"...He Suddenly Collapses"

Case 1, Year 1

Key Concepts

- Body fluids, fluid balance and dehydration.
- Factors affecting body fluid homeostasis.
- Heat production and heat loss.
- First aid (ambulance service).
- Intravenous fluid therapy, osmolality.
- Syncope.
- Resilience and coping with stress.

Trigger

(40 Minutes)

Reda Shehry, an 18-year-old first- year Dentistry student at a university in Riyadh, decides to participate in a state race organised by the university students' union. It is only the second week in his course and he feels stressed. Also he is a little worried being away from his family in Medina. It is midmorning, very hot and Reda is sweating a lot during the race. About 50 minutes into the race, he suddenly collapses.

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Facilitation Questions

- Do you like sports? What do you like?
- Have you ever been in a cross country race?
- Did you face any challenges as you move to the university system? What are these challenges?

- What causes him to sweat a lot?
  - Hot weather.
  - Increased heat production by exercising muscles.
  - Decreased evaporation because of humidity

- What do we lose in sweat?
  - Water +++
  - Electrolytes such as: Na+, K+

Hypotheses

1. Stress/worried

1. **Personal factors**

- Coping skills
- Adaptation skills
- Financial problems
- Type-A personality

2. **Family**

- Missing family members, friends
- Family problems

3. **Environmental factors**

- University (course design, lack of support)
- Different from high school to university
- Moving to another state (different life style, unable to have new friends)

4. **Activities**

- Doesn't like sport
- Not happy with course

Hypotheses

2. Sweating a lot

- Very hot environment
- Exercise
- muscle activity
- Sympathetic overactivity
- Decreased evaporation
- Increased humidity.

Further Questions

(History is given via a close friend)

- Any illnesses in the morning before the race.
- Is there anything worrying him?
- Any past history of illness or hospital admission
- Prior experiences in this sport.
- Any past history of loss of consciousness? Situation

Progress 1

The manager of the event immediately calls an ambulance. Reda is transported to the nearest hospital. On his way to the hospital, he becomes conscious and aware of the surroundings.

Reda has always been healthy. He gives no prior history of hospital admission. This is his first time to take part in such a race.. He has been motivated by his roommates to join in the race and participate in sport activities. The night before the race, he felt a little unwell. The morning of the race, he felt no appetite for food.

He feels unable to adjust to the course and some of the subjects are new to him. Although he calls his family from time to time, he misses a lot his mother and his friends in Medina.

On the day of the race, the weather is too hot and humid and Reda has no prior experience of a long-distance running in such weather.

About 50 minutes into the race, he feels a little dizzy and vomits twice. He wants to stop but he forces himself.

New Terms

- **Dizzy**: *a sense of rotation, a sense that surroundings are moving.*
- **Roommate**: *A person or a friend who shares a room or residence.*
- **Vomit:** *to disgorge the contents of the stomach through the mouth.*

Ranking Hypotheses

2. Sweating a lot

- Very hot environment +++
- Exercise +++
- muscle activity +++
- Sympathetic overactivity ++
- Decrease evaporation +++
- Increase humidity.+++

3. Collapses suddenly

- Heart problem (0)
- Heat exhaustion ++
- Hypoglycemia ?++
- Decreased blood flow to the brain ++
- Fall/trip (0)
- Simple fainting +/+++

Discussion Questions?

- Have you ever fainted?

- What was the situation?

- Sight of blood
- Seeing a dead body
- Injection/pain
- Anxiety/fear

- Vomiting

- What do you think is the common link between those reasons and faint?

Simple faint –

Most likely due to vagus nerve stimulation (vasovagal syncope).

Further Questions

- Check his vital signs such as blood pressure, pulse rate, body temperature and respiratory rate.
- Check his state of hydration (if he has lost too many fluids in sweat): dry tongue and skin lost its elasticity.
- Examine his heart and lungs and the nervous system to detect any abnormalities.

Progress 2

In the hospital, the registrar takes the history and examines him. The doctor finds nothing abnormal except that Reda is dehydrated.

