

# Module B

## Treating Diabetes

### 4 Hyperglycaemia

# Learning aims

Be alert to the signs and symptoms of hyperglycaemia in older residents

Be able to decide if hyperglycaemia is present based on measured glucose values

To be aware of the consequences of untreated hyperglycaemia

# Definition of normal and hyperglycaemic glucose values

- ⊙ Normal (non-diabetic) non-fasting glucose levels in younger individuals are: 4.0 – 5.9 mmol/l (pre-prandial) and under 7.8 mmol/l (after about 90-120 minutes after a meal (post-prandial))
- ⊙ Hyperglycaemia is the medical term for a blood glucose (sugar) level that is higher than normal.
- ⊙ While *severe* hyperglycaemia can be life threatening, *minor* degrees of hyperglycaemia are very common among people with diabetes on a day-to-day basis. There is no clear cut off that defines severe hyperglycaemia although levels greater than 15 mmol/l should always require closer attention by care staff.



# Importance of monitoring and recording meal times

- ① Blood glucose levels are normally maintained within a tight range in people who do not have diabetes.
- ① In residents with diabetes, it is important to check glucose levels regularly and to monitor glucose levels over time to see if they are rising. *If so treatment can be given before people experience the symptoms of hyperglycaemia.*
- ① Blood glucose levels tend to rise and fall in relation to meals – *so it is important to record the time of blood glucose monitoring and its relation to meal times.*

## Further definitions - blood glucose concentrations

- ① **Fasting blood glucose concentration** – this refers to blood glucose measured after an overnight fast, of at least 8 hours, i.e. no oral intake of any carbohydrate containing meals or liquids, and no intravenous infusions containing glucose.
- ① **Post-meal glucose concentration** – also known as post-prandial glucose concentration. Levels tend to be higher after a meal because carbohydrate from the diet is absorbed from the gut. The usual time to check blood glucose is 2 hours after a meal.



# Important points about glucose levels

- ⊙ Note that normal glucose levels should be distinguished from *target* concentrations and 'cut-off' values for diabetes and pre-diabetes.
- ⊙ When managing diabetes it is sometimes not feasible to aim for blood glucose levels that are within the normal range.
- ⊙ Over-treatment always carries the risk of **hypoglycaemia** (<4.0 mmol/l, low blood sugar) that can cause symptoms including shakiness, confusion, and loss of consciousness.
- ⊙ **Hypoglycaemia** increases the risk of falls and other adverse events and it is important to maintain a degree of compromise.

# Further points

- ① For example, it would not be so unusual to see the postprandial (post-meal) target set at 10-12 mmol/L in moderate-severe frail or disabled residents – *individual circumstances will determine these values that are set.*
- ① Thus, the most appropriate upper limit of blood glucose will vary from one resident to another according to his/her functional health status, frailty status, other comorbidities, as well as the agreed aims of care.
- ① Setting aims of care should be a joint decision between the resident (plus or minus the family or carer) and the care staff
- ① For all residents with diabetes, minimising any unpleasant symptoms of hyperglycaemia is an important objective when setting blood glucose targets.

# Symptoms and signs - general

- 🎯 Hyperglycaemia is responsible for the classic symptoms of uncontrolled diabetes:
- thirst
  - polyuria (excessive urination)
  - unintentional weight loss.





# Osmotic symptoms and signs

- ① These are the so-called 'osmotic' symptoms resulting from the production of high volumes of urine (polyuria), that is loaded with glucose.
- ① Polyuria may manifest itself as urinary incontinence or nocturia (the need to wake and pass urine at night).
- ① Normal levels of glucose are filtered and then reabsorbed by the kidneys
- ① When levels of glucose in the blood are high (above the 'renal threshold for reabsorption'), glucose starts to appear in the urine in measurable amounts. Water is lost along with the glucose in the urine, which in turn stimulates thirst and contributes to weight loss.

# Further symptoms and signs

- ◎ However, it is important to understand that high blood glucose concentrations do not always cause typical osmotic symptoms.
- ◎ Some residents, who have high blood glucose levels, may tolerate these without needing to urinate frequently (and so don't feel thirsty).
- ◎ This phenomenon can occur in people of any age, and some residents may not recognise these typical symptoms and yet have a high blood glucose.



# More on symptoms and signs

- ◎ Therefore, do not rely on the presence or absence of symptoms of hyperglycaemia especially in older people.
- ◎ In certain circumstances, for example, during illness, severe hyperglycaemia may develop ***within hours***, before any symptoms are apparent.



## Effect of SGLT-2 inhibitors

- ① It is also important to recognise that certain glucose lowering medications (the sodium glucose co-transporter 2 (SGLT-2 inhibitor) class of glucose-lowering drugs, for example, dapagliflozin, canagliflozin) act by directly increasing urinary glucose losses.
- ① Thus, the presence of glucose in the urine of a resident receiving one of these drugs is not a reliable guide to blood glucose levels.

# Age effects - symptoms and signs

- ◎ Furthermore, people may experience thirst less as they get older. Residents in care homes may not be able to access drinks without assistance and may have communication difficulties which make this harder.
- ◎ Residents may easily become dehydrated if fluid lost in urine is not matched by drinking more. Confusion or impaired consciousness may be the first signs of dehydration.



# Dehydration

- ① Low blood pressure, or a fall in blood pressure on standing (postural hypotension) and an increased heart rate (tachycardia) are other signs of dehydration.
- ① A very dehydrated state with high blood glucose levels (more than 30 mmol/L) can lead to kidney failure.



