POSITION STATEMENT

Use of Blood Glucose Meters

The Australian Diabetes Educators Association (ADEA) promotes the reliable and accurate use of blood glucose meters within the health care setting and in diabetes self management.

**ADEA recommends:**

- Blood glucose meters not be used as a method of screening for diabetes.

- Testing at the point of care may be appropriate in defined circumstances, such as in remote indigenous communities where laboratory testing is unavailable and postponement of treatment would be potentially harmful for the individual. The meter used at the point of care must have a vigorous quality improvement program in use.

- Outside of the acute clinical setting, blood glucose meters only be used to monitor blood glucose levels in people with a confirmed diagnosis of diabetes.

- Appropriateness of self blood glucose monitoring be assessed on an individual basis, taking into consideration the person’s disease and co-morbidity status, age, culture, dexterity and physical and intellectual capabilities, identified glycaemic targets, current medication regimen, potential confounders that may interfere with the accuracy of results obtained, and level of motivation.

- All people with diabetes using insulin therapy are encouraged to perform blood glucose monitoring.

- Individuals using blood glucose meters have access to a health professional deemed competent in the use of the meter.

- Further diabetes education is essential to ensure self management behaviours are underpinned by a sound knowledge of how dietary intake, physical activity, medication, stress and illness all interact to affect blood glucose levels.

- Although some blood glucose meters allow the measurement of glucose levels from small samples of blood from the forearm and other sites, blood taken from the capillary bed of the fingertip is the preferred sample, particularly when blood glucose levels are changing rapidly.
• Health professionals only use blood glucose meters after successfully completing an education program that results in the attainment of competency in meter operation, control testing and problem solving.

• Quality improvement practices are implemented within clinical settings to ensure both blood glucose monitoring equipment and operators meet high standards of performance and process.

• All health services using blood glucose meters provide:
  o a well-defined policy and procedure
  o a training program for personnel performing the tests
  o quality improvement procedures
  o regular equipment maintenance
  o external auditing of meters
  o appropriate lancet devices that meet infection control considerations.

• In certain clinical situations different strip technology may be more appropriate than others, such as in the care of patients using icodextrin dialysate solution, or patients receiving intravenous preparations containing maltose. In these situations it is essential to consult product information and/or the manufacturer of the glucose meter and test strip to ensure icodextrin and maltose do not interfere with blood glucose readings.

• Blood glucose measurement using portable blood glucose meters not be used in isolation when evaluating the glycaemic control of people with diabetes.
Purpose

The purpose of this position paper is to:

- Identify where and when it is appropriate to use blood glucose meters.
- Outline appropriate education requirements for the use of blood glucose meters.
- Establish guidelines in relation to quality improvement in the use of blood glucose meters.
- Outline additional methods available to measure glycaemia.

Background

Emerging trends in medical technology have made available blood glucose meters that can provide timely and rapid results in a wide variety of health care settings. The use of these meters assists health care professionals to make timely therapeutic decisions. Monitoring blood glucose levels using meter technology has become an essential component of the modern management of people with diabetes mellitus.

Testing blood glucose levels using blood glucose meters has also gained popularity as a means for people with diabetes to monitor their own blood glucose levels at home, and to direct subsequent therapy. Questions have been raised as to the reliability of earlier blood glucose meters, but these issues have largely been resolved by the development of more sophisticated technology. Accordingly the use of blood glucose meters by people with diabetes is an integral part of the American Association of Diabetes Educators (AADE) 7™ Self-care Behaviors.

Large clinical studies such as the Diabetes Control and Complications Trial and the United Kingdom Prospective Diabetes Study have provided clear evidence of the beneficial effect of intensive therapy in people with diabetes and have emphasised self blood glucose monitoring as an important component for intensive therapy, particularly for people requiring insulin therapy. However, debate continues as to the utility of self monitoring in people who do not use insulin therapy. Several studies of self blood glucose monitoring have shown little or no effect on the medium term blood glucose control in those with type 2 diabetes not treated by insulin, and a relationship between self testing and reduced self rated quality of life was found.

