all of a mother's body sensations help control all of the different parts of the physiology of the infant and small child. This is called regulation.

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No Needless Pain ... and autonomic regulation

This domain acknowledges that discomfort, pain or anxiety may be inevitable in healthcare encounters, either as a result of healthcare interventions or as a consequence of the child's injury or illness. It includes caring in ways that anticipate and avoid pain and discomfort, recognising and managing pain without hesitation. It also includes the imperative to explore and recognise constraints to pain recognition and treatment, which can include individual or professional beliefs and perspectives or institutional policy and practice norms.

Evidence summary

- Recurrent or continuous unrelieved or inadequately treated pain results in physiological and emotional dysregulation.
- The chronic stress of unrelieved pain results in above-normal levels of interleukin-6 (IL-6), an immune-system protein that promotes inflammation.
- Prolonged or recurrent painful procedures result in symptoms similar to post traumatic stress syndrome.
- Measurement and assessment of pain in paediatrics is complex, including behavioural, developmental and physiological aspects. Observational tools are observer dependent.
- While the gold standard to assess patient comfort is self-reporting, self-reporting is unlikely to be achievable in pre- or non-verbal children, as well as in children with altered consciousness.
- The development of 'cooperation-independent' monitors for pain are based on autonomic nervous system indicators, the best of which reflect variability in the parasympathetic tone (heart rate variability and the analysis of the respiratory fluctuations of heart rate).

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Hydration

... and autonomic regulation

This domain is primarily focused on hydration in infants and children. It acknowledges the particularly complex and precise mechanisms that regulate hydration and water homeostasis. Maintaining optimal fluid balance in ill or injured infants and children is imperative because illness and injury quickly disrupt these delicately balanced mechanisms and that infants and children have a heightened risk of dehydration.

Evidence summary

- The regulation of water balance is essential for the maintenance of health and life.
- Water has many roles in the human body, all related to maintaining homeostasis and regulation. These roles include providing substance in cell wall integrity; functioning as a solvent, substrate and reactant for all chemical bodily functions; being the transport medium for nutrients and waste products; thermoregulation; lubrication, and shock absorption.
- The balance of water in the body is very precisely regulated through homeostatic mechanisms: a loss of 1% of body water is usually compensated within 24 hours. The body attempts to control the water/fluid balance (homeostasis) by regulation of both fluid intake and output/losses.
- The homeostatic mechanisms which detect and regulate water/fluid balance are very sensitive and are triggered by minute changes in plasma osmolarity. In young infants dysregulation poses a significant challenge and a greater risk of dehydration or fluid overload than in older children and adults.
- In infants and children, dehydration can affect volume regulation, consciousness, extremity weakness and cause hypotonia and tachycardia.

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Nutrition

... and autonomic regulation:

This domain is centred around maintaining optimal nutrient intake when managing illness and restoring health. Loss of appetite is common in illness. In addition, children may object to unfamiliar food. Treatment regimes and hospitalisation often require that infants and children take or swallow unfamiliar substances, which may further affect appetite and food intake. Supporting optimal nutrition for the infant or child in hospital requires sensitivity, patience and creativity.

Evidence summary

- The body requires the nutrients from a variety of food types for energy, for growth and repair of tissue and to maintain temperature.
- Macro- and micronutrients determine healing ability, cell wall and mucosal integrity and in this way also affect innate immunity.
- High refined sugar intake affects blood sugar regulation and there is some evidence that refined sugar intake affects the ability to self-regulate behaviour.
- Rather than the precautionary practice of keeping infants and small children nil by mouth for long periods of time (e.g. in diarrheal disease and severe burn injury), there is instead good evidence for early feeding in most situations.
- Early feeding decreases changes in intestinal permeability induced by infection and supports better enterocyte healing and maintenance of disaccharide activity.
- For children who have diarrhoea there is now strong evidence for early re-feeding with oral rehydration therapy.
- There is no need to avoid lactose in the diet in the vast majority of cases of young children with acute diarrhoea.
- A balanced intake of essential fats is essential to support optimal brain development for infants, since lipids make up 60% of a healthy infant brain.

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Management of Microbial Load

... and autonomic regulation

This domain focuses on understanding and supporting the delicately balanced human microbiome. This vast system of microbes has protective functions that affect the host's metabolism, immunity and response to infection. The developing and dynamic microbiome of the infant or child is easily disrupted by stress, illness, and necessary treatments including antibiotic use, increasing vulnerability to pathogens.

Evidence summary

- In the human body, the intestinal microbiome is a signalling hub that integrates environmental information from inputs e.g diet with genetic and immune signals to affect the host's metabolism, immunity and response to infection.
- The microbiota plays a fundamental role in the induction, training and function of the host immune system.
- The colon contains a population of a vast quantity ($\times 10^{14}$) of commensal microorganisms that play an important role in enzyme production and supports metabolism including digestion of polysaccharides for which humans have no enzymes.
- These commensal microorganisms also enable the body to synthesize vitamins.
- Commensal microorganisms also stimulate the adaptive immune system including Type1 helper (Th1) cells, which inhibit Th2 helper cells possibly providing protection against allergies like asthma.
- Pathogens (disease causing organisms) are responsible for infections. Microbial load and virulence affect the extent of the infection and the infection risk.
- Prompt initiation of antibiotics to treat infections reduces morbidity and save lives.
- Optimising infection control measures and the use of antibiotics is critical to effectively treat infections, protect patients from harms caused by unnecessary antibiotic use, and combat antibiotic resistance.

