Exploring Homeostasis in Children: the body's dynamic balancing act.

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Homeostasis: Clinical relevance of the body's dynamic balancing act

Abstract

Homeostasis has an established and significant role in the adaptability and survival of living organisms. As such, it is essential for clinical healthcare workers such as children's nurses to comprehend the concept, and grasp the knowledge of homeostasis regulation, including the mechanisms of homeostasis, the systemic approach to homeostasis and dysregulation. Comprehension of associated diagnosis processes, clinical management, and tailored holistic care planning can then be ensured. This article provides an overview of homeostasis and common factors that impact on homeostasis processes. Dysregulation and disease processes are illustrated through a children focused case study, exploring the complexity of homeostatic mechanisms in maintaining a stable internal environment.

Key Words

- Homeostasis mechanisms
- Negative Feedback Loop
- Positive Feedback Loop
- Diabetic Keto Acidosis - DKA
- Dysregulation
- Person Centred Holistic Care

Aims and intended learning outcomes.

This article aims to provide an overview of homeostasis to enhance understanding of its essential components such as negative and positive feedback loops, highlighting differences in children and its clinical relevance in children's nursing. This is linked to aspects of The Code (Nursing and Midwifery Council (NMC) 2018) themes on practising effectively and practising safety.

After reading this article and completing the Time Out activities, you should be able to:

- Discuss the relevance of understanding homeostasis process in children's nursing.
- Outline the activities which take place at each of the 4 stages of the negative feedback loop.
- Discuss the roles played by the nervous and endocrine systems in homeostasis processes.

- Identify common factors that impact negatively on homeostasis, often leading to dysregulation and disease.
- Discuss how to create a person-centred care plan in children's nursing for homeostasis related disorders.

Introduction

Homeostasis is crucial for the survival and adaptation of organisms, which have dynamic internal environments and are exposed to diverse external environments. To function effectively, the human body needs to sustain an internal environment which is conducive to the optimal function of cells, enzymes, and organs. It is essential that the internal environment is supportive of biochemical processes such as the maintenance of optimal pH, glucose, and carbon dioxide levels (Mc Gloin and Skull 2022). Homeostasis processes robustly maintain such constancy in the internal environment in response to external environmental fluctuations and some internal stimuli (Torday 2015). For children (0-18 years of age), the children's nurse must understand the physiological differences in these groups, and the consequential implications to nursing practice (Brady 2021).

Background

The significance of homeostasis has been highlighted in literature through the years, dating back to the 1800s, with early biologists being fascinated by how living organisms often naturally cure themselves of most diseases (Cannon 1929). Emphasis has been on understanding homeostasis' clinical relevance as it relates to preventing and understanding disease and dysregulation in physical health. Based on the work originated by Bernard (1865), which discussed the processes of physiologic control, Cannon (1929), termed the phenomenon of autonomous control ‘*homeostasis,*’ stemming from the Greek words ‘*homeo*’ meaning ‘similar’ and ‘*stasis*’ meaning stable. This is still the current understanding of homeostasis in the 21st century, although emerging research is now working towards understanding homeostasis’ links with psychological processes (Cummins 2017).

Homeostasis Overview

Definition of homeostasis: Homeostasis is the dynamic process in which continuous changes are happening within an organism, to maintain a relatively constant internal environment conducive to the optimal function of cells, enzymes, and organs, in relation to regulated variables such as pH, glucose levels and temperature (Torday 2015; Niedzwiecki and Kinn 2022).

To sustain an internal environment with optimal conditions for cellular function and for overall organismal health, homeostasis is enabled by functions of key mechanisms which maintain regulation of critical physiological variables such as temperature, blood glucose, pH, and nutrient levels, among others *(Table 1).* These physiological variables also interact and are interdependent in the maintenance of homeostasis, such as the connections between water/ fluid balance, blood volume and electrolyte balance. It is crucial that homeostatic systems are adaptable to different conditions and stressors and can maintain regulation of physiological variables to ideal targets or ranges. To regulate these physiological variables, homeostasis relies on negative and positive feedback mechanisms (Niedzwiecki and Kinn 2022). It is important to note that although there are many similarities between adults and children in how homeostasis is regulated, there are significant physiological differences. These are especially noticeable at the stages of neonate and premature infants (Brady 2021). In children, for physiological parameters such as water balance, blood pressure and nutrition, the ability to maintain homeostasis is restrained by the greater nutritional and metabolic requirements usually related to variable body mass and developing hormones. Children have different water balance requirements because their higher metabolic rates lead to greater fluid loss. The percentage of total body water changes with age: it is 70% in infants, 65% in children, and 60% in adults (Kight and Waseem 2023). Infants and young children are therefore sensitive to even a small degree of impaired water balance. Furthermore, as children are still developing their bodies, they are also still developing their ability to regulate temperature. Physiological and neuroendocrine differences indicate that children's thermoregulatory systems are not yet fully mature, and that neonates and infants are the most affected (Tsuzuki 2023; Smith 2019).

Physiological Variable	Homeostatic control
Temperature	Body temperature regulation ensures optimal enzymatic activity and cellular function.
pH (Acid-Base balance)	Maintenance of stable pH in bodily fluids, particularly blood, is crucial for proper enzyme function and overall cellular activity
Blood Pressure	Control of blood pressure ensures adequate organ and tissue perfusion and prevents damage to blood vessels
Oxygen and Carbon Dioxide Levels	Regulation of gaseous exchange in the respiratory system is essential to support cellular respiration
Nutrient Levels	Nutrient concentration, including vitamins and minerals, needs regulation to support various physiological processes and metabolic reactions
Blood Glucose Levels	Regulation of blood glucose is essential for providing steady energy supply to cells and preventing hyperglycaemia and hypoglycaemia
Water Balance	To maintain proper hydration levels in the body, homeostasis controls water intake, absorption, and excretion.