He continues the intravenous fluid (5% dextrose and 0.9 Sodium Chloride, see image below) which was commenced in the ambulance. He advises him to drink more fluid. The doctor tells Reda that exercising in a hot and humid environment, loss of fluid because of excessive sweating, and a lack of experience in exercising together with his emotional stress might have contributed to his faint (a temporary decrease in blood flow to the brain). His emotional stress and vomiting might have contributed by vagus nerve stimulation resulting in a temporary decrease in heart rate (vasovagal syncope).

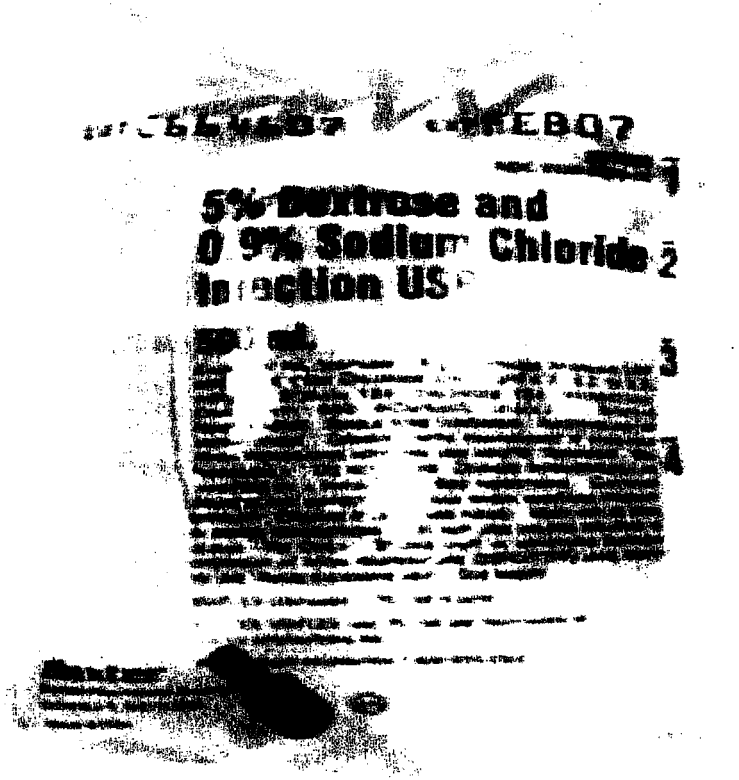

Image sources: www.calculated-success.org/images/beginning5.jpg

Learning Issues

Please Read the Progress

"My mouth is dry"

PBL Case 2, Foundation Block
Year 1

Learning Objectives:

This PBL Package targets the following objectives:

- Discuss the main differences between the sympathetic and parasympathetic nervous systems.
- Explain the scientific basis behind the presenting problems in the case.
- Discuss the roles of the sympathetic and parasympathetic systems in controlling body organ systems.
- Discuss the roles of the adrenal gland in enhancing the sympathetic nervous system.
- Discuss the mechanisms controlling the secretion of sweat and saliva and the role of the autonomic nervous system.
- Discuss the use of relaxation therapy in enhancing the parasympathetic nervous system and attenuating the sympathetic responses.
- Discuss relationships in family and impact on health.

Discussion Questions:

- Are there any difficult words you do not understand?
- List the key information about Sarah.
- Identify Sarah's presenting problems (after hearing the noise).
- For each problem make a list of how it may be caused (generate hypotheses).
- What further information would you like to know to help you differentiate between your hypotheses? (What questions would you like to ask Sarah?)

Hypotheses

Dry mouth:

- Environment is too hot.
- Did not drink for a few hours.
- Has a fever
- Anxiety/fear.
- Problems with her salivary glands.

Shaking hands:

- Anxiety.
- Fears/worries.
- Becoming nervous.
- Increased nerve stimulation to the hands/arms muscles.
- Panic attacks (e.g., increased sympathetic activity).
- Drugs: e.g., sympathomimetics.

Hypotheses

Dry mouth:

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Facilitation Questions

What are the structures and functions needed so that our mouths are not dry?