Appropriate use of blood glucose meters

Screening for diabetes in asymptomatic individuals

The Australian national prevalence study, AusDiab, showed that type 2 diabetes affects 7.4% of the Australian population in people aged 25 years or older, half of whom are undiagnosed. Unrecognised hyperglycaemia will place individuals at risk of developing long term complications of diabetes before their disease is diagnosed. Screening for type 2 diabetes in asymptomatic individuals has therefore been proposed as one strategy to reduce the diabetes burden. However, to date, there have been no published randomised controlled trials on the effects of early intervention in people with screen-detected diabetes. The current Australian guidelines therefore recommend
screening for diabetes only in people deemed to be at high risk of developing the condition.\textsuperscript{13}

Fasting plasma glucose, followed by an oral glucose tolerance test in people with an equivocal result, is deemed the best screening test for type 2 diabetes. However, Point of Care (POC) capillary blood glucose testing has been shown to be useful in certain situations, for example, remote areas of Australia where laboratory resources are absent or severely limited in terms of obtaining results in a timely manner to assist with clinical intervention.\textsuperscript{14} In this situation, the World Health Organisation recommends a random POC plasma glucose level $\geq 12.2\text{mmol/L}$ is used for the diagnosis of diabetes, and less than $5.5\text{mmol/L}$ to exclude diabetes.\textsuperscript{15}

\textit{Screening for diabetes in people with impaired fasting glucose or impaired glucose tolerance}

Testing of POC capillary blood glucose is not recommended for screening people for diabetes in those with known impaired fasting glucose (IFG) or impaired glucose tolerance (IGT); rather the National Health and Medical Research Council (2001),\textsuperscript{16} the Australian Diabetes Society and the Australian Diabetes Educators Association (2007)\textsuperscript{17} and the World Health Organization\textsuperscript{18} recommend that people with these conditions undergo a formal fasting 75gram Oral Glucose Tolerance Test to test for, and diagnose diabetes.

\textit{Monitoring blood glucose in people without a confirmed diagnosis of diabetes}

Within the acute clinical setting there are medical conditions other than diabetes mellitus where measuring blood glucose levels by health professionals may be warranted, such as intensive care units and special care nurseries. During hospitalisation it may also be appropriate to measure blood glucose levels in people previously diagnosed with IFG or IGT to determine any effect of an acute illness on their blood glucose status. However, it is not recommended that people diagnosed with IFG or IGT use blood glucose meters to monitor their blood glucose levels at home, nor are subsidies provided by the National Diabetes Services Scheme to these individuals.\textsuperscript{17}

\textit{Monitoring blood glucose in people with diabetes}

Modern management of people with diabetes in hospitals and community health services includes the use of portable capillary blood glucose meters. This includes women with gestational diabetes mellitus. The rapidity with which results can be obtained using these meters can facilitate the subsequent making of therapeutic decisions which can improve diabetes management and conceivably shorten hospital stays or prevent hospitalisation in some cases. Clinically, blood glucose monitoring using meter technology may occur in a variety of settings including the hospital inpatient or outpatient services, private medical and diabetes education practices, aged and disability residential care, emergency care, at a community care setting, school, workplace, sporting field, or in the person’s home.

\textit{Self monitoring blood glucose in people with diabetes}
Unequivocally, good glycaemic control helps to reduce the development and progression of diabetes related complications.\textsuperscript{3,5} For many people this requires intensive treatment using insulin therapy and active self management. The availability of low cost blood glucose meters improves the ability of people with diabetes to intensively monitor and allows the person to become actively involved in the management of their disease. Self monitoring may contribute in several ways. Firstly, it can reinforce beneficial health behaviours and increase compliance with medication. The immediate feedback provided by self monitoring also helps to establish short term blood glucose patterns and, with appropriate education, assists people with diabetes to make day to day decisions regarding their therapy, such as appropriate insulin dose adjustment and management of hypoglycaemia and sick days. However, as mentioned previously, there is still debate as to the utility of self monitoring in people with type 2 diabetes who do not use insulin therapy.\textsuperscript{5-10} Therefore the decision to self blood glucose monitor should be determined by the individual in consultation with their health care professional.

Alternate Site Testing

Recent innovations in meter technology allows the measurement of glucose values using small samples of blood, which can be derived from the forearm and sites other than the capillary bed of the fingertip. For some people this has been a welcome alternate strategy to the pain or discomfort experienced when using fingertips to measure blood glucose levels.\textsuperscript{19,20} However, studies have identified clinically significant variations in blood glucose levels between samples obtained from the fingertips and those from the forearm. Less variation has been found with samples taken from the base of the thumb. These variations appear more apparent with rapid rises and falls in blood glucose levels.\textsuperscript{21,22} Therefore, alternative sites should not be used when blood glucose levels are likely to be fluctuating, for example, post meal or to confirm hypoglycaemia.

