The Management of Type 1 Diabetes in Adults. A Consensus Report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD)

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CONSENSUS REPORT

The American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD) convened a writing group to develop a consensus statement on the management of type 1 diabetes in adults. The writing group has considered the rapid development of new treatments and technologies and addressed the following topics: diagnosis, aims of management, schedule of care, diabetes self-management education and support, glucose monitoring, insulin therapy, hypoglycemia, behavioral considerations, psychosocial care, diabetic ketoacidosis, pancreas and islet transplantation, adjunctive therapies, special populations, inpatient management, and future perspectives. Although we discuss the schedule for follow-up examinations and testing, we have not included the evaluation and treatment of the chronic microvascular and macrovascular complications of diabetes as these are well-reviewed and discussed elsewhere. The writing group was aware of both national and international guidance on type 1 diabetes and did not seek to replicate this but rather aimed to highlight the major areas that health care professionals should consider when managing adults with type 1 diabetes. Though evidence-based where possible, the recommendations in the report represent the consensus opinion of the authors.

SECTION 1: INTRODUCTION AND RATIONALE FOR THE CONSENSUS REPORT

Type 1 diabetes is a condition caused by autoimmune damage of the insulin-producing β-cells of the pancreatic islets, usually leading to severe endogenous insulin deficiency. Type 1 diabetes accounts for approximately 5–10% of all cases of diabetes. Although the incidence peaks in puberty and early adulthood, new-onset type 1 diabetes occurs in all age-groups and people with type 1 diabetes live for many decades after onset of the disease, such that the overall prevalence of type 1 diabetes is higher in adults than in children, justifying our focus on type 1 diabetes in adults (1). The global prevalence of type 1 diabetes is 5.9 per 10,000 people, while the incidence has risen rapidly over the last 50 years and is currently estimated to be 15 per 100,000 people per year (2).

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Prior to the discovery of insulin a century ago, type 1 diabetes was associated with a life expectancy as short as a few months. Beginning in 1922, relatively crude extracts of exogenous insulin, derived from animal pancreases, were used to treat people with type 1 diabetes. Over the ensuing decades, insulin concentrations were standardized, insulin solutions became more pure, resulting in reduced immunogenicity, and additives, such as zinc and protamine, were incorporated into insulin solutions to increase the duration of action. In the 1980s, semisynthetic and recombinant human insulins were developed, and in the mid 1990s, insulin analogs became available. Basal insulin analogs were designed with prolonged duration of action and reduced pharmacodynamic variability compared with protamine-based (NPH) human insulin, while rapid-acting analogs were introduced with quicker onset and shorter duration than short-acting ("regular") human insulin, resulting in reduced early postprandial hyperglycemia and less later hypoglycemia several hours after the meal (3).

The discovery of insulin transformed the lives of many people, but it soon became apparent that type 1 diabetes is associated with the development of long-term complications and shortened life expectancy. Over the last 100 years, developments in insulin, its delivery, and technologies to measure glycemic indices have markedly changed the management of type 1 diabetes. Despite these advances, many people with type 1 diabetes do not reach the glycemic targets necessary to prevent or slow the progression of diabetes complications, which continue to exert a high clinical and emotional burden.

Recognizing the ongoing challenge of type 1 diabetes and the rapid development of new treatments and technologies, the European Association for the Study of Diabetes (EASD) and the American Diabetes Association (ADA) convened a writing group to develop a consensus report on the management of type 1 diabetes in adults, aged 18 years and over. The writing group was aware of both national and international guidance on type 1 diabetes and did not seek to replicate this, but rather aimed to highlight the major areas of care that health care professionals should consider when managing adults with type 1 diabetes. The consensus report has focused predominantly on current and future glycemic management strategies and metabolic emergencies. Recent advances in the diagnosis of type 1 diabetes have been considered. Unlike many other chronic conditions, type 1 diabetes places a unique burden of management on the individual with the condition. In addition to complex medication regimens, other behavioral modification is also needed; all of this requires considerable knowledge and skill to navigate between hyper- and hypoglycemia. The importance of diabetes self-management education and support (DSMES) and psychosocial care are rightly documented in the report. While acknowledging the major significance and cost of screening, diagnosing, and managing the chronic microvascular and macrovascular complications of diabetes, a detailed description of the management of these complications is beyond the scope of this report.

