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Unit No. 2

GETTING STARTED WITH CONTINUOUS GLUCOSE MONITORING: FROM GUIDELINES TO IMPLEMENTATION

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ABSTRACT

Glycated haemoglobin (HbA1c) is widely recognised as the primary tool for evaluating glycaemic control in people living with diabetes (PwD), but it does not assess day-to-day diabetes control, glycaemic variability, acute glycaemic variations, or hypoglycaemia. Day-to-day tools used for measuring glycaemic markers, such as self-monitoring of blood glucose (SMBG) and continuous glucose monitoring (CGM), complement HbA1c to provide a complete picture of the individual's glycaemic control. The use of CGM has improved the quantity and quality of glycaemic information available to PwD and clinicians, enabling rapid review to facilitate informed decisions in treatment adjustment and lifestyle management. Although the use of CGM to monitor people with type 1 diabetes mellitus or insulin-treated type 2 diabetes mellitus (T2DM) has been increasingly incorporated into international and regional guidelines, it remains underutilised in clinical practice for T2DM. In this article, data from the recent Asia Pacific consensus on CGM, existing literature, and clinical experience are used to provide guidance on the appropriate use of CGM in the T2DM population in Singapore. We recommend CGM in individuals with T2DM on either intensive insulin therapy or basal insulin with suboptimal glycaemic control, as well as for certain special subgroups, such as the elderly. We also discuss solutions to overcome common challenges faced during initiation of CGM and provide clinicians with a simplified approach for interpreting and reviewing data from the Ambulatory Glucose Profile report generated from CGM use.

Keywords: Glycaemic variability; continuous glucose monitoring; type 2 diabetes mellitus; clinical recommendations; Asia

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INTRODUCTION

In Singapore, the prevalence of diabetes increased from 8.6 percent in 2010 to 9.5 percent during the period 2019-2020,[1] and is expected to increase drastically to 15.9 percent by 2050.[2] As such, healthcare professionals, especially primary care providers who provide holistic and team-based chronic care for people living with diabetes (PwD),[3] need to be equipped with the tools and knowledge to optimise glycaemic control for better disease management.

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For many decades, glycated haemoglobin (HbA1c) has been widely recognised as the primary tool for evaluation of glycaemic control and is used to predict diabetes complications.[4,5] However, HbA1c is a broad marker that assesses average glycaemic control over the past three months and does not reflect day-to-day diabetes control, glycaemic variability, acute glycaemic variations, or hypoglycaemia.[4,6-8] Day-to-day markers such as fingerstick blood glucose monitoring (also known as self-monitoring of blood glucose [SMBG]) and continuous glucose monitoring (CGM) should be used to complement HbA1c to provide a complete picture of glycaemic control.[4,7] SMBG is an established day-to-day glycaemic measure,[7] but has several limitations, including low compliance due to the inconvenience and discomfort of testing and the inability to provide glucose trends to facilitate proactive management.[7,9,10]

The approach to glucose monitoring has been revolutionised by the advent of CGM, and its use has risen drastically in recent years.[6,7] In this article, data from the recent Asia Pacific (APAC) consensus on CGM,[11] existing literature, and clinical experience are used to provide guidance on the appropriate use of CGM in the type 2 diabetes mellitus (T2DM) population in Singapore. This includes the initiation of CGM and proper utilisation of data from Ambulatory Glucose Profile (AGP) reports to guide clinical decisions.

BACKGROUND OF CGM

CGM devices measure glucose levels in the interstitial fluid in the subcutaneous space using a sensor and transmitter to transmit real-time glucose data to a receiver or smartphone.[5,12] The advent of CGM technology has improved the quantity and quality of glycaemic information available to PwD and clinicians,[5] including current glucose levels and trends and the direction and rate of change via trend arrows.[13] These data are presented in a structured and intuitive format as an AGP report, enabling rapid review by healthcare professionals and PwD to facilitate informed decisions in treatment adjustment and lifestyle management.[7,13]