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Skin and Mucosal Integrity

... and autonomic regulation:

This domain focusses on supporting the integrity of the skin and mucosa to provide the body's first line of defence and is vital for optimum innate immunity. Vigilance, skilful and proactive care can reduce risks to integrity arising from events such as dehydration, nutrient loss or venepuncture. The delicate skin-mucosal boundaries around the anus are threatened by diarrhoea. The integrity of the mucosal boundaries of nose, lips and the oropharyngeal mucosa are particularly at risk through common traumatising and invasive interventions such as nasogastric tube insertion or suctioning of the airways.

Evidence summary

- The skin lines the exterior of the body and the mucosal membranes line the interior surfaces, forming a boundary in contact with the surrounding environment. The integrity of these boundaries provides the body's first line of defence and their integrity ensures optimum innate immunity.
- Preventing a breach in the skin or mucosa in order to protect this integrity through preventative activities, barrier creams, dressings and moisturising further supports innate immunity.
- Innate antimicrobial factors present in and on the mucosa form one arm of the innate immune system, protecting mucosal surfaces from bacterial infection. These factors can rapidly kill bacteria deposited on intact mucosal surfaces and prevent acute invasive infections.
- Innate immunity was previously thought to be a nonspecific immunological programme that was engaged by peripheral organs to maintain homeostasis after stress and injury. Emerging evidence indicates that this highly organized response also takes place in the central nervous system.

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Developmentally Supportive Care ... and autonomic regulation

This domain centres on providing supportive care to children of all ages, offering care in partnership with families in ways that notice what each individual child can do and the milestones they have reached, and which celebrates and encourages competence towards the next steps. New understandings of neuronal wiring and the integration of cognitive, emotional and behavioural development show the complexity of influences on how children learn to speak, think and regulate their responses and behaviour. This supportive awareness extends throughout the paediatric population, including newborns (both premature and term infants), infants, toddlers, pre-schoolers and school aged children, as well as through puberty and adolescence.

Evidence summary

- Technological advances in imaging and epigenetics have significantly expanded the understanding of neurodevelopment, showing that supporting the process of development requires awareness of intricate vulnerabilities beyond simply monitoring growth and development.
- Integration of the scientific knowledge bases around early childhood development has further intensified with emerging discoveries about development in the womb and in the first months and years.
- The core concepts related to child development and regulation are that: experiences build brain architecture; 'Serve and return' interaction shapes the brain; and toxic stress derails regulation and healthy development.
- Advances in social neuroscience and interpersonal neurobiology add significant insights to attachment theory. Regulation and neurodevelopmental integration in children is linked to the presence of their mother or a trusted, engaged family member who facilitates regulation in various ways across the age range.
- This regulation is linked to the 'serve and return' interactions between the child and the engaged adult.

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A System of Action ... and *autonomic regulation*

This domain is about the sustaining health care systems that work for infants, children and young adolescents - including units, facilities and health systems. Nursing care extends to supporting the functional operation of systems that are welcoming, safe, effective, timely, efficient, equitable, age-appropriate, directed by the best available evidence and provided in ways that are supportive of families and communities.

Evidence summary

- A system of action that facilitates best care in child health and paediatric healthcare services (units, clinical and larger systems) has at its core care encounters that are welcoming and safe. Encounters with children and their families should be engaged, supportive and facilitate restoring regulation in ways that limit perceived stress and thus enable children to better manage allostatic load.
- Child- and family-friendly healthcare is about ensuring best evidence- based care of children at every level of health care provision. It requires quality care of children that ensures no needless deaths, no needless injury, no needless waste, no needless waiting, no needless helplessness, and no-one left out – not children, nor their families, nor health care providers.
- From the preceding evidence in this table, the negative effects of the practice of separating the mother-child pair during treatment procedures and hospitalisation of the child should be clear.
- The familiar attachment patterns of protest, despair and detachment that are visible in young children separated from their mothers are now understood to result from the loss of regulatory functions that would otherwise be provided through the mother's presence.
- The principle that separation of the mother-child pair during stressful healthcare events, starting from the immediate newborn period, results in harmful effects of dysregulation and subsequent epigenetic changes underlies the clinical practice models of Zero Separation, Kangaroo Mother Care and Skin to Skin Care.
- When stress is managed for the child it should also reduce the stress of caregiving, especially in the context of the high demand placed on staff in limited resource settings.
- Children's opinions, once recognised and heard, can make a significant difference to practitioners who work with them. They challenge us to ensure quality health care and treatment within a spirit of increasing respect for the equality, dignity, protection and participation of children and their families.
- A system of action is centered around monitoring and management of practice breakdowns, resolving conflict, resolving system failures, and designing and delivering contextually appropriate care that utilises the best available evidence in conjunction with locally available resources.

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About this framework

This framework represents an approach to providing fundamental children's nursing care developed by Dr Minette Coetzee at the Child Nursing Practice Development Initiative (CNPDI) in the Department of Paediatrics and Child Health at the University of Cape Town between 2008 and 2019. Originally known as the Seven Steps, and then the Seven (Plus One) Steps, the impetus for the work was to align emerging understandings and research outcomes with current children's nursing practice. Concepts were developed through continuous exploration of emerging scientific fields and refined through a decade of teaching and learning alongside children's nursing students, practitioners and educators from across Africa. The framework is designed to comprehensively address the major influences on regulatory function through an intentionally Afrocentric guide to children's nursing care planning. This framework provides the basis for curricula in the majority of children's nursing educational programmes in southern and eastern Africa and informs care planning in an increasing number of clinical settings.

Using and citing this framework

This evidence summary document and an accompanying poster can be downloaded at <https://open.uct.ac.za/handle/11427/31206>

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