Two members of the writing group, one from the ADA and one from the EASD, were assigned to be the primary authors of each section. The chosen individuals had specific knowledge of the area and were tasked with reviewing and summarizing the available literature. Each section, in turn, was reviewed and approved by the entire writing group. The draft consensus report was peer reviewed (see the Acknowledgments section) and suggestions were incorporated as deemed appropriate by the authors. The revised draft report was presented at the virtual ADA Scientific Sessions in 2021, after which public comments were invited. The report was further revised in light of this consultation. Large areas of clinical practice in type 1 diabetes are based on expert opinion and cohort studies rather than RCTs and so the writing group considered both observational and clinical trial findings, rather than relying solely on unbiased RCTs and meta-analyses. The report represents the consensus opinion of the authors, given that the available evidence is incomplete.

SECTION 2: DIAGNOSIS OF TYPE 1 DIABETES

Adults with new-onset type 1 diabetes can present with a short duration of illness of 1–4 weeks or a more slowly evolving process that can be mistaken for type 2 diabetes. Several other types of diabetes, for example monogenic diabetes, can be misdiagnosed as type 1 diabetes. In older adults, pancreatic cancer may present with diabetes and weight loss. A new and emerging issue is the development of profound insulin deficiency associated with the use of immune check-point inhibitors, which may present with hyperglycemia and diabetic ketoacidosis (DKA) (4).

Most of the available data discussed below are derived from White European populations and may not be representative of other ethnic groups. The clinical presentation may differ, but the classical triad of thirst and polydipsia, polyuria, and weight loss are common symptoms of type 1 diabetes. Accurate classification of the type of diabetes has implications beyond the use of insulin treatment; education, insulin regimen, use of

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A consensus report of a particular topic contains a comprehensive examination and is authored by an expert panel (i.e., consensus panel) and represents the panel's collective analysis, evaluation, and opinion. The need for a consensus report arises when clinicians, scientists, regulators, and/or policy makers desire guidance and/or clarity on a medical or scientific issue related to diabetes for which the evidence is contradictory, emerging, or incomplete. Consensus reports may also highlight gaps in evidence and propose areas of future research to address these gaps. A consensus report is not an American Diabetes Association (ADA) position but represents expert opinion only and is produced under the auspices of the ADA by invited experts. A consensus report may be developed after an ADA Clinical Conference or Research Symposium.

adjuvant therapies, access to newer technologies, need for psychosocial support to address the profound psychological impact of the diagnosis of diabetes, and concurrent disease screening may all depend on the diagnosis an individual receives. Furthermore, accurate diagnosis allows an assessment of the risk of diabetes in first-degree relatives and appropriate counseling. Although profound insulin deficiency is the hallmark of type 1 diabetes, some adults with type 1 diabetes maintain some insulin secretion for years after diagnosis and may not require insulin treatment at diagnosis (5), leading to diagnostic uncertainty about the type of diabetes and its management.

Differentiating Type 1 Diabetes From Type 2 Diabetes

Identifying whether an adult with newly diagnosed diabetes has type 1 diabetes may be challenging where the individual has features pointing toward both type 1 diabetes and type 2 diabetes, such as an older adult with a low or normal BMI or young adult with an elevated BMI. Ketoacidosis, once considered pathognomonic of type 1 diabetes, may occur in ketosis-prone type 2 diabetes. Misclassification of type 1 diabetes in adults is common, and over 40% of those developing type 1 diabetes after age 30 years are initially treated as having type 2 diabetes (6–8). From a patient perspective, a misdiagnosis of type 2 diabetes can cause confusion and misunderstanding, especially for those with type 1 diabetes who have overweight or obesity. This can impair the acceptance of the diagnosis and future management plans. No single clinical feature confirms type 1 diabetes in isolation (9,10). The most discriminative feature is younger age at diagnosis (<35 years), with lower BMI (<25 kg/m^2), unintentional weight loss, ketoacidosis, and glucose >20 mmol/L (>360 mg/dL) at presentation also being informative. Other features classically associated with type 1 diabetes, such as ketosis without acidosis, osmotic symptoms, family history, or a history of autoimmune diseases are weak discriminators (8–10).