Blood Volume	Maintenance of appropriate blood volume is crucial for cardiovascular function and adequate tissue perfusion
Electrolyte Balance	Regulation of electrolytes such as potassium, sodium, calcium, and others, is crucial for maintaining cellular osmolarity and facilitating nerve and muscle function
Hormone Levels	Hormone level regulation ensures proper communication between cells and organs, influencing various physiological functions
Heart rate and Respiratory Rate	Heart rate and respiratory rate are regulated to meet the body's oxygen and energy demands
Body Weight	Homeostasis influences appetite, metabolism, and energy balance to regulate body weight within a certain range
Osmolarity	The osmotic balance of bodily fluids is regulated to prevent cell swelling or dehydration

Table 1 Key physiological variables under homeostatic control

TIME OUT 1
Write down 2 reasons why it is important to understand homeostasis processes in children's nursing.

Regulatory mechanisms and key components of Homeostasis:

Negative feedback loops: Most homeostatic processes involve negative feedback loops. These counteract and reverse deviations from ideal optimal conditions for physiological functions caused by any stimulus. There are four cyclical but distinct stages to understand in homeostasis processes which use negative feedback loops in response to stimuli altering optimal conditions; 1) Set point, 2) Receptors or Sensors, 3) Control centre or Integrator and 4) Effectors: Using pH as an illustrative variable, the 4 stages can be understood as:

- ***Set Point*** - This first stage refers to the ideal or target value that an organism, such as the human body seeks to maintain for each regulated physiological variable, such as blood pH, which has a set point or target range between 7.35 and 7.45 in children (McGloin and Skull 2022, Brady 2021). A stimulus, for instance, increased CO_2 levels from hyperventilation, resulting in increased concentration of hydrogen ions (H+), will cause deviation from the blood pH's set point, seen as pH levels falling below 7.35 in arterial blood gas (ABG) results (acidosis).

- ***Receptors -*** deviations from set point are detected at the second stage of the homeostasis process by Sensory ***Receptors*** whose purpose is to recognise changes in the body's internal environment and send the information along. For deviations in blood pH, the body possesses two groups of chemoreceptors responsible for the detection of changes in the concentration of hydrogen ions (H+), 1) peripheral, PaO2, and H+ receptors located in the carotid and aortic bodies and 2) central, H+ receptors in the ventrolateral medulla (Benner et al 2023).
- ***Control Centre:*** Once receptors detect alterations from the set point and relay the information, the third stage in the homeostasis process, the ***Control Centre*** is activated. This is often in the brain or specific glands which have vital integration and decision-making functions. In the case of blood pH value alterations, there is a complex homeostatic process involving respiratory, endocrine, renal, and buffer mechanisms (Ribet et al 2021). However, information will primarily be sent to the respiratory centre in the medulla oblongata of the brain, which acts as the control centre for pH regulation (Rateau 2020). The medulla oblongata compares the information received from the chemoreceptors to the pH set point of between 7.35 and 7.45 in children and determines the required response to correct the deviation back to the

set point, bringing the homeostatic process to its fourth and last point, the ***Effectors*** stage.

- ***Effectors:*** This is the stage where the control centre, often using either the nervous system or the endocrine system for communication between components, will cause an effector, in the form of structures such as muscles or glands to conduct responses required to restore stability. For blood pH regulation, both the nervous system and the endocrine system will coordinate actions to maintain the set point. Rapid short-term adjustments to blood pH will be made by the nervous system through respiratory organs' control of CO_2 levels. The endocrine system, primarily through hormonal stimulation of kidney processes, which control the excretion and reabsorption of ions and buffer systems, will achieve the more prolonged regulation and maintenance of the pH within the set point range (Rateau 2020).

Although the last stage in understating the negative feedback loop is the effector stage, the process is cyclical (*Fig.1),* and physiological variables will continuously be monitored by receptors, with deviations addressed by the control centre and corrected via effectors to return internal environment to set points.