CGM-derived metrics, such as time in range (TIR), time below range (TBR), time above range (TAR), glucose management indicator (GMI), and glycaemic variability have become widely accepted markers for glycaemic control and are valuable for insulin dose adjustment and re-evaluation of the treatment plan.[4] TIR correlates well with HbA1c and risk of diabetes complications, and glycaemic variability is associated with an increased risk of hypoglycaemia.[4]

Although the use of CGM to monitor people with type 1 diabetes mellitus (T1DM) or insulin-treated T2DM has been increasingly incorporated into international and regional guidelines,[4,11,14] it remains underutilised in

clinical practice, with <10 percent of people with T2DM in Singapore using CGM.[6] This is likely due to cost, perceptions regarding the complexity and inconvenience of CGM use among physicians and PwD, and clinical inertia due to inadequate training in CGM.[7,8,12]

INITIATION OF CGM IN T2DM

Population of People with T2DM Suitable for Initiation of CGM

The benefits of using CGM have been well established amongst people with T1DM[4,6]; however, identifying the appropriate population within the larger T2DM group remains a topic of discussion. As per the American Diabetes Association 2023 guidelines, the use of CGM should be considered from the start of insulin treatment, following the diagnosis of diabetes that requires such treatment.[15] This allows for tracking of glucose levels with subsequent insulin dose adjustments and lifestyle modifications, removing the burden of frequent SMBG.[15] The recent APAC consensus guidelines recommend that CGM use should be considered in all people with T2DM on intensive insulin therapy or basal insulin, subject to individual factors, such as insulin regimen intensity and glycaemic control (especially people with suboptimal glycaemic control, and those at high risk of problematic hypoglycaemia or nocturnal hypoglycaemia), and subject to availability of resources.[11] **Table 1** summarises the subgroups of people with T2DM who are suitable for CGM.

Table 1: Populations who may benefit from CGM use and level of Evidence (adapted from Kong et al)[11]

Recommended populations for CGM use (adapted from Kong et al)[11]
Level of evidence: A
• All individuals with T1DM or T2DM on intensive insulin therapy (multiple daily insulin injections or insulin pump therapy) [Note: a subgroup that may be prioritised for continual use includes those with suboptimal glycaemic control[a]]
• All individuals with T1DM or T2DM on intensive insulin therapy (multiple daily insulin injections or insulin pump therapy) with high risk of problematic hypoglycaemia (frequent/severe/nocturnal hypoglycaemia or hypoglycaemia unawareness)
• Use of CGM in people with T2DM treated with basal insulin, with or without glucose-lowering drugs (oral/injectables), to improve glycaemic control, clinical outcomes, and quality of life compared with conventional glucose monitoring [Note: Consider continuous/intermittent CGM based on patient factors/availability of resources (expert opinion)]
• All individuals with T1DM and T2DM on basal insulin with suboptimal glycaemic control[a]
• Pregnant women with T1DM on intensive insulin therapy (multiple daily insulin injections or insulin pump therapy) for improved maternal and neonatal outcomes
Level of evidence: B
• Early initiation of CGM after the diagnosis of T1DM helps in reducing HbA1c levels, glycaemic variability, and hypoglycaemia episodes, as well as optimising therapeutic adjustment. CGM also helps in educating and improving patient behaviours on dietary and lifestyle choices
• Frail older adults (age >65 yrs) with T2DM on basal insulin with or without glucose-lowering drugs (oral/injectables) to assist in detecting hypoglycaemia
• Diabetes with comorbid chronic kidney disease, especially in those with advanced disease with high risk for hypoglycaemia
• People with T1DM or T2DM on intensive insulin therapy (multiple daily insulin injections or insulin pump therapy) or T2DM on basal insulin, with or without glucose-lowering drugs, who are fasting during Ramadan
• Pregnant women with T2DM on insulin with or without additional oral glucose-lowering drugs, or those with GDM, especially if on insulin

[a]Suboptimal glycaemic control may be individualised by the clinician based on individual risk factors and institutional practices

CGM = continuous glucose monitoring
GDM = gestational diabetes mellitus
HbA1c = glycated haemoglobin
T1DM = type 1 diabetes mellitus
T2DM = type 2 diabetes mellitus