The very strong relationship between type 2 diabetes incidence and age means that even "classical" features of type 1 diabetes may have a limited predictive value in older adults, as type 2 diabetes in this age-group is so common (11). The majority of older adults with low BMI will have type 2 diabetes (9,12,13), even more so when a person's ethnicity is associated with high type 2 diabetes risk (14). Rapid progression to insulin treatment (<3 years) is strongly suggestive of type 1 diabetes at any age (6,8,15). The diagnosis of type 1 diabetes can be more difficult in adults who progress to insulin therapy more slowly. Controversy remains as to whether latent autoimmune diabetes of adulthood (LADA) is a discrete subtype, a milder form of type 1 diabetes, or a mixture of some individuals with type 1 diabetes and others with type 2 diabetes (16,17).

Differentiating Type 1 Diabetes From Monogenic Diabetes

Monogenic diabetes is found in approximately 4% of those diagnosed with diabetes before the age of 30 years; the likelihood of monogenic diabetes rises to 20% where islet antibodies are negative and C-peptide secretion is maintained (18). Monogenic diabetes is commonly mistaken for type 1 diabetes because of the young age at onset. A diagnosis of monogenic diabetes allows specific treatment with discontinuation of insulin in many cases and has implications for family members and screening for concurrent conditions (19,20).

Investigation of an Adult With Suspected Type 1 Diabetes

An algorithm for the investigation of adults with suspected type 1 diabetes is shown in Fig. 1.

Islet Autoantibodies

An assessment of islet autoantibodies at diagnosis is recommended as the primary investigation of an adult with suspected type 1 diabetes. GAD should be the primary antibody measured and, if negative, should be followed by islet tyrosine phosphatase 2 (IA2) and/or zinc transporter 8 (ZNT8) where these tests are available. Islet cell antibody (ICA) measurement is no longer recommended because it is an imprecise biological assay that has been superseded by the direct measurement of single antibodies (21,22).

In people with clinical features suggesting type 1 diabetes, the presence of one or more positive islet autoantibodies is highly predictive of rapid progression and severe insulin deficiency and these individuals should be considered to have type 1 diabetes, even if they did not require insulin at diagnosis (23,24). As positive GAD antibodies may be found at a low level in adults without autoimmune diabetes and false positive results may occur, GAD should only be measured in those suspected to have type 1 diabetes (24).

The absence of autoantibodies does not exclude type 1 diabetes, since approximately 5–10% of White European people with new-onset type 1 diabetes have negative islet antibodies (8,9,25), and further consideration of the diagnosis is necessary. Furthermore, antibodies may disappear over time (26). In those diagnosed below the age of 35 years, type 1 diabetes is still the most likely diagnosis, particularly if there are no clinical features of type 2 diabetes or monogenic diabetes. In those aged over 35 years, type 2 diabetes becomes increasingly likely with absent islet autoantibodies and older age. However, it can be hard to differentiate between type 1 diabetes and type 2 diabetes based on age and clinical features in non-White European populations.

It is important to make a clinical decision about how to treat the person with diabetes. Regardless of any features of type 2 diabetes or absence of islet antibodies, if there is a clinical suspicion of type 1 diabetes, the individual should be treated with insulin. However, in some individuals, where the clinical course is more suggestive of type 2 diabetes, a trial of noninsulin therapy may be appropriate. Those whose diabetes is treated without insulin will require careful monitoring and education so that insulin can be rapidly initiated in the event of glycemic deterioration. Type 2 diabetes and other types of diabetes should be considered in all age-groups, but in those aged under 35 years, negative islet antibodies should raise the suspicion of monogenic diabetes.

C-Peptide Measurement

Beyond 3 years after diagnosis where there is uncertainty about diabetes type, a random C-peptide measurement (with concurrent glucose) within 5 h of eating is recommended. Where a person is treated with insulin, this test should always be performed prior to insulin discontinuation to exclude severe insulin deficiency.