# Life-threatening Hyperglycaemic States

🎯 The development of the following two conditions should be treated as medical emergencies:

- (1) Hyperosmolar hyperglycaemia state (HHS)**, which may eventually cause drowsiness, severe dehydration and even coma. It is easy to misdiagnose this condition as a stroke. This condition used to be called hyperosmolar nonketotic coma.
- (2) Diabetic Ketoacidosis (DKA)**, which can occur in those with type 1 diabetes (and in cases of type 2 diabetes) and may be accompanied by a build-up of keto-acids (ketones) in the blood.



# Hyperosmolar hyperglycaemia state (HHS)

- ◎ **Hyperosmolar Hyperglycaemic State (HHS)** is a dangerous medical condition that occurs in people with type 2 diabetes.
- ◎ It is associated with very high circulating levels of blood glucose levels (often over 30mmol/l) without significant ketones.
- ◎ Many underlying factors may increase the risk of HHS developing such as infection (e.g. covid-19), diuretic overuse leading to dehydration, or it can be precipitated by a heart attack (myocardial infarction) or a stroke.
- ◎ **Urgent hospital admission is required** - liaise with your Manager and call for immediate medical assistance (GP or ambulance service) as the associated mortality can be high if not recognised and treated early



# Diabetic Ketacidosis (DKA)

- ⊙ Although less common in older people with diabetes (type 1 or type 2), DKA can be a serious illness when it occurs.
- ⊙ The key biochemical features of DKA are: hyperglycaemia, high levels of ketones in blood/urine, and blood acidosis.
- ⊙ **Symptoms and signs include:** rapid and deep breathing (called Kussmaul-Kien breathing), dehydration, abdominal pain, change in mental status (confusion or disorientation), polyuria, etc.
- ⊙ In **Covid-19 positive** residents with diabetes, stop SGLT-2 therapy if resident is taking this to lessen risk of dehydration and DKA
- ⊙ **Urgent hospital admission is required:** liaise with your Manager and call for immediate medical assistance (GP or ambulance service) as, similarly to HHS, the associated mortality in older people can be high if not recognised and treated early.

# DKA – specific effect of acidosis on symptoms and signs



- ⦿ This acidity causes the rapid deep breathing that is characteristic of diabetic ketoacidosis (DKA).
- ⦿ Other symptoms include confusion and/or tiredness
- ⦿ Breath may smell 'fruity' and nausea may be present

# Confirming hyperglycaemia - 1

- ① Blood glucose – If you suspect hyperglycaemia check a blood glucose finger prick test.
- ① If you are required to conduct this test as part of your duties, be sure that you have had proper training in the use of the blood glucose meter.
- ① If the level is  $> 11\text{mmol/l}$ , particularly if the resident is unwell, it should be re-tested promptly, along with testing for **ketones** in blood or urine samples, as **diabetic ketoacidosis (DKA)** is a risk.
- ① If you find very high levels of glucose and/or raised ketones (e.g. inform a qualified nurse or doctor immediately).

# Confirming hyperglycaemia – 2

- ① You may be familiar with another measure of blood glucose called glycated haemoglobin (also known as haemoglobin A1c or HbA1c).
- ① HbA1c provides an estimate of the average level of glucose control over the previous 8-12 weeks. *See module A (blood glucose and urine monitoring section)*
- ① It is important to know that the HbA1c is different from a standard glucose meter reading and cannot be used to confirm the immediate presence of a high glucose level.
- ① Since severe hyperglycaemia can develop within hours or days, the use of HbA1c to confirm hyperglycaemia at that exact time is not possible.

# Key messages

KM

Hyperglycaemia is a characteristic feature of diabetes

KM

Hyperglycaemia can be life-threatening if severe, e.g. in DKA or HHS.

KM

Typical symptoms such as thirst or polyuria are classed as 'osmotic' based but these are not always present.

KM

Atypical symptoms might include a fall, a change in vision, or a change in memory.

# Questions

Q1. What is hyperglycaemia?

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- B. A term for levels of blood glucose above the normal range

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Q2. Which of the symptoms below are signs of hyperglycaemia?

- A. Unintentional weight gain
- B. Unintentional weight loss
- C. Thirst
- D. Decreased urination



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Q2. Which two symptoms below are signs of hyperglycaemia?

- A. Unintentional weight gain
- B. Unintentional weight loss**
- C. Thirst**
- D. Decreased urination

# Questions

Q3. Hyperglycaemia causes symptoms in all those who experience it.

True or false?

- A. True - symptoms are always obvious
- B. False - some individuals may not show symptoms

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Q4. If hyperglycaemia is suspected in an unwell resident, and the blood glucose finger prick test is taken. What is considered a level that requires ketone testing as well:

- A. 11mmol/L or above
- B. 20mmol/L or below
- C. 20mmol/L or above
- D. 5 mmol/L or above

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Q5. What is glycated haemoglobin (also called HbA1c)?

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- ⊙ **B. An estimate of the average level of blood glucose control over the previous 8-12 weeks**

# Questions

Q6. Which of the following are life-threatening hyperglycaemic states:

- A. Hypoglycaemic coma
- B. Diabetic ketoacidosis
- C. Hyperosmolar hyperglycaemic state
- D. Hyperkalaemia



# Questions

Q6. Which of the following are life-threatening hyperglycaemic states:

- A. Hypoglycaemic coma
- B. Diabetic ketoacidosis**
- C. Hyperosmolar hyperglycaemic state**
- D. Hyperkalaemia

# References

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# Further reading

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Learning completed