People with T2DM on Intensive Insulin Therapy (Multiple Daily Injections of Insulin or Continuous Subcutaneous Insulin Infusion) or Basal Insulin

The continuous/intermittent use of CGM should be considered in people with T2DM on intensive insulin therapy or basal insulin, in line with the recommendations from global and national guidelines.[11,14,15] Substantial evidence, including several large meta-analyses, have shown that the use of CGM compared with standard of care (usually SMBG) improved HbA1c and reduced the risk of hypoglycaemia in people with T2DM on intensive insulin therapy.[6,12,16-19] CGM-derived metrics, such as TIR and glucose variability, also improved with the use of CGM, while TAR and TBR decreased.[12,20] The volume of glucose data collected from CGM allows for better adjustment of doses to optimise the individual's insulin regimen, based on their CGM metrics.[13]

Likewise, in people with T2DM on basal insulin, the use of CGM significantly improved glycaemic outcomes and self-reported patient outcomes compared with conventional SMBG.[11]

Other People with T2DM

Although most guidelines recommend the use of CGM in insulin-treated T2DM,[14,15] there is a growing body of evidence that suggests that the use of CGM in non-insulin treated T2DM may also result in better glycaemic control and reduced HbA1c levels.[12,13,21,22] The use of CGM benefits individuals who are non-adherent to lifestyle and dietary measures, need constant feedback to motivate behavioural change, or who are unable to achieve their target HbA1c because it provides key information on how different factors, including food, medications, and lifestyle modifications affect glucose levels and allows for sufficient data to be collected for meaningful retrospective analysis of patterns and trends.[6,13] PwD are more likely to adhere to their medications and lifestyle modifications when they can see the positive impact of these interventions on their glycaemic control and subsequent outcomes.[13] However, the use of CGM in individuals with non-insulin treated T2DM is generally driven by resource-availability,[6,12] and additional research is required to confirm the benefits and cost-effectiveness of CGM in this population.

CGM USE IN SPECIAL GROUPS OF PEOPLE WITH T2DM

People Aged ≥65 years with T2DM

The use of CGM is valuable in elderly people aged ≥65 years with T2DM because they have a higher risk of severe hypoglycaemia, which may be compounded by cognitive and physical impairments or other comorbidities.[11,23] In an observational study of 48 people aged ≥65 years with T2DM, frailty was significantly associated with worse mean glucose levels and higher glucose variability with marked daytime post-prandial hyperglycaemia.[24] Hence, the use of CGM to monitor glycaemic fluctuations and minimise hypoglycaemic episodes may be particularly useful in this population.

People with T2DM Fasting During Ramadan

Glucose control during Ramadan is an important consideration as fasting may lead to increased risk of complications, such as hypoglycaemia, hyperglycaemia, and dehydration in people with T1DM or T2DM.[11,25] Observational studies have shown that CGM can be used to monitor glycaemic variability during intermittent fasting and feasting during Ramadan and can aid in reducing HbA1c and the potential complications of fasting.[11]

Pregnant Women with T2DM or Gestational Diabetes Mellitus (GDM)

Use of CGM should be considered in pregnant women with T1DM but may also be considered in pregnant women with T2DM or GDM, as CGM can aid in patient behaviour, lifestyle modifications, and insulin dose titration. Further research is required to confirm the benefits of CGM in pregnant women with T2DM or GDM, as the majority of existing data focuses on pregnant women with T1DM.[11,12,15]

People with T2DM and Renal Disease

People with T2DM on haemodialysis may have lower average glucose levels during and immediately after dialysis; the use of CGM can identify these glycaemic patterns, enabling management of insulin doses and diet accordingly to mitigate the risk of hypoglycaemia.[12] Moreover, HbA1c may be an unreliable glycaemic marker in patients with chronic kidney disease because it is sensitive to non-glycaemic changes in red blood cell volume and turnover.[12] Observational data have shown that CGM-derived metrics, such as GMI and TIR, are clinically useful for guiding glycaemic management[26,27] and can be used adjunctively to HbA1c for monitoring glycaemic control. However, additional research is necessary before a stronger recommendation can be made in this population.