Flow chart for investigation of suspected type 1 diabetes in newly diagnosed adults, based on data from White European populations

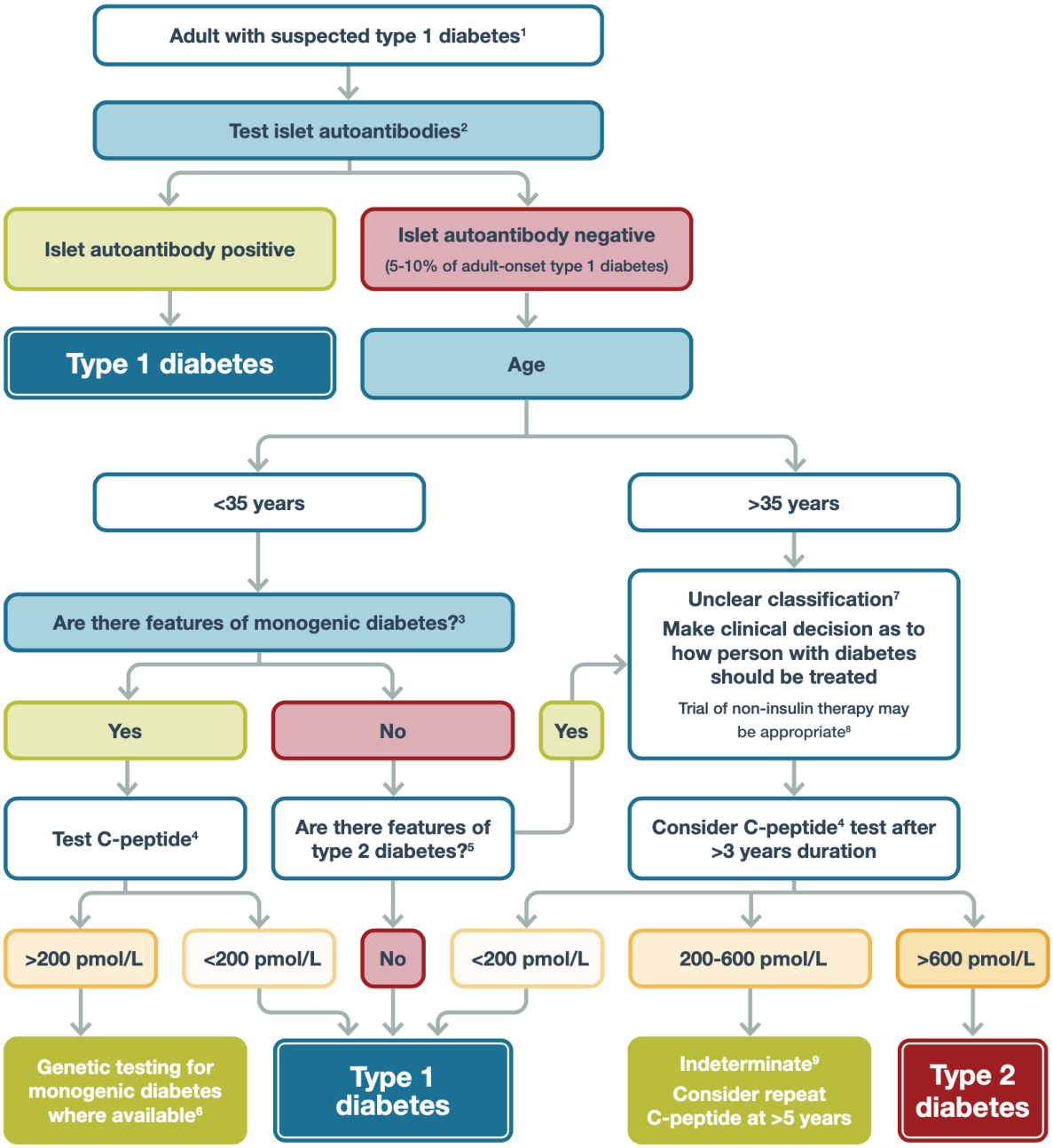

Figure 1—Flowchart for investigation of suspected type 1 diabetes in newly diagnosed adults, based on data from White European populations. [1]No single clinical feature confirms type 1 diabetes in isolation. The most discriminative feature is younger age at diagnosis (<35 years), with lower BMI (<25 kg/m^2), unintentional weight loss, ketoacidosis, and glucose >20 mmol/L (>360 mg/dL) at presentation also being informative. Other features classically associated with type 1 diabetes, such as ketosis without acidosis, osmotic symptoms, family history, or a history of autoimmune diseases are weak discriminators. [2]GAD should be the primary antibody measured and, if negative, should be followed by islet tyrosine phosphatase 2 (IA2) and/or zinc transporter 8 (ZNT8) where these tests are available. In those diagnosed below the age of 35 years who have no clinical features of type 2 diabetes or monogenic diabetes, a negative result does not change the diagnosis of type 1 diabetes since 5–10% of people with type 1 diabetes do not have antibodies. [3]Monogenic diabetes is suggested by the presence of one or more of the following features: HbA_{1c} <58 mmol/mol (7.5%) at diagnosis, one parent with diabetes, features of specific monogenic cause (e.g., renal cysts, partial lipodystrophy, maternally inherited deafness, severe insulin resistance in the absence of obesity), and monogenic diabetes prediction model