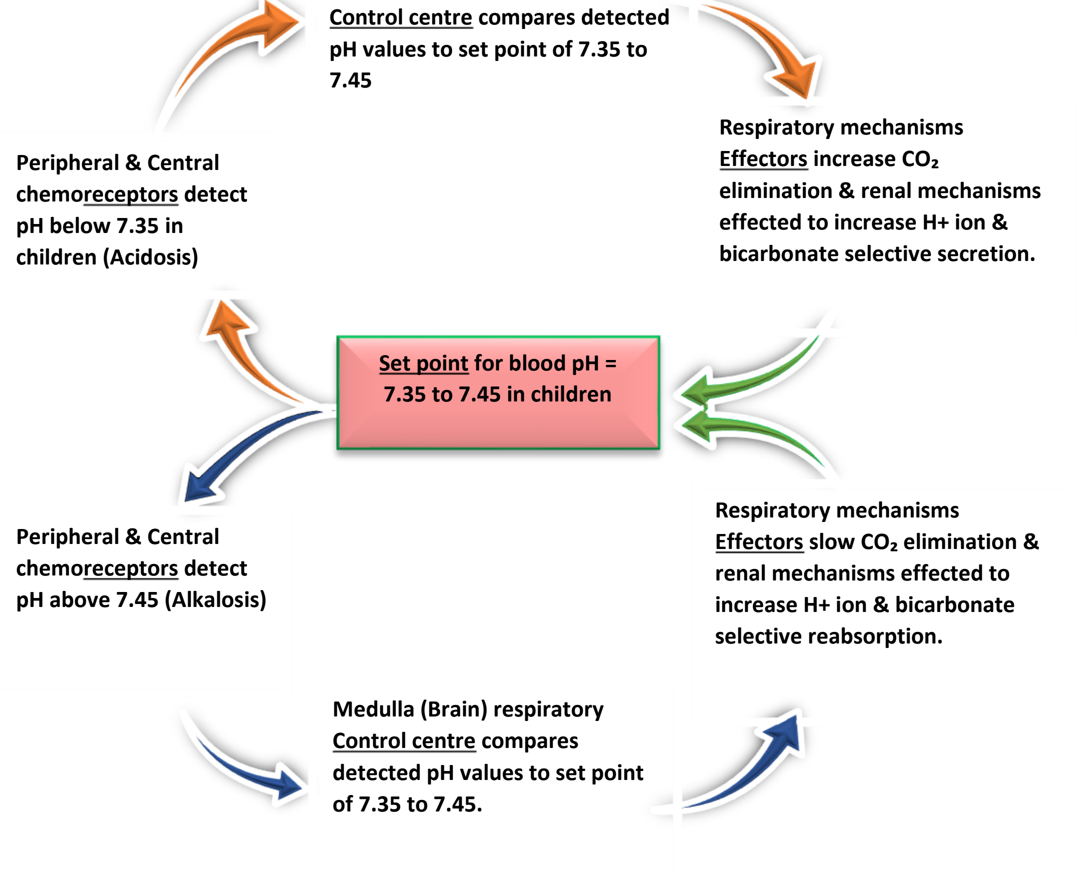
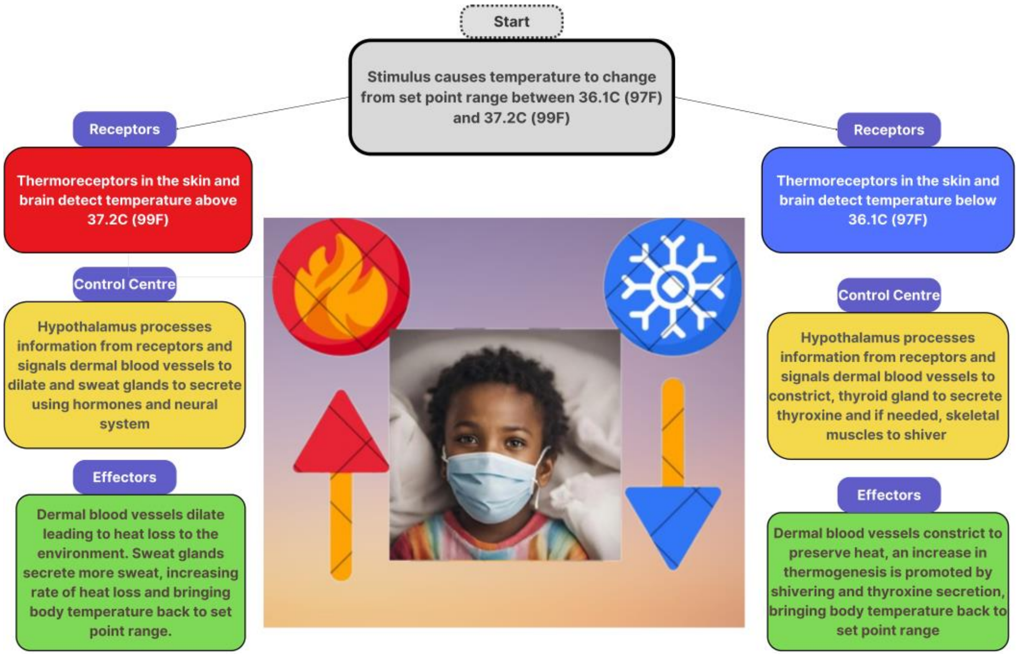


Fig. 1 *pH negative feedback loop in increase and in decrease pH deviations*

Body temperature is another common example of the negative feedback loop in homeostatic processes. In response to stimuli such as exposure to extreme cold, thermoreceptors in the body, including central thermoreceptors in the anterior hypothalamus, deep body thermoreceptors in the abdominal viscera and peripheral thermoreceptors in the skin, detect deviations from the set point range of 36.1C (97F) to 37.2C (99F) (Yousef et al 2023). The information is relayed to the control centre, where the anterior hypothalamus integrates the information, and the posterior hypothalamus signals effectors to action required changes to restore set point. In elevated temperatures above 37.2C (99F) dermal blood vessels are signalled to dilate and sweat glands to secrete, causing heat loss from the body to the environment. In the case of a drop in temperature, dermal blood vessels are signalled to constrict to preserve body heat, the thyroid gland is signalled to secrete thyroxin, which increases obligatory thermogenesis. In babies and young children, brown adipose tissue (BAT) is involved in thermogenesis, with infants exhibiting a higher percentage of BAT compared to adults. This type of thermogenesis, known as non-shivering thermogenesis, results in an increase in metabolic heat production beyond the basal metabolic rate, raising temperature without the involvement of muscle movement (Tews et al. 2022). Contrary to this, if further heat is required in older children and adults, skeletal muscles are signalled to shiver and promote thermogenesis (Brady 2021) (*Fig. 2*).



Stimulus causes temperature to change from set point range between 36.1C (97F) and 37.2C (99F)

Thermoreceptors in the skin and brain detect temperature above 37.2C (99F)

Hypothalamus processes information from receptors and signals dermal blood vessels to dilate and sweat glands to secrete using hormones and neural system

Dermal blood vessels dilate leading to heat loss to the environment. Sweat glands secrete more sweat, increasing rate of heat loss and bringing body temperature back to set point range.