- *Normal body temperature.*
- *Drinking enough water.*
- *Normal salivary gland.*
- *Normal salivary duct.*
- *No inflammation or infection in mouth, gums, etc.*
- *Normal fluid loss (e.g., no excessive sweating, diarrhoea)*
- *Environment not hot.*
- *No general illness.*
- *No over stimulation of sympathetic*

Facilitation Questions

What do you usually experience in such situations?

- *Increased heart rate.*
- *Sweating a lot.*
- *Dry mouth.*
- *Shaking hands.*
- *Cold hands.*
- *Lack of a desire to eat.*

Please Read
The Progress

Progress 1 (continue)

She remembers similar experience of dry mouth, sweating and loud heart beats when she exercises at school. Also she experienced similar changes when the neighbor's dog attacked her a few months ago.

Luckily, her father returns home earlier. He finds her in tears. She later learns that the crashing noise coming from her room was caused by a broken glass cup; her cat jumped in the darkness over a desk and crashed few things.

New Terms

New problems:

- Sarah is worried/afraid
- Her grandmother died last year after a brief illness.

Original problems:

- Dry mouth.
- Shaking hands.
- Rapid heart.
- Desire to cry/fear

Discussion Questions

What are the causes of her worries?

- Sudden illness of her grandfather.
- She is alone at home and it is too dark.
- The noise that she heard coming from her room.
- Her mother did not ring or contact.
- She watched a scary film, added to her fears.
- Her grandmother died after a brief illness.
- She does not want her grandfather to die.

Discussion Questions?

Which body system is stimulated in these situations?

The nervous system, particularly the sympathetic nervous system (a component of the autonomic nervous system).

Do you think the nervous system does play a role? How?

Yes, through the autonomic nervous system.

Learning Issues

Discussion Questions

- What other changes could have happened in Sarah's body other than those mentioned in the case scenario?

- What chemicals/hormones are expected to be raised in Sarah's blood when she was frightened? Explain their roles.

Facilitation Questions

What are the scientific bases behind relaxation therapy?

1. Inhibition of the sympathetic nervous system
2. Stimulation of the parasympathetic nervous system.

What is the role of the hypothalamus in regulating the functions of the autonomic nervous system?

How would you explain the improvement of Sarah's grandfather?

The relaxation therapy + the medications for anxiety helped in the stimulation of the parasympathetic nervous system (feels better, no anxiety and good sleep at night).

Please Read Progress 2

Possible Students' Responses

Discussion Questions

- Are there any terms that you do not understand?
- Summarise the key information that you have obtained from this progress.
- How would you explain the improvement in Sarah's grandfather pulse and respiratory rates?
- What are the possible mechanisms by which a relaxation therapy has helped Sarah's grandfather and reduced his anxiety?

Interpretation

- Pulse rate and respiratory rate are back to normal.
- Decreased sympathetic stimulation.
- Increased parasympathetic stimulation.

"...I love my roller-skiing"

Case 3, Year 1

Learning Objectives:

This PBL package (Tutorials One and Two) targets the following objectives:

- Discuss the anatomy of the lower limb with particular emphasis on the tibia, fibula, and the ankle joint.
- Discuss the general principles about inflammation and the pathogenesis of infection.
- Discuss the role of body defence mechanisms in protecting the body.
- Discuss the microbiology and pathogenesis of osteomyelitis.
- Understand the role of investigations in finding out the cause and site of infection.

Discussion Questions:

- Are there any difficult words you do not understand?
- List the key information about Ali.
- Identify Ali's presenting problems.
- For each problem make a list of how it may be caused (generate hypotheses).
- What further information would you like to know to help you differentiate between your hypotheses? (What questions would you like to ask Ali and his mother?)

New Terms

Limp: a type of asymmetric abnormality of the gait. Limping may be caused by pain, weakness, neuromuscular imbalance, or a skeletal deformity. The most common underlying cause of a painful limp is physical trauma however in the absence of trauma other causes should be explored.

Hypotheses

2. Fever

- Systemic infection (bacterial, viral, parasitic)
- Heat exhaustion.
- Heat stroke.
- Increased heat production and decreased heat loss.
- Excessive secretion of thyroxin.
- Increased catabolism.
- Cancer.

Facilitation Questions

Normally we walk without a limp, what are the anatomical structures and functions do we need?