Persistent C-peptide >600 pmol/L (nonfasting) is strongly suggestive of type 2 diabetes, and people with C-peptide in this range are often able to replace insulin with other agents (27–30). Routine C-peptide testing in those with clinically diagnosed type 1 diabetes of at least 3 years duration has led to reclassification in 11% of those with adult-onset diabetes (31). By contrast, low or absent C-peptide confirms the diagnosis of type 1 diabetes. Although low C-peptide concentrations may occur in some types of secondary diabetes and very long-standing type 2 diabetes, these situations are unlikely to be confused for type 1 diabetes; however, in some cases, investigation of other types of diabetes may be appropriate.

Plasma C-peptide is the recommended test where available, with modestly higher performance than urine measurement. The latter may be confounded by impaired renal function. If urinary C-peptide:creatinine ratio is used, a value <0.2 nmol/mol can be used to define severe insulin deficiency.

Genetic Testing

As monogenic diabetes was less likely to have been considered in the past, molecular genetic testing for neonatal diabetes should be considered for all people with type 1 diabetes, regardless of current age, who were diagnosed under 6 months of age as more than 80% have monogenic neonatal diabetes, and the 30–50% with ATP-sensitive potassium (K_{ATP}) channel mutations can replace insulin with sulfonylureas (32,33).

Monogenic diabetes should be considered in those with one or more of the following features: age at diagnosis of less than 35 years, HbA_{1c} <58 mmol/mol (7.5%) at diagnosis, one parent with diabetes, and features of specific monogenic cause (e.g., renal cysts, partial lipodystrophy, maternally inherited deafness, severe insulin resistance in the absence of obesity) (34). A monogenic diabetes prediction model risk calculator (www.diabetesgenes.org/mody-probability-calculator; accessed 20 August 2021) may also be used to identify which individuals diagnosed between 6 months and 35 years are at increased risk of monogenic diabetes (35). Those at increased risk should have islet autoantibody and C-peptide testing. Molecular genetic testing should only be considered if the antibodies are negative and nonfasting C-peptide is >200 pmol/L (36–38). Molecular genetic testing is not universally available.

SECTION 3: AIMS AND GOALS OF MANAGEMENT OF TYPE 1 DIABETES

The aim of diabetes care and management is to support people with type 1 diabetes to live a long and healthy life. The management strategies to achieve this aim broadly include:

- Effectively delivering exogenous insulin to maintain glucose levels as close to the individual's target range as is safely possible to prevent the development and progression of diabetes complications while:
  - Minimizing episodes of hypoglycemia, of all levels, including level 1 (<3.9 to ≥3.0 mmol/L [<70 to ≥54 mg/dL]) but, in particular, level 2 (<3.0 mmol/L [<54 mg/dL]) and level 3 (severe event characterized by altered mental and/or physical functioning that requires assistance from another person for recovery) hypoglycemia, and preventing episodes of DKA, while treating these appropriately should they occur.
- Effectively managing cardiovascular risk factors.
- Providing approaches, treatments, and devices that minimize the psychosocial burden of living with type 1 diabetes and, consequently, diabetes-related distress, while promoting psychological well-being.

Management strategies should adapt to new therapies and technologies as they become available, according to the wishes and desires of the person with diabetes.

The importance of glycemic management was demonstrated convincingly by the DCCT (39) and the Epidemiology of Diabetes Interventions and Complications (EDIC) follow-up study (40). With the use of intensive insulin therapy that aimed to achieve blood glucose levels close to the nondiabetes range, HbA_{1c} was lowered by ~2% (22 mmol/mol) to a mean HbA_{1c} of ~7.0% (53 mmol/mol) over a mean of 6.5 years, compared with standard care (mean HbA_{1c} ~9.0% [75 mmol/mol]) (39). The risk of primary development of retinopathy was reduced by 75%, and progression of retinopathy slowed by 54%. The development of microalbuminuria was reduced by 39% and clinical neuropathy by 60% in those assigned to intensive therapy. These benefits persisted beyond the end of the trial despite equivalent glucose levels in the two groups (HbA_{1c} ~8% [64 mmol/mol]) in the posttrial period; furthermore, reductions in incident cardiovascular disease and mortality in the intensively treated group emerged with time (40). This seminal study has been the basis for glycemic target recommendations for type 1 diabetes worldwide. The cost of intensive management was, however, a 2–3-fold increase in the rates of severe hypoglycemia, as well as weight gain.