COMMON CHALLENGES FACED DURING INITIATION OF CGM

Although the benefit of CGM in improving glycaemic control in insulin-treated T2DM is widely recognised, adoption of CGM in local clinical settings is limited by several challenges, including lack of awareness, experience and/or training with CGM, social stigma, limited reimbursement, and insufficient consultation durations for interpretation of AGP reports.[6,11] To improve adoption and facilitate patient counselling, suggested strategies to overcome common barriers to CGM adoption are listed in **Table 2**.

Table 2: Strategies to overcome common challenges faced during adoption of CGM

Challenges	Strategies to overcome challenges
Physician inertia to familiarise themselves and the patient with new systems[30]	Guideline development for CGM use[7] Clinical programmes and training for HCPs and allied staff on benefits of CGM[6] Increased literature on CGM and CGM-based metrics, focusing on primary care[7]
Cost of CGM device and lack of reimbursement or subsidies	Cost-effectiveness analyses and real-world evidence in specific countries to generate data needed to address unmet need[6]
Lack of awareness of/ evidence for CGM use in specific populations	Real-world evidence and randomised controlled clinical trials comparing CGM with conventional blood glucose monitoring in specific populations[6]
Inadequate training of patients on how to use the technology safely and social stigma[12]	Patient educational materials and videos, community support groups[6]
Insufficient consultation time for interpretation of AGP data[12]	Education for HCPs and patients on interpretation of results[6] Development of an efficient workflow to obtain glycaemic data in advance or at the time of consultation[7] Integration of CGM data into EMR[7]

AGP = Ambulatory Glucose Profile
CGM = continuous glucose monitoring
EMR = electronic medical record
HCP = healthcare professional

INTERPRETATION OF AGP REPORTS

A key benefit of CGM over SMBG is the wealth of glycaemic information provided. These data are typically presented in a structured AGP report,[7] which is recognised as an internationally agreed standard for summarising and interpreting CGM data to facilitate identification of patterns and trends in daily glucose control.[4,28] Proper interpretation of the AGP report is required to leverage on the volume of data available, and clinical decisions should be made based on a holistic and detailed overview of the AGP report and case information derived from patient-physician consultations.[11,28]

An example of an AGP report is shown in **Figure 1.** This displays large volumes of glucose data collected over a specified duration (minimally 7-14 days) and provides important feedback on hypo- and hyperglycaemic patterns and glucose variability, as well as the impact of insulin doses, meals, exercise and stress.[8,13] The AGP report allows for immediate identification of key metrics for glycaemic control, including TIR, TBR, TAR, glycaemic variability, average glucose, and GMI.[13] The AGP graph provides a visual representation of the glucose values measured over a specified analysis period (usually the previous 14 days), which uncovers patterns of hyper- and hypoglycaemia, and provides an overview of glycaemic variability.[28] Daily glucose reports are generated, which aid clinicians and PwD in reviewing daily glucose patterns to identify specific reasons for glucose fluctuations.[13,29]