- Normal skin and subcutaneous tissue.
- Normal skeletal muscles.
- Normal bones (Axial, pelvis, and lower limbs).
- Normal joints.
- Normal nerves/normal connections.
- Normal arterial blood supply.
- Normal venous drainage.
- Normal lymph and lymphatics.

Facilitation Questions

Normally we have a normal body temperature, what are the anatomical structures and functions do we need to maintain a normal body temperature?

- Normal skin (including normal sweat glands).
- Normal autonomic nervous system and nervous connections.
- Normal hypothalamus.
- Normal blood volume.
- Normal muscle functions.
- Normal metabolism and normal metabolic processes.
- Normal hormones.
- Reasonable environmental temperature/humidity.
- No infections.
- No cancer.
- No toxins.

Further Questions

- Any history of trauma to his left leg?
- Any history of joint problem?
- Any history of prolonged exposure to sun? Exercising in sun?
- Any history of heart or lung problems?
- Any history of problems at school? Any problems at home?
- Any history of congenital disorders or problems after birth?
- Any history of hospital admission or similar disorders?

History

Two days ago , Ali's mother noticed that Ali walks with a limp particularly when he puts his weight bearing on the left leg. She also noticed that the skin covering the lower part of his left leg is reddish in color and swollen. She adds, "Ali jumped when I tried to touch his left leg ". Ali cannot remember if he had a fall or if he had hit his leg. His mother adds, " Yesterday , Ali did not go to school and stayed in bed most of the day. He did not finish his lunch and went to bed without dinner. This is not usual for him. I took his temperature and it was 38.5 °C. I gave him two spoonful of Panadol syrup but did not help his fever. He was feverish and sweating at night and this morning."

On further questions from Dr Mona, his mother says, "Ali likes his roller-skiing a lot. His father bought it as a gift last year and since then Ali practices daily around the house, in the backyard and whenever we go shopping in a Mall". His mother remembers that he fell about 2-3 weeks and had a small wound over his right elbow. Ali has no sore throat, cough, diarrhoea or pain on passing urine.

New Words/Terms

- **Weight-bearing:**
- **Roller-skiing:.**
- **Panadol:**

Ranking Hypotheses

1. **A limp**

- Joint problems e.g., hip, knee, ankle +/++.
- Nerve problem e.g., nerve injury, nerve inflammation)/+.
- Muscle problem e.g., muscle tear, muscle inflammation, myopathy, etc +/++.
- Skin/subcutaneous (foot) infection, inflammation. ++/+++
- Ligament tear/injury. +
- Arterial insufficiency. +/0
- Bone fracture (tibia, fibula, femur). +/+++
- Venous disease e.g., deep venous thrombosis. 0/++
- Bone tumour. +/+++
- Bone infection.+/+++
- Haematoma (collection of blood). +

Hypotheses

3. Not feeling well:

- Did not sleep well. /o
- Because of fever/infection.++/+++
- Depressed. /o
- Problems at home./o
- Problems at school./o
- Low blood glucose./+
- Anaemia?
- Cancer. ?
- Pain./++
- Heart/lung/liver/kidney problems./?/o

Clinical Examination

Clinical Examination

Ali looks unwell. He has limp on walking. His vital signs are summarized in the table below:

Vital signs	Ali	Normal range
Pulse rate	100	75-110 /min
Blood pressure	110/70	80-110/60-75 mmHg
Temperature	38.8 °C	36.6-37.2 °C
Respiratory rate	23	16-22/min

Discussion Questions

- List the key information in this progress.
- Identify any new problems and add to your list.
- For each new problem make a list of how it may be caused (generate hypotheses).
- What are your learning issues?

Hypotheses

2. Fever

- Systemic infection (bacterial, viral, parasitic) +++/++
- Heat exhaustion. o/o
- Heat stroke. o/o
- Increased heat production and decreased heat loss. +/++
- Excessive secretion of thyroxin. o/o
- Increased catabolism.+/o
- Cancer. o/++

Refining Hypotheses

Most likely:

The presence of systemic symptoms such as fever, sweating, loss of appetite, not feeling well together with local inflammatory changes in the lower part of his left leg suggests the presence of infection (bone) or cancer.