probability >5% (www.diabetesgenes.org/exeter-diabetes-app/ModyCalculator; accessed 20 August 2021). [4]A C-peptide test is only indicated in people receiving insulin treatment. A random sample (with concurrent glucose) within 5 h of eating can replace a formal C-peptide stimulation test in the context of classification. If the result is ≥600 pmol/L, the circumstances of testing do not matter. If the result is <600 pmol/L and the concurrent glucose is <4 mmol/L (<72 mg/dL) or the person may have been fasting, consider repeating the test. Results showing very low levels (<80 pmol/L) do not need to be repeated. Where a person is insulin-treated, C-peptide must be measured prior to insulin discontinuation to exclude severe insulin deficiency. Do not test C-peptide within 2 weeks of a hyperglycemic emergency. [5]Features of type 2 diabetes include increased BMI (≥25 kg/m^2), absence of weight loss, absence of ketoacidosis, and less marked hyperglycemia. Less discriminatory features include non-White ethnicity, family history, longer duration and milder severity of symptoms prior to presentation, features of the metabolic syndrome, and absence of a family history of autoimmunity. [6]If genetic testing does not confirm monogenic diabetes, the classification is unclear and a clinical decision should be made about treatment. [7]Type 2 diabetes should be strongly considered in older individuals. In some cases, investigation for pancreatic or other types of diabetes may be appropriate. [8]A person with possible type 1 diabetes who is not treated with insulin will require careful monitoring and education so that insulin can be rapidly initiated in the event of glycemic deterioration. [9]C-peptide values 200–600 pmol/L are usually consistent with type 1 diabetes or maturity-onset diabetes of the young (MODY) but may occur in insulin-treated type 2 diabetes, particularly in people with normal or low BMI or after long duration.

The main results of the DCCT were published in 1993, before any of the current insulin analogs and diabetes technologies, except for insulin pumps, were available. Increasingly, achieving and maintaining glucose levels in the target range have become possible with fewer episodes of hypoglycemia (41–44). Although the evidence of HbA_{1c} reduction remains the most robust measure associated with chronic diabetes complications and is the only measure that is prospectively validated, more recent studies have begun to examine the relationship between time that glucose is within the target range and long-term complications and have provided the basis for glycemic targets with newer glucose monitoring technologies (45,46).

The glycemic target should be individualized considering factors that include duration of diabetes, age and life expectancy, comorbid conditions, known cardiovascular disease or advanced microvascular complications, impaired awareness of hypoglycemia (IAH), and other individual considerations, and it may change over time. Goals should be achieved in conjunction with an understanding of the person's psychosocial needs and a reduction in diabetes distress if elevated. An HbA_{1c} goal for most adults of <53 mmol/mol (<7.0%) without significant hypoglycemia is appropriate. Following discussion between the person with diabetes and their health care team, achievement of lower HbA_{1c} levels than the goal of 53 mmol/mol (7%) may be acceptable, and even beneficial, if these can be achieved safely without adverse effects of treatment. Less-stringent HbA_{1c} goals (such as <64 mmol/mol [<8.0%]) may be appropriate for individuals with limited life expectancy or where the harms of treatment are greater than the benefits. It should be recognized that any reduction in HbA_{1c} from high initial levels has significant benefit even if the "goal" is not reached.

Capillary blood glucose monitoring (BGM) can help people with type 1 diabetes achieve these HbA_{1c} goals. A preprandial capillary plasma glucose target of 4.4–7.2 mmol/L (80–130 mg/dL) is appropriate for many people. Postprandial glucose may be targeted if HbA_{1c} goals are not met despite reaching preprandial glucose targets. Postprandial glucose measurements should be made 1–2 h after the beginning of the meal, which generally corresponds to peak levels in people with diabetes. A peak postprandial capillary plasma glucose of <10.0 mmol/L (<180 mg/dL) is appropriate for most people with diabetes, although an ideal target for normoglycemia is <7.8 mmol/L (<140 mg/dL). Higher goals in those with limited life expectancy or where the harms of treatment are greater than the benefits are recommended (Table 1).