Health care professionals must be aware if patients are using alternative sites so that variations in results can be taken into consideration when making management decisions. People with diabetes are encouraged to use a consistent testing site.

Appropriate education regarding the use of blood glucose meters

Appropriateness of self blood glucose monitoring should be assessed on an individual basis, taking into consideration the person’s disease and co-morbidity status, age, culture, dexterity and physical and intellectual capabilities, identified glycaemic targets, current medication regimen, potential confounders that may interfere with the accuracy of results obtained and level of motivation. Where self blood glucose monitoring is recommended, care is required to ensure an accurate technique and that self management behaviours are underpinned by a sound knowledge of how dietary intake, activity, medication, stress and illness interact to affect blood glucose levels. The ability to recognise and interpret clinical signs and symptoms and to know when to access expert advice is also essential.

Note: Further information about education essential for sound self management can be found in the ADEA Clinical Practice Guidelines relating to The Role of Diabetes Educators and Accredited Practising Dietitians in the Delivery of Diabetes Self Management and Nutrition Education Services for People with Diabetes.
Essentials for teaching self blood glucose monitoring

Individuals using blood glucose meters require access to a health professional deemed competent in the use of the meter.

Where meters are sold in pharmacies and other retail environments, it is essential for a staff member deemed competent in the use of blood glucose meters and the interpretation of blood glucose results to provide education to the person purchasing the meter.

Education required:

- Use of the individual meter.
- Correct skin preparation of the testing site.
- Calibration and checking procedures.
- Quality control procedures according to the manufacturer’s instructions.
- Problem solving of meter action and function.
- The recording and interpretation of results.
- Specific frequency and times to perform blood tests and the circumstances that indicate additional testing is required.
- Individual target ranges for capillary blood glucose levels to enable the interpretation of results.
- What to do and who to notify if blood glucose levels are outside of the target range.
- Safe use and disposal of used lancets.15
- Where and how to purchase blood glucose supplies, including the National Diabetes Services Subsidy (NDSS).
- Additional meter features such as averages and electronic download capabilities.
- Information on the completion of the warrantee process.

Maintenance of expertise and certification of ongoing competence are essential. Personnel involved in teaching self blood glucose monitoring should receive demonstration and instruction for each brand or type of meter and strip sold, and be accredited directly for each meter, either by a company representative or a designated diabetes resource person (for example, a diabetes educator). Each pharmacy or retail environment is then responsible for maintaining a register of accredited staff and re-accreditation should be performed at least bi-annually.

Quality Improvement

Use of a blood glucose meter by health care professionals to test an individual’s blood glucose level implies legal accountability for the results, as changes in medication and dietary therapy can be made based on blood glucose results obtained. Individuals with diabetes and health professionals need to be confident in the accuracy of test results, irrespective of the setting in which they are performed. Quality improvement management practices are therefore required to ensure that both the equipment and operators meet high standards of performance and process.
Choice of meter

With advances in technology, blood glucose meters pose few problems if personnel are trained with a specific meter and strip. When more than one meter is used, the responsibility of the operator becomes more complex. It is therefore advisable to designate one type of meter and strip for routine testing throughout a hospital, health care facility or service. The decision process in meter choice is best done with a diabetes educator. Laboratory and clinical staff should be involved in the decision process.

Strip technology

Certain strip technology may be more appropriate than others in certain clinical situations, for example care of patients on peritoneal dialysis using icodextrin (Extraneal®) or intravenous immunoglobulin preparations such as Intragram®. Diabetes mellitus is now the most common cause of end stage kidney disease in adults. Continuous ambulatory peritoneal dialysis is one treatment option for renal replacement therapy. The type of dialysate solution used will depend on various clinical parameters. Extreme care should be taken when icodextrin (Extraneal®) is used as this solution has been identified as causing falsely elevated blood glucose levels in capillary blood glucose testing in tests strips that use either glucose dehydrogenase pyrroloquinolnequinoone or glucose-dye-oxidoreductase-based methods. Intravenous immunoglobulin preparations containing maltose such as Intragram®, CMV Immunoglobulin and Tetanus immunoglobulin (for intravenous use) can also interfere with the readings performed using test strips with glucose dehydrogenase. Blood glucose meters using this technology in these particular clinical situations can result in inaccurate blood glucose determinations. It is therefore essential to consult the product information and/or the manufacturer of the glucose meter and test strip to ensure that icodextrin and maltose do not interfere with the reliability of blood glucose readings.