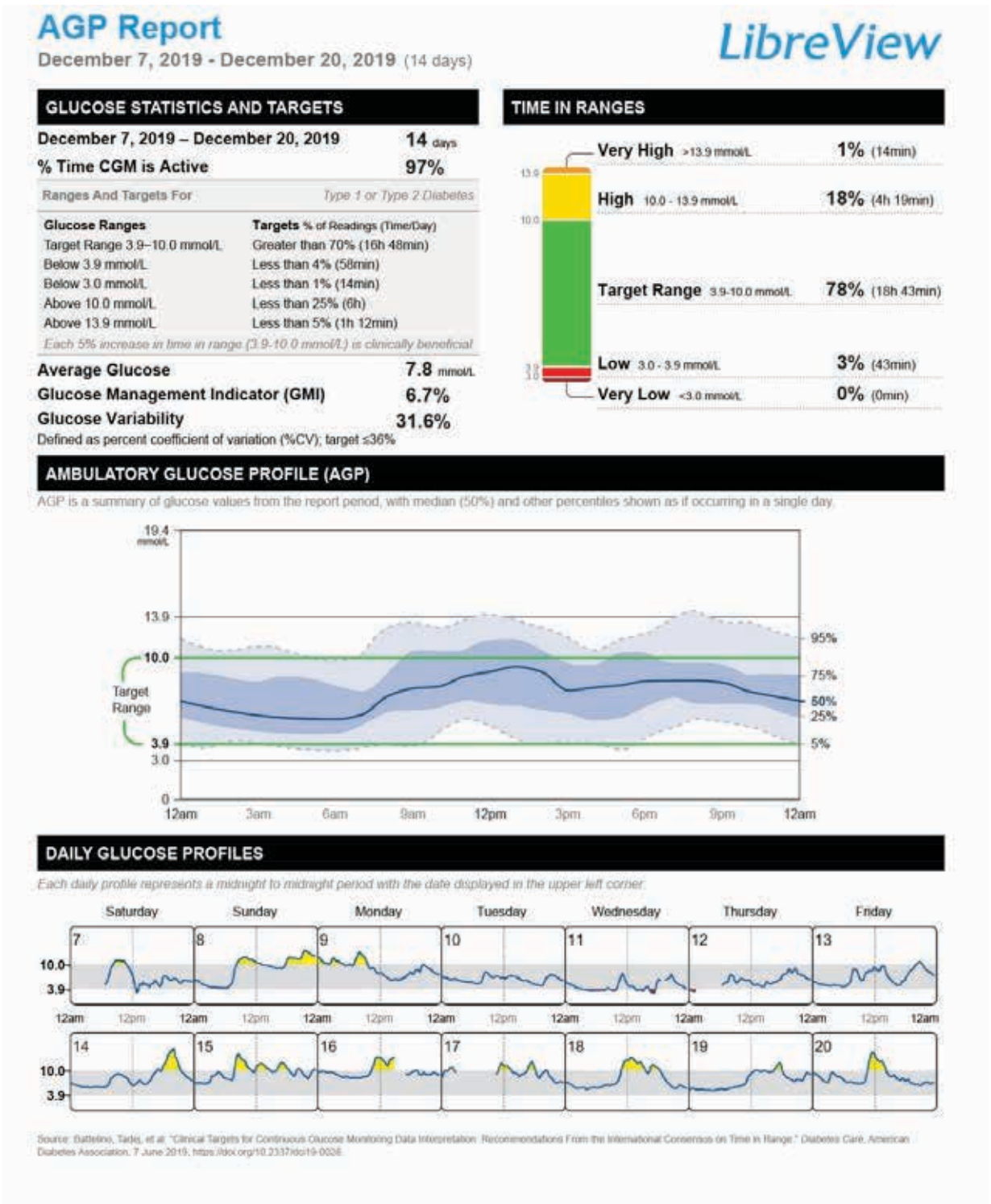
It is suggested that in clinical practice, PwD should undergo a review of their AGP report four weeks after the initial assessment, then subsequent follow-ups every 3-6 months.[8] The glycaemic targets for PwD may include TIR >70 percent and glycaemic variability (percent coefficient of variation) ≤36 percent, although the targets should be personalised based on individual factors.[4,8,11] These key metric readings allow clinicians to identify abnormal readings and glycaemic patterns, quantify glucose exposure, variability, and stability, and formulate a personalised diabetes management plan.[4,8] Motivated PwD with good self-management skills can also use these metrics to identify and implement necessary lifestyle changes accordingly.

Key barriers to CGM adoption include time constraints as well as clinician/PwD inexperience in data interpretation; thus a streamlined and efficient workflow during clinical consultations is essential to guide clinical decisions.[7] We have adapted insights from Kong et al and Szmuilowicz et al to provide a simplified approach for reviewing an AGP report during a patient-physician consultation, detailed in **Figure 2.**[11,29]