Table 1—Glycemic targets for most adults with type 1 diabetes

Variable	Target value
HbA_{1c}	<53 mmol/mol (<7.0%)
GMI	<53 mmol/mol (<7.0%)
Preprandial glucose	4.4–7.2 mmol/L (80–130 mg/dL)
1–2 h postprandial glucose[a]	<10.0 mmol/L (<180 mg/dL)
TIR	>70%
TBR	
Readings and time <3.9 mmol/L (<70 mg/dL; level 1 and level 2 hypoglycemia)[b]	<4%
Readings and time <3.0 mmol/L (<54 mg/dL; level 2 hypoglycemia)[b]	<1%
Time above range	
Readings and time >10.0 mmol/L (>180 mg/dL; level 1 and level 2 hyperglycemia)[c]	<25%
Readings and time >13.9 mmol/L (>250 mg/dL; level 2 hyperglycemia)[c]	<5%
Glycemic variability (%CV)[d]	≤36%

All glycemic targets should be individualized and agreed with the person with diabetes. Lower or higher targets may be appropriate according to individual characteristics. [a]A postprandial glucose target of <7.8 mmol/L (<140 mg/dL) may be recommended if this can be achieved safely. Higher targets in those with limited life expectancy or where the harms of treatment are greater than the benefits are recommended. In some individuals at notably higher risk for level 3 hypoglycemia, it may be necessary to increase the glucose target range to decrease the TBR. [b]Level 1 hypoglycemia is defined as blood glucose levels <3.9 to ≥3.0 mmol/L (<70 to ≥54 mg/dL); level 2 hypoglycemia is defined as blood glucose levels <3.0 mmol/L (<54 mg/dL). [c]Level 1 hyperglycemia is defined as blood glucose levels >10.0 to ≤13.9 mmol/L (>180 to ≤250 mg/dL); level 2 hyperglycemia is defined as blood glucose levels >13.9 mmol/L (>250 mg/dL). [d]Some studies suggest that lower %CV targets (<33%) provide additional protection against hypoglycemia. GMI, glucose management indicator.

Further measurements that complement HbA_{1c} and BGM are assessments of the glucose management indicator (GMI) and time in range (TIR) from continuous glucose monitoring (CGM) data. GMI is calculated based on the average sensor glucose over the last 14 days and provides an approximation of a laboratory-measured HbA_{1c} in some individuals, but it may be higher or lower than actual HbA_{1c} in others (45). GMI and TIR may be more useful than HbA_{1c} for clinical management because they reflect more recent blood glucose levels and provide more detailed clinical information. A typical GMI goal is <53 mmol/mol (<7.0%). TIR is often taken as 3.9–10 mmol/L (70–180 mg/dL) for most adults and time below range (TBR) as below 3.9 mmol/L (70 mg/dL) (risk alert level), as well as less than 3.0 mmol/L (54 mg/dL) (clinically significant). Other metrics are also defined (Fig. 2). TIR is associated with microvascular complications (45,46), and a TIR of 70% roughly corresponds to an HbA_{1c} of 53 mmol/mol (7.0%). An international consensus conference reported that for most adults with type 1 diabetes, a target TIR should be above 70%, with TBR less than 4% and less than 1% for clinically significant hypoglycemia. The primary target for older people with a long duration of diabetes should be TBR less than 1% (47).

The cornerstone of type 1 diabetes therapy is insulin replacement. This is challenging because insulin demands vary widely according to meals, exercise, and many other factors. Furthermore, the insulin doses needed to prevent hyperglycemia are associated with a high risk of hypoglycemia, leaving people with type 1 diabetes walking a tightrope between high and low glucose levels. Insulin management must be supported by adequate monitoring of glucose and education and