Thermoreceptors in the skin and brain detect temperature below 36.1C (97F)

Hypothalamus processes information from receptors and signals dermal blood vessels to constrict, thyroid gland to secrete thyroxine and if needed, skeletal muscles to shiver

Dermal blood vessels constrict to preserve heat, an increase in thermogenesis is promoted by shivering and thyroxine secretion, bringing body temperature back to set point range

Fig. 2 *Temperature negative feedback loop in deviations*

Positive feedback loops: These are feedback loops which amplify deviations from set points. They are less common in maintaining stability but are used in specified homeostatic processes. Positive feedback loops include the processes in clotting where the initial response to injury is amplified to enable the formation of a clot to stop bleeding (Topaz 2018). Negative feedback loops are eventually used to stop the clotting and prevent health risks associated with clots in healthy vessels. Oxytocin release during childbirth leads to amplified production of oxytocin, which in turn amplifies uterine contractions until the child is delivered. In lactation, the child's suckling of breasts is detected by sensory receptors in the skin of the breast which send impulses to the hypothalamus. The hypothalamus then effects the pituitary gland to release more oxytocin *(Fig.3)* leading to more milk production (McCormack et al 2020).

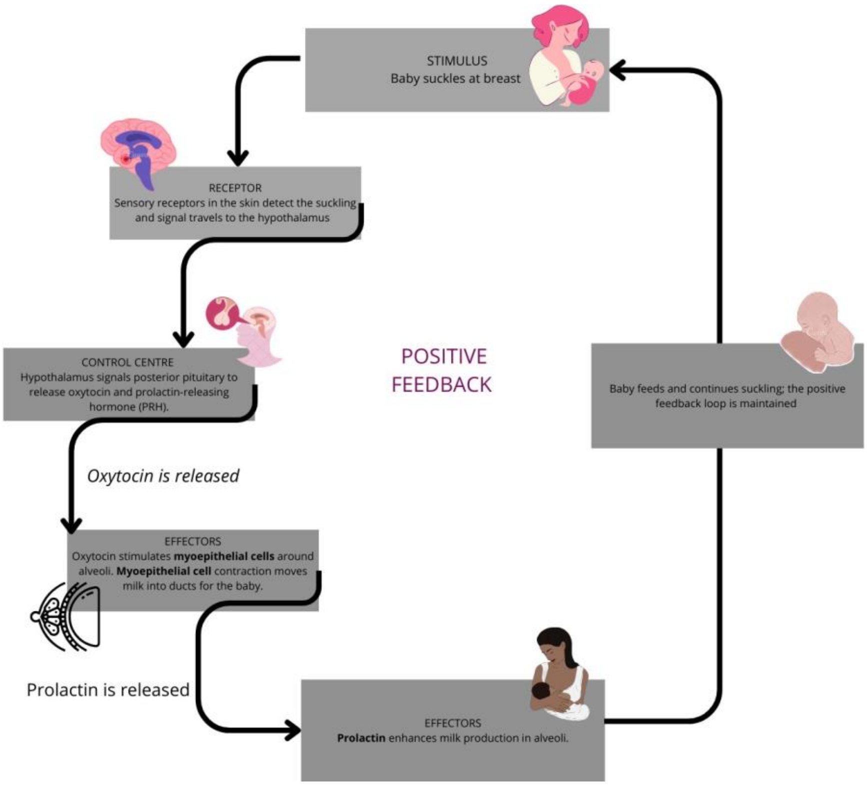


Fig. 3 *Oxytocin positive feedback loop*

Pancreatic regulation of glucose homeostasis is another example of the negative feedback loop: the pancreas, a vital organ in the endocrine system, which exhibits both endocrine and exocrine functionalities (Waugh and Grant 2018). Despite constituting only 1-2% of the pancreas, the endocrine component comprises specialised clusters known as the islets of Langerhans.

These islets house diverse hormone-producing cells, categorised as alpha, beta, delta, pancreatic polypeptide (PP), and epsilon cells, each responsible for distinct hormone secretion (Roder et al 2016, Aggarwal et al 2023;). These cells play a pivotal role in maintaining blood glucose levels, a critical aspect regulated within a narrow range of 4-7 mmol/Lt (NICE 2023). Key hormones involved include glucagon from the alpha cells and insulin from the beta cells. This delicate balance is achieved through the counteractive actions of glucagon and insulin, a phenomenon referred to as glucose homeostasis, primarily governed by a negative feedback mechanism. The diagrams provided below illustrate the pancreas's intricate involvement in stabilising blood glucose levels.

Low Blood Glucose Level (Hypoglycaemia)