CONCLUSION

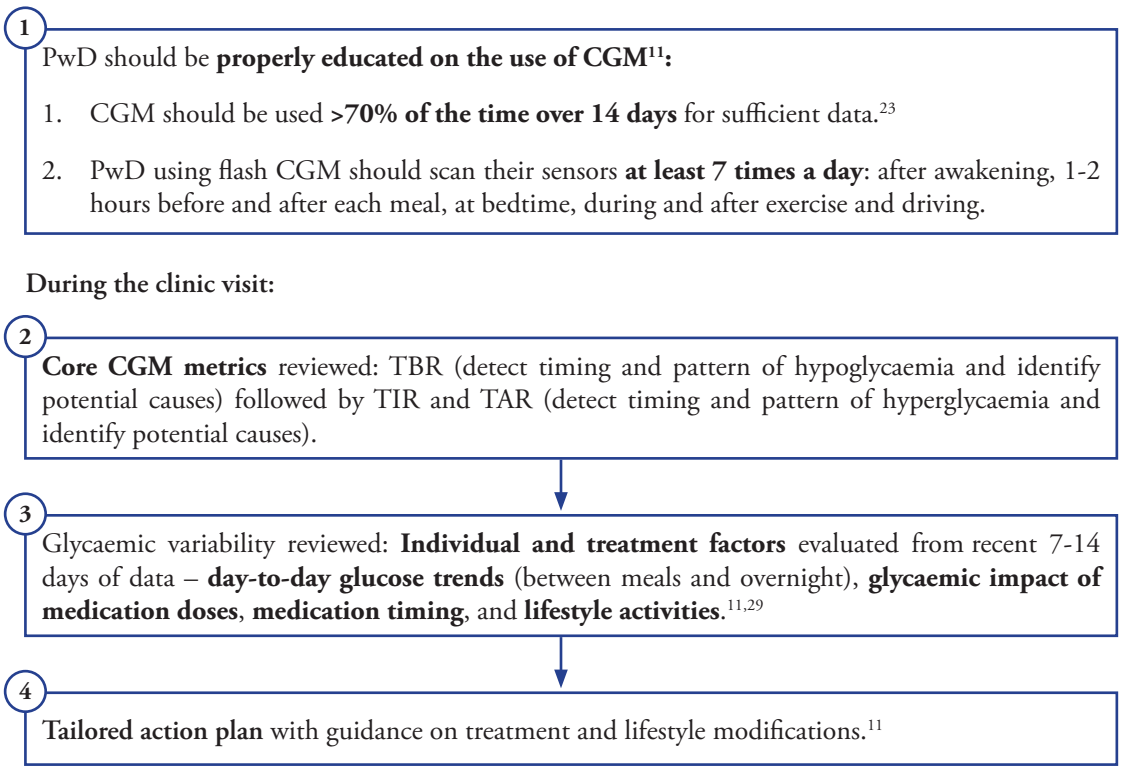
CGM is a valuable technology that improves glycaemic control in people with T2DM, and this article provides guidance on its appropriate use among subgroups within the T2DM population. Further efforts to overcome the challenges of adopting CGM in clinical practice and difficulties in interpretation of AGP data will aid in optimising outcomes in people with T2DM, which is especially relevant given the rising disease burden of diabetes in the region.

Figure 1: AGP report



Source: Battelino, Tadej, et al. "Clinical Targets for Continuous Glucose Monitoring Data Interpretation: Recommendations From the International Consensus on Time in Range." Diabetes Care, American Diabetes Association, 7 June 2019, https://doi.org/10.2337/dci19-0028.

Figure 2: Simplified approach for reviewing an AGP report during a patient-physician consultation



AGP = Ambulatory Glucose Profile
CGM = continuous glucose monitoring
PwD = people with diabetes
TAR = time above range
TBR = time below range
TIR = time in range

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LEARNING POINTS

- **CGM is an established tool for monitoring glucose levels in diabetes and has proven benefits, including improved HbA1c and reduced risk of hypoglycaemia, yet it remains underutilised among the people with T2DM in Singapore.**
- **CGM should be used in people with T2DM, especially those who are on intensive insulin therapy/ basal insulin; other populations may also benefit from CGM use.**
- **Proper interpretation of the AGP report from a CGM device facilitates streamlined review of daily glycaemic data and provides deeper insights to formulate a personalised diabetes management plan.**