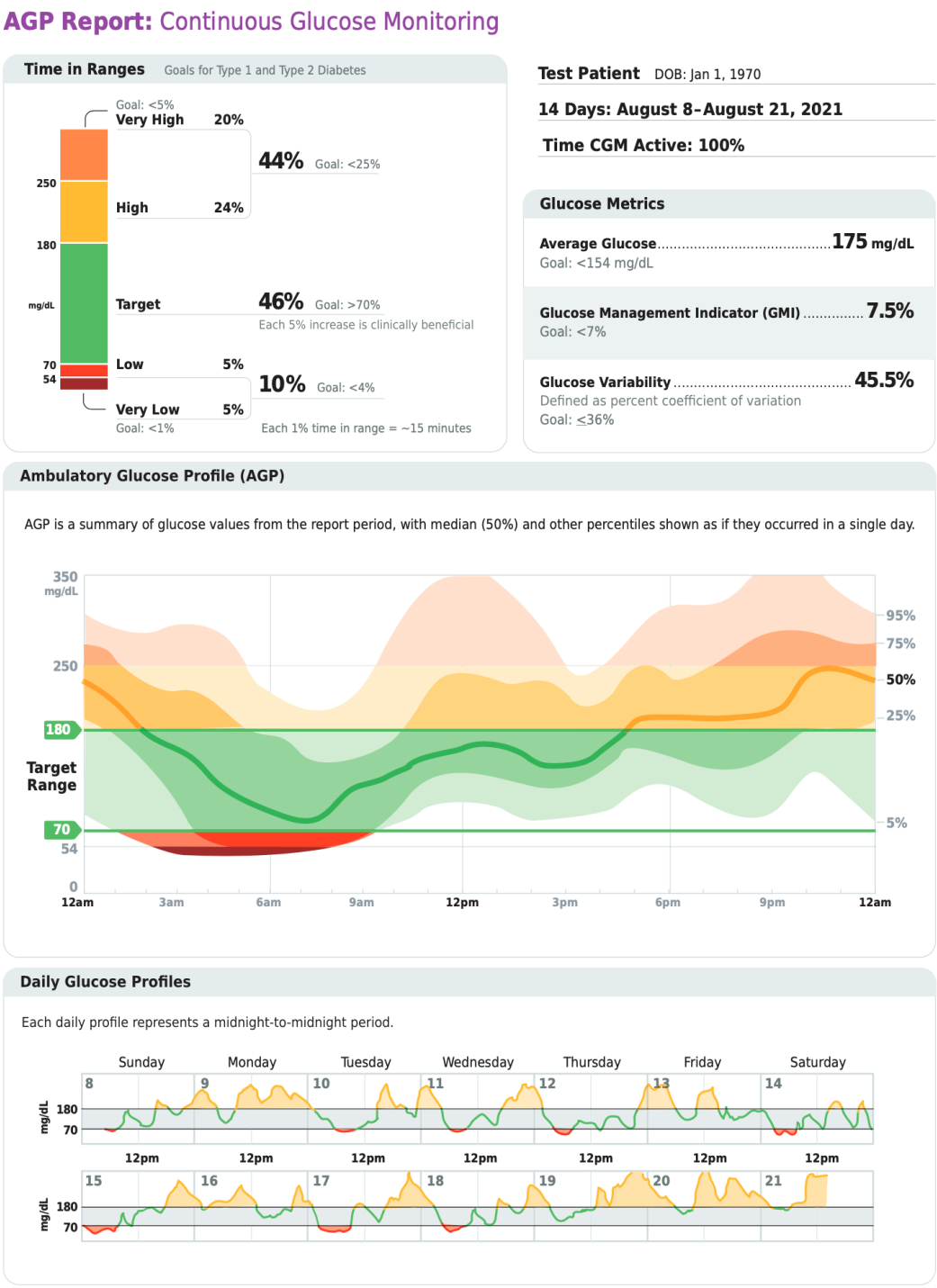

Figure 2—CGM visualization in an ambulatory glucose profile (AGP) report. Figure courtesy of R.M. Bergenstal and the International Diabetes Center, Minneapolis, MN. To convert glucose values to mmol/L, values in mg/dL should be divided by 18. DOB, date of birth.

training to allow the individual with type 1 diabetes to make the most of their treatment regimen.

The prevention of long-term complications of diabetes, particularly cardiovascular disease, extends beyond glycemic management to include the optimal management of blood pressure and use of lipid-lowering medication. There is an absence of high-quality data to guide blood pressure targets in type 1 diabetes, but RCTs in other populations have demonstrated that treatment of hypertension to a blood pressure <140/90 mmHg reduces cardiovascular events and microvascular complications. Blood pressure targets should be individualized, but a target of <140/90 mmHg is appropriate