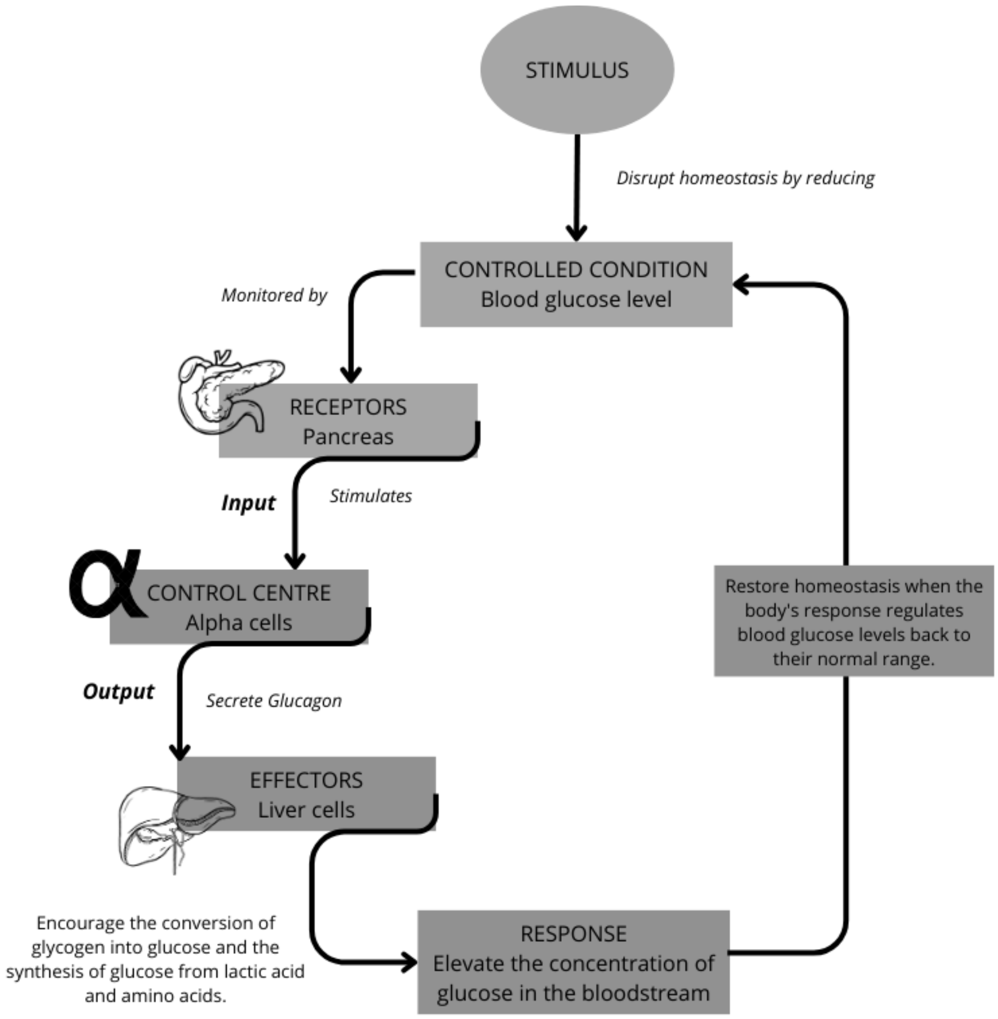


Fig. 4 Pancreatic regulation of glucose homeostasis (hypoglycaemia).

- When a stimulus causes blood glucose levels to drop from set point (hypoglycaemia), the alpha cells in the pancreatic islets increase the secretion of glucagon.
- Glucagon, in turn, prompts liver cells to speed up the breakdown of glycogen into glucose and the creation of glucose from lactic acid and specific amino acids.
- Consequently, the liver releases glucose into the bloodstream more rapidly, causing an increase in blood glucose levels and a return to set point.

High Blood Glucose Level (Hyperglycaemia)

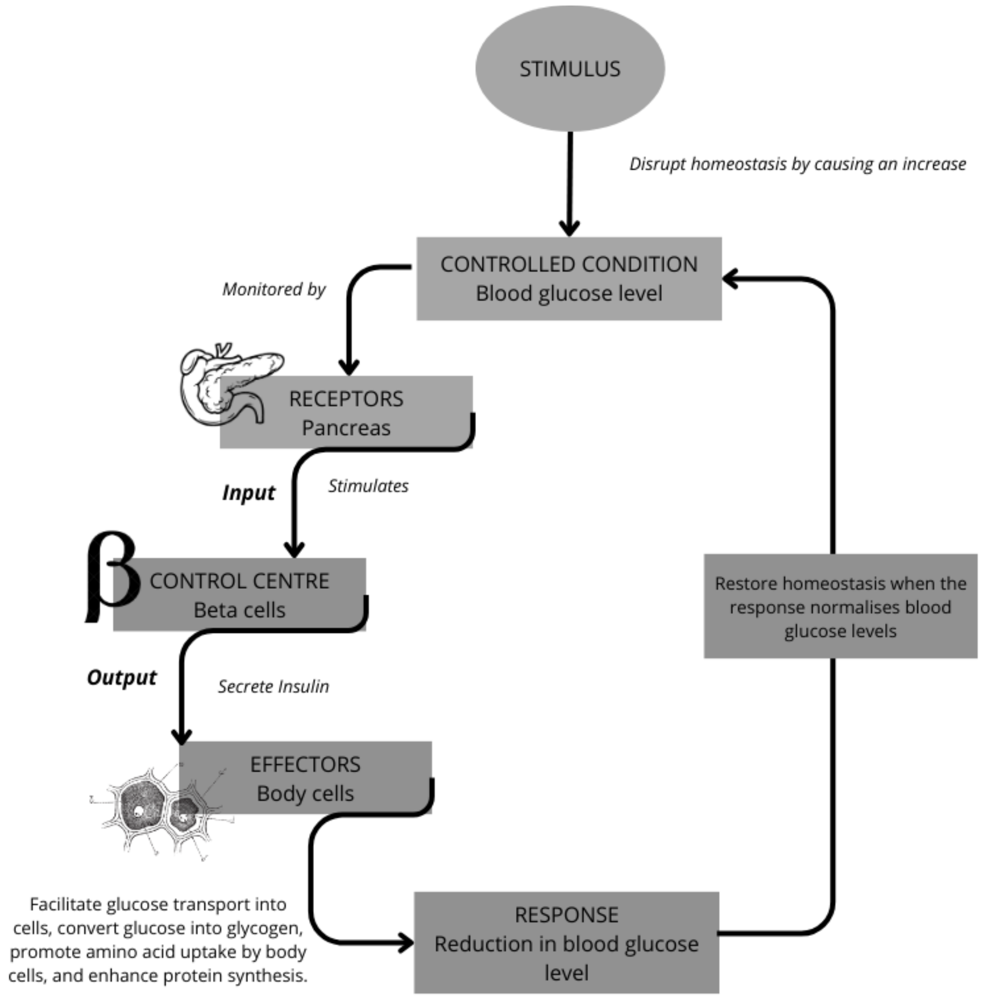


Fig. 5 Pancreatic regulation of glucose homeostasis (hyperglycaemia).