Less likely:

- Bone fracture.
- Haematoma.
- Muscle tear.
- Family problem/school problem.
- Joint problem.
- Nerve injury.
- Deep venous thrombosis.
- Arterial insufficiency.

Learning Issues

- What are the possible causes for his red, and swollen lower limb? What are the underlying mechanisms?
- What is inflammation? What is the pathogenesis of inflammation?
- How does the body respond to infection?
- What are the mechanisms underlying the development of fever?
- What are the main anatomical structures of the lower part of the leg?
- How can microbes enter our bodies? Discuss possible ways.

TUTORIAL TWO

Students will discuss their learning issues for 50 minutes. Then:

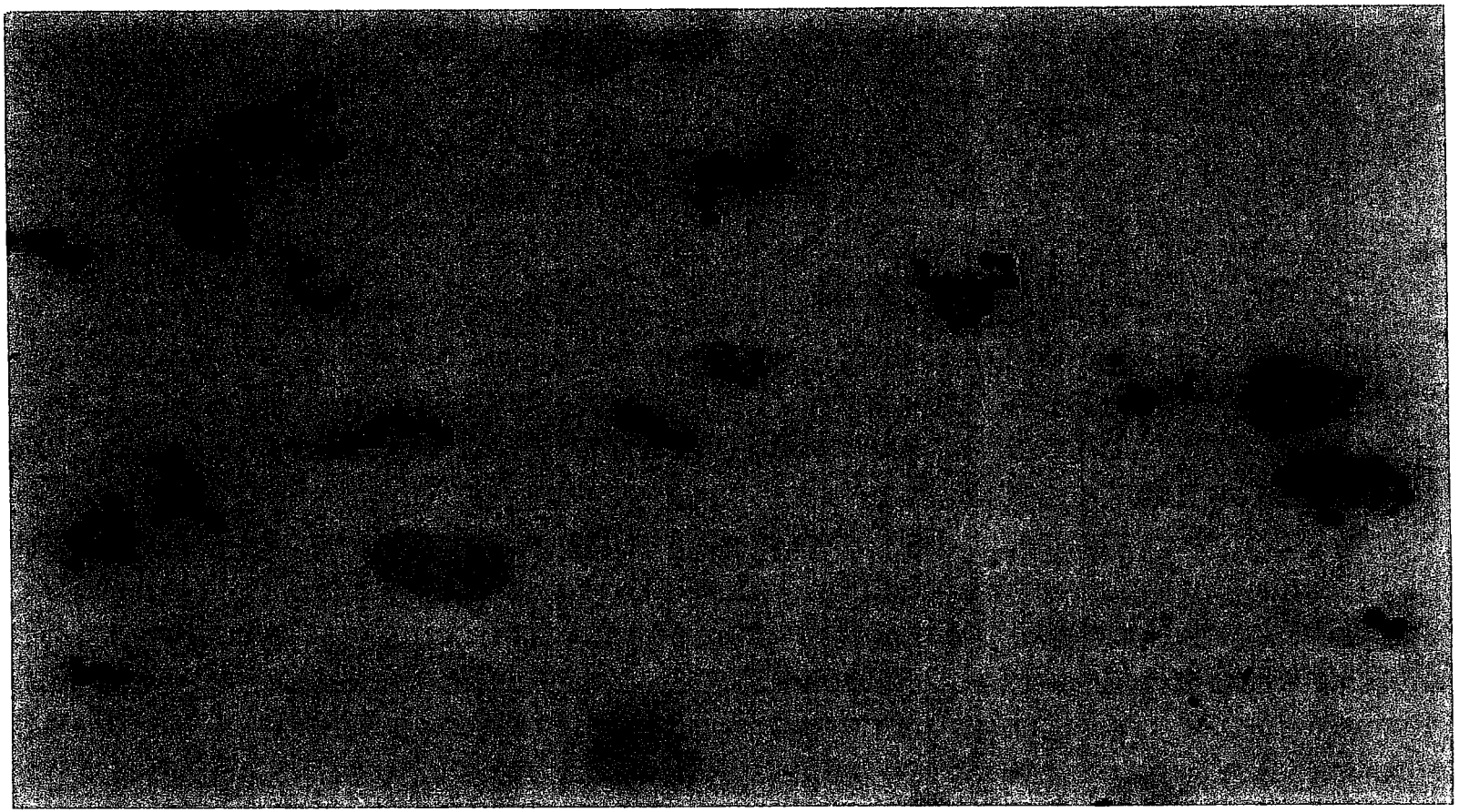
- What does inflammation mean? What are the main causes of inflammation? Discuss the mechanisms underlying acute inflammation.
- What is your refined hypothesis? Justify your view.
- If Ali's problem is caused by an infection. Discuss the pathogenesis of his infection.