Personnel

Testing of capillary blood glucose levels using portable blood glucose meters should be limited to experienced and certified staff. Staff using these meters require instruction from a company representative or diabetes educator and need to be able to demonstrate the skillful use of the available blood glucose meter and strip prior to certification. Blood glucose monitoring certification programs will ideally include an audit of the persons’ technique using the meter, accurate testing with internal quality control solutions and a short answer test on the use of the meter and interpretation of the blood glucose testing results.

Re-certification of ongoing competence is best performed at least bi-annually and a formal list of accredited staff be displayed by the employing institution.

Accredited personnel will maintain their skill and reliability in the performance of blood glucose monitoring only if this is done with reasonable frequency. Protocols are also required to be readily available, outlining the appropriate action if blood glucose or quality control results are in doubt.

Quality control

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Health care facilities using portable blood glucose meters require an established quality control program to ensure the accuracy and precision of the blood glucose meters. Internal quality control using control solutions with a known value or simultaneous determinations of venous blood glucose level by the laboratory will assist in checking the integrity of strips and monitor reagents, operator performance, and device reliability. It is recommended the results be documented and regularly checked, and corrective action taken when necessary. Some companies have external quality control mechanisms, using control solutions with an unknown result, enabling an additional layer of review.

It is recommended that quality control be performed daily in acute care settings. Extra quality control tests need to be performed when a result is significantly abnormal to the one anticipated, after a battery change, new packet of strips is to be used, or there has been the potential for damage to the meter.

**Other methods of measuring glycaemia**

Blood glucose levels obtained from a blood glucose meter should not be used as the only evaluation of glycaemic control in people with diabetes.

*Glycated haemoglobin testing (HbA1c)*

Glycohaemoglobin is formed by a non-enzymatic interaction between glucose and haemoglobin. Formation of glycohaemoglobin, often referred to as glycated haemoglobin or HbA1c, is irreversible and the level in the red blood cell depends on the blood glucose concentration over the life of the cell. The HbA1c is accepted as an important index in diabetes management, reflecting the degree of metabolic control over the preceding six to eight weeks, and was the major outcome determinant of the Diabetes Control and Complications Trial. Based on the findings of this trial and others, targets for glycaemic control have been established, which, if met, should minimise the development of diabetes related complications. It is therefore recommended all people with diabetes have an HbA1c estimation at least annually.

*Fructosamine*

Fructosamine is a measure of non-enzymatic glycation of proteins in the blood, the major constituent of which is albumin. While HbA1c reflects glycaemia over the proceeding six to eight weeks, fructosamine reflects glycaemic control over the previous two to three weeks. The use of fructosamine estimation may be a more suitable test of glycaemia during pregnancy or where there is altered red cell turnover or haemoglobinopathies.

*Continuous Glucose Monitoring*

Continuous glucose monitoring (CGM) determines blood glucose levels on a continuous basis (every few minutes) and can be a useful adjunct to self blood glucose monitoring in persons with diabetes. A typical system consists of a disposable glucose sensor that is introduced just under the skin, and worn for a few days until replacement, a link from the sensor to a non-implanted transmitter which communicates to a radio receiver, and an
electronic receiver that displays blood glucose levels in a practically continuous manner. The rise and fall in the trends in glycaemic excursions are also monitored.

Continuous glucose monitors measure the glucose level of interstitial fluid. There is a lag time between interstitial and blood glucose levels of about 5 minutes.\textsuperscript{29-31} While this lag time is insignificant when blood glucose levels are relatively consistent, when blood glucose is changing rapidly, CGM may read in the normal range while the ‘true’ blood glucose value may be significantly out of range. Despite this caveat, continuous monitoring allows examination of how the blood glucose level responds to insulin, physical activity, dietary intake and other factors. The additional data can be useful in the adjustment of insulin to carbohydrate ratios. CGM during periods when blood glucose levels are not typically checked (e.g. overnight) can help to identify problems in basal insulin dosing. Monitors may also be equipped with alarms to alert patients of hyperglycemia or hypoglycemia so that a patient can take corrective action(s) if they are unable to detect symptoms of either condition.

References