- When blood glucose levels rise (hyperglycaemia) the beta cells stimulate the release of insulin in the pancreatic islets.
- Insulin influences body cells by enhancing glucose uptake, accelerating glycogen synthesis from glucose, increasing amino acid uptake by cells for protein synthesis, and boosting fatty acid synthesis.
- As cells take in and utilize glucose, blood glucose levels decrease.

TIME OUT 2
Draw a figure of the feedback loop for the physiological variable of blood pressure in adolescent children, outlining activities which take place at each of the four cyclical stages discussed in this article.

Role of Endocrine and Nervous systems:

The endocrine and nervous systems are fundamental communication components which often work together to achieve homeostasis (Niedzwiecki and Kinn 2022), as demonstrated in pH, blood glucose and temperature regulation above. The nervous system's neurotransmitters and the endocrine system's hormones both play significant roles in detecting deviations from physiological variables' set points as receptors, and often in signalling deviations to the appropriate control centre. The control centres then use neurotransmitters or hormones in response, to communicate with effectors to return variables to set points, or in the case of positive feedback loops, to amplify the changes as required (McGloin and Skull 2022).

There are multiple internal and external stimuli that can disrupt the dynamic balances maintained within the body's internal environment (Torday 2015). Homeostasis exists to counteract the deviations from optimal conditions which may result from these disruptions. However, there are certain factors which can impact negatively on homeostasis processes, leading to dysregulation and disease.

TIME OUT 3
Discuss 2 physiological variables in which neonates and adolescents will differ in homestatic responses to stimuli.

Homeostasis clinical relevance, Dysregulation and Disease

As established in this article, a fundamental principle of homeostatic regulation is to govern the composition of the internal environment and sustain equilibrium. This is achieved using a multitude of physiological mechanisms that meticulously regulate physiological variables within narrow limits (Waugh and Grant 2018) such as in the illustrated examples. Although the body's homeostatic systems are both complex and effective, their ability to adjust to stress is limited. In instances where a system undergoes substantial change, especially if it occurs rapidly, the system’s capacity for adjustment may be exceeded, leading the system to move outside of its typical physiological range (Lasakosvitsch and Dos Anjos Garnes 2019). When the body cannot preserve an equilibrium among the critical variables, normal physiological functions are interrupted, laying the groundwork for disease development (Waugh and Grant 2018). Diseases can arise from various origins, categorised as intrinsic, extrinsic, or idiopathic. Intrinsic factors indicate that the root cause originates within the body, encompassing conditions like hereditary disorders or endocrine imbalances such as diabetes mellitus. On the other hand, extrinsic factors point to external sources as the trigger, including pathogens invading the body, chemical burns, or other identifiable external influences. Idiopathic causes, meanwhile, refer to those of unknown origin, adding complexity to the diagnostic process.

The more common factors disrupting homeostasis are rooted in:

- Genetic variations,
- Environmental influences,
- Diet and nutrition,
- Side effects of some medications
- Venoms and toxins
- Immune response mediators

Case Study

According to the 2021 study by Gregory et al (2022), approximately 8.4 million individuals worldwide are affected by type 1 diabetes (T1D). Among this population, 1.5 million are under 20 years old, 5.4 million falls within the 20–59 age bracket, and 1.6 million are 60 years or older. T1D is primarily triggered by an autoimmune assault on the pancreas's insulin-producing beta cells, resulting in a complete lack of insulin (NICE 2023). This deficiency disrupts the body's homeostasis, necessitating therapeutic interventions such as insulin administration to restore balance. Diagnosis of T1D mostly occurs among individuals aged 10 –14 years (NICE 2024).

Receiving a diagnosis of diabetes during adolescence represents a significant life-altering event that may lead to psychological distress (Christie and Martin 2021). Such distress can impede the adoption of essential self-management behaviours crucial for effective diabetes control. Younger teenagers, often focused on the immediate present, might disregard the long-term risks associated with diabetic complications (Christie and Martin 2021). The following case study presents a compelling case illustrating the critical consequences of uncontrolled diabetes.

TIME OUT 4
Identify 5 key actions that are undertaken in your role to ensure the provision of person centred holistic care for children who are newly diagnosed T1D.

Case study - Amara Das

Presenting complaint

A 15-year-old girl presents to paediatric Emergency Department. She is presenting with a 1-day history of abdominal pain and thirst, preceded by a few days of poor appetite, sore throat, stomach pain and vomiting. She has a past medical history of type 1 diabetes and reveals her blood sugar levels are erratic. On examination, she is found to be tachycardic, tachypnoeic, with a high capillary blood glucose and positive glucose and ketones in her urine.

Past Medical History

- T1D diagnosed at the age of 14 years
- Immunisations up to date
- No known allergies
- Current Medications:
    - Insulin detemir (Levemir) twice a day
    - Insulin aspart (NovoRapid) before meals
- Poor medication adherence (HbA1c 59 mmol/mol on admission)

Social History

Amara lives with mum and dad, and has a 3-year-old brother. After being diagnosed with T1D she developed psychological distress which deteriorated over the last 6 months, leading to poor management of blood sugar levels.