Progress 1

Dr. Mona explains to Ali's mother, that the clinical examination raises the possibility that Ali has an infection in one of the bones of his leg (called tibia) and surrounding soft tissue, just above the ankle joint. Dr Mona adds, the presence of fever, sweating, and poor appetite, together with the presence of a swollen, red and painful area of the lower part of his left leg supports the presence of infection. Also the enlarged, painful lymph nodes on his left inguinal region are also in support of infection. The plain X-ray shows no abnormality and no fractures. This excludes bone fracture as a cause for Ali's presentation. An X-ray usually do not reveal the infection of the bone early in the disease process, we might need to do another imaging technique called MRI scan to confirm the presence of bone infection. Therefore, we need to admit Ali to the hospital for further investigations (blood tests and MRI scan) and treatment.

The results of Ali's tests are shown below:

Blood Culture



Blood culture report: Gram-positive cocci are present in clusters.

Discussion Questions

- Are there any terms that you do not understand?
- Summarise the key information that you have obtained from this progress.
- Use the results of these investigations to refine your hypothesis.
- Why do we need a blood culture in Ali's case?
- How would you explain the failure of an early plain X-ray to show the bone infection? What are the main differences between an MRI scan and a plain X-ray?
- What are your management goals and management options?

New Words/Terms

(Oxford Concise Colour Medical Dictionary)

Complete Blood Count – A count performed as a diagnostic laboratory test, indicating the red blood cell count and the white blood cell count in one microliter of whole blood and other quantitative information about blood composition, such as cell volume, hematocrit, and hemoglobin content. This information is used in the diagnosis of anemia, infections, and other medical disorders

ESR- the rate at which red blood cells (erythrocytes) settle out of suspension in blood plasma, measured under standardized conditions. The ESR increase if the level of certain proteins in the plasma rises, as in rheumatic disease, chronic disease, and malignant disease, and thus provides a simple but valuable screening test for these conditions.

New Words/Terms

(Oxford Concise Colour Medical Dictionary)

MRI – a diagnostic imaging technique based on the emission of electromagnetic wave from the body when the patient is placed in a strong magnetic field and exposed to radiofrequency radiation. Most images rely on the signal from hydrogen in water, which is particularly strong, although other elements can be used. A major advantage over computerized tomography is the lack of X-rays, which reduces exposure to ionizing radiation. MRI is used for the noninvasive diagnosis and treatment planning of a wide range of disease and also to guide interventional radiological procedures.

Gram- Positive bacteria- Bacteria that are stained dark blue or violet by gram staining, in contrast to gram-negative bacteria, which are not affected by the stain. The stain is caused by a high amount of peptidoglycan in the cell wall, which typically, but not always lacks the secondary membrane and lipopolysaccharide layer found in Gram-negative bacteria.

Please Read the Closure

Case Closure

Dr Mona commences Ali on an intravenous antibiotic called Cloxacillin. It is given every 6 hours. She explains the results of investigations to Ali's parents. She says, "the MRI scan and the blood culture results support the diagnosis of osteomyelitis (bone infection) and the blood culture helped us in identifying the type of bacteria causing the infection. The organism is a Gram-positive bacteria known as *Staphylococcus aureus*. Such bacteria can enter our body via skin wounds. It is possible that when Ali hurt his elbow, a few weeks ago, this type of bacteria which is normally present on the skin, entered his body and then reached the blood stream and finally settled in his tibia. We do not know why bacteria choose a particular area to settle in but this depends on many factors including our body defence mechanisms.