TIME OUT 5
Read current BSPED DKA Guidelines https://www.bsped.org.uk/media/1959/dka-guidelines.pdf and compare these with your organisation's polices and guidelines, taking notes of any local variations, considering the rationale for the variations.

Initial Assessment and ABCDE findings		**Management Plan: ABCDE**	**Rationale**
Airway	Patent	Ensure airway patency. Insert NGT if consciousness reduced or recurrent vomiting	ABCDE Approach is in line with Resuscitation Council UK (2021) guidelines to the care of all
Breathing	RR 28 SpO2 93% Mild Respiratory Distress	Give prescribed 100% Oxygen via face mask.	
Circulation	HR 110 BP 110/70 CRT 2 secs	Insert IV cannula and take blood samples (Full Blood Count (FBC), Urea & Electrolytes (U&Es), Arterial Blood Gases (ABGs), and Blood cultures.	

		✚ Cardiac monitor for T waves (peaked in hyperkalaemia) ✚ Administer IV fluids 10 ml/kg 0.9% sodium chloride bolus over 30 mins (BSPED, 2021).	deteriorating and critically unwell patients, to assess and treat the patient. Management plan is also based on BSPED (2021) and PEWS guidelines (NHS 2023).
Disability	✚ Alert (AVPU) ✚ BM 28.9 mmol/L	✚ Hourly monitoring of consciousness level including Glasgow Coma Scale (GCS) score	
Exposure	✚ Temp 37 ºC ✚ Intact skin ✚ Weight 47 Kg (most recent clinic weight)	✚ Monitor any temperature changes. ✚ Weigh the child if clinically indicated and if possible	
PEWScore (NHS 2023)	✚ 4 (Low)	✚ Registered professional to reassess within 60 mins	
ISBAR	✚ Care escalated to medical team and nurse in charge	✚ Request Medical Review by ST3+ or equivalent and inform nurse in charge	

Laboratory Results:

Full Blood Count (FBC)	Urea & Electrolytes (U&Es)	Arterial Blood Gases (ABGs)
WBC 20.0 x10^9/L (6-17)	Na 135 mmol/L (133-146)	pH 7.21 (7.35-7.45)
Hb 130 g/L (110-140)	K 5.0 mmol/L (3.5-5.5)	pCO2 5.0 (4.6-6.4)
Plt 350 x10^9/L (150-400)	Cl 99 mmol/L (95-106)	pO2 12 (11-15)
	HCO3 14 mEq/L (19-28)	HCO3 14 mEq/L (22-26)
	Urea 4.0 mmol/L (0.8-5.5)	Lactate 3 mmol/L (0.6-2.5)
	Cr 30 umol/L (13-39)	Potassium 5 mEq/L
	Glucose 28.9 mmol/L (3-6)	Bicarbonate HCO3 14 mEq/L
		BE -9.6 mEq/L
		Ketones 5 (blood beta-hydroxybutyrate)

Initial management (BSPED 2021)

According to BSPED (2021) DKA should be diagnosed in children and young people who exhibit:

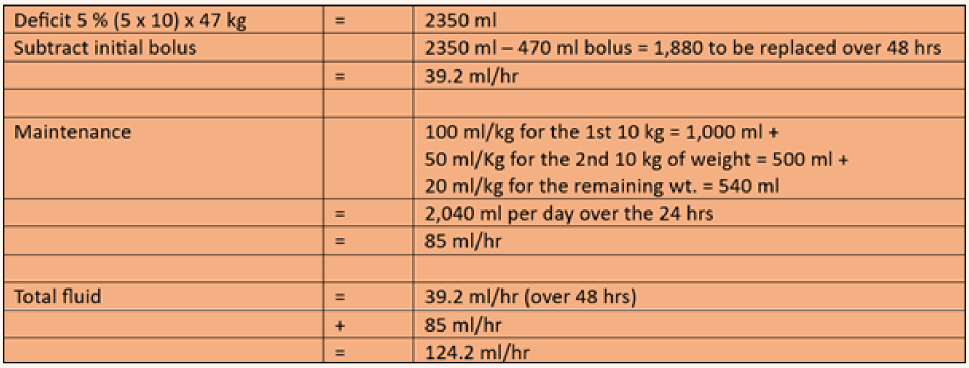
- Acidosis, indicated by a blood pH below 7.3 or plasma bicarbonate below 15 mmol/Litre
- Ketonaemia, indicated by blood beta-hydroxybutyrate above 3 mmol/Litre

Initial Fluid Bolus and Calculation:

- Administer an initial fluid bolus of 10ml/kg 0.9% sodium chloride as standard DKA management.
- Calculate fluid requirements using the formula:

REQUIREMENT = DEFICIT + MAINTENANCE

- *Assume a 5% fluid deficit in mild DKA cases in children and young people (pH 7.2-7.29 and/or bicarbonate <15), to be replaced over 48 hours.*
- *Calculate maintenance fluid volumes based on the Holliday–Segar formula, to be replaced over 24 hours.*



Deficit 5 % (5 x 10) x 47 kg	=	2350 ml
Subtract initial bolus		2350 ml – 470 ml bolus = 1,880 to be replaced over 48 hrs
	=	39.2 ml/hr
Maintenance		100 ml/kg for the 1st 10 kg = 1,000 ml + 50 ml/Kg for the 2nd 10 kg of weight = 500 ml + 20 ml/kg for the remaining wt. = 540 ml
	=	2,040 ml per day over the 24 hrs
	=	85 ml/hr
Total fluid	=	39.2 ml/hr (over 48 hrs)
	+	85 ml/hr
	=	124.2 ml/hr

Fluid and Medication Administration:

- Administer 0.9% sodium chloride with 20 mmol potassium chloride in 500 ml until blood glucose levels are below 14 mmol/L because hypokalaemia can occur up to 48 hrs after starting DKA management.
- Avoid oral fluids as there is risk of aspiration.
- Except for the initial bolus, ensure all fluids contain 40 mmol/L potassium chloride, unless renal failure is evident.
- Commence IV insulin infusion 1-2 hours after initiating fluid therapy. Use pre-filled syringes of 50 units of soluble insulin in 50 ml of 0.9% sodium chloride (if available). Recommended insulin rates are 0.05 Units/kg/hr to 0.1 Units/kg/hr. Cerebral oedema is more likely to occur if insulin is administered early.
-

Risk Management:

- Mitigate venous thrombosis risk because children with femoral lines inserted carry a higher risk of vein thrombosis. The line should remain in situ for the shortest possible duration (BSPED, 2021).
- Maintain strict fluid balance. Catheterisation may be useful in children with loss of consciousness and children who need close monitoring of fluids.

Monitoring Protocols:

- Conduct hourly blood glucose measurements to monitor for hyperglycaemia, which should decrease.
- Assess capillary blood ketone levels every 1-2 hours for return to blood ketone target level of <3 mmol/L
- Perform observations, including neurological observations, every half-hour as DKA can cause reduce consciousness level and cause cerebral oedema.
- Promptly report symptoms of confusion, headache, or any changes in the ECG.
- Monitor patient weight twice daily as fluid management is based on the patient's weight and must be precise.
- Conduct medical reviews every 2 hours to detect any deterioration.
- Keep a vigilant watch for complications, such as cerebral oedema, hypoglycaemia, hypokalaemia, systemic infections, aspiration pneumonia, and sepsis to prevent further complications.

Family Communication:

- Consistently inform and update family members regarding the patient's condition and progress.

Transitioning Care

- Cease IV fluids once ketosis is resolving, and oral fluids are well tolerated.
- Initiate subcutaneous insulin administration at least 30 minutes before discontinuing the IV insulin infusion, following local protocol.

Post-recovery education and support

- Investigate the contributing factors to the DKA incident involving Amara and her family members (BSPED 2021).
- Evaluate mental well-being and consider referral to a psychologist for additional support (Edge 2015).
- Offer comprehensive emotional support throughout the recovery process.
- Enhance support by gaining a deeper understanding of the impact of Type 1 Diabetes on Amara and her family (Robinson 2015).
- Assess Amara's willingness to adhere to self-management interventions, emphasizing a family-centred approach (Edge 2015).
- Arrange a referral to the Diabetes team for further education and ongoing follow-up.
- Encourage adherence to the prescribed insulin protocol to promote treatment concordance.

Table 2 - Amara's Care Plan

Care Plan

The clinicians involved in Amara's care acknowledge the intricate nature of managing Diabetic Ketoacidosis (DKA) and underscore the significance of family-centred care (Campbell et al 2023). Recognising the initial signs and symptoms presented by patients during the onset of DKA is pivotal, potentially reducing the incidence of severe ketoacidosis in children and adolescents (Segerer et al 2021). Predominant symptoms include vomiting, abdominal pain, and respiratory distress (Rahak et al 2023).

This scenario highlights the considerable challenges involved in managing T1D during adolescence and the potential for significant consequences. Maintaining blood glucose levels within the normal set point range demands a stringent regimen encompassing blood glucose monitoring, insulin delivery, as well as dietary and activity control according to clinicians' protocol. Effective T1D management is critical to prevent both immediate and long-term health complications (Gormley-Fleming and Peate 2019; Disla et al 2023). Healthcare professionals wield considerable influence over Amara's adjustment to diabetes by providing robust support and encouraging her adherence to the daily self-care tasks essential for adopting a healthy lifestyle (Robinsons 2015). There must be parity between the physiological and mental health integrated care provided for Amara and her family on account of the emotional challenges of long-term conditions such as T1D diagnosis in young people.

TIME OUT 6

Ella Frank is a 6 year old who has been brought by her mother into the area you work. On initial assessment, her temperature is 39.2°C. Design a person centred holistic care plan for Ella, and reflect on how the care plan is influenced by your understanding of homeostasis in children.

Conclusion

This article illustrates the importance of homeostasis as a fundamental survival process used by organisms such as the human body in the effort to regulate and govern the composition of their internal environment and maintain equilibrium. Components of homeostasis evidenced in positive and negative feedback loop mechanisms have been explored with examples and illustrations displaying the complexities of how critical physiological variables' normal levels are maintained through the homeostatic processes. The essential roles played by the endocrine and nervous systems in maintaining homeostatic processes have been highlighted with illustrative examples.

Using a DKA case study, the clinical relevance of understanding the dynamic process of homeostasis has been established. This highlighted the importance of healthcare workers' understanding of the mechanisms of homeostatic processes, so as to understand disease and dysregulation and provide tailored holistic care plans which achieve better outcomes for patients. The importance of integrated care encompassing parity between physiological and mental health needs in children diagnosed with long-term conditions such as T1D has also been highlighted.

Key Points:

- The relevance of the homeostasis concept is an established feature of clinical practice that healthcare workers must understand.
- Comprehending the concept of homeostasis allows healthcare workers to grasp the knowledge of most disease and dysregulation processes and consequently create tailored care plans.
- Understanding of disease and dysregulation enables healthcare workers to appropriately support patients in managing their needs, e.g. in DKA management.

TIME OUT 7
Identify how understanding the clinical relevance of homeostasis applies to your practice and the requirements of your regulatory body.

TIME OUT 8
Now that you have completed the article, reflect on your practice in this area and consider writing a reflective account.

Conflict of interest

None declared.

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