Continuous Glucose Monitoring–Derived Data Report—Simply a Better Management Tool

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The introduction of A1C into routine diabetes care some 30 years ago provided the first reliable marker of glycemic control, clearly related to devastating chronic complications of diabetes. A1C became the standard metric to judge the quality of diabetes care and the primary outcome for all diabetes intervention trials investigating novel medications and new technologies. This dependence on A1C as our sole glycemic management guide and primary outcome measure was questioned by some investigators (1); however, the A1C was familiar and convenient and became the key diabetes pay-for-performance quality metric in the U.S. After decades of the "A1C era" in diabetes care, it is now evident that the management of diabetes guided by A1C has not yielded our desired results, and despite novel medicines and diabetes technology the mean A1C has actually deteriorated in the last decade (2–5). As national A1C levels were slipping, an impactful article entitled "Resurgence in Diabetes-Related Complications" was published (6), pointing out that while health care access, delivery, and preventive services are far from ideal, we also need to focus on innovative strategies to safely achieve glycemic targets. It seems fair to ask, what went wrong? Wasn't the introduction of continuous glucose monitoring (CGM) going to transform diabetes management (7)?

While it often takes 17 years to get approved therapies or technology innovations adopted and implemented in clinical practice (8), we believe that in the case of CGM, effective implementation will also involve a refinement of our management philosophy. Our current training on use of the CGM glucose profile and data report is to always address any noted patterns of hypoglycemia first. This is a sound principle, and using CGM we have been extremely successful in minimizing hypoglycemia as demonstrated in randomized clinical trials (9–11) and cohort studies (12). Unfortunately, in routine clinical care, we often forget the word *first* in the CGM teaching principle of "address hypoglycemia *first*." We are happy we prevented or reversed the feared and potentially dangerous condition of hypoglycemia, but then we often do not aggressively shift our focus to minimize the hyperglycemia usually also present. Maybe this is because the hyperglycemia is generally much less symptomatic and is a long-term issue that does not evoke the same urgency of attention as hypoglycemia. We seem surprised when the A1C actually drifts up or the CGM time in range (TIR) 70–180 mg/dL seems stuck at 50% when the international consensus target for TIR is over 70%. The "zero-harm strategy" (13) of "no hypoglycemia" advocated by many may finally prove harmful by also being associated with a general increase in hyperglycemia and chronic complications of diabetes (3,6). The big question for every endocrinologist, primary care physician, nurse practitioner, pharmacist, or diabetes educator is, with the availability of CGM, are we all ready to adopt a balanced diabetes management philosophy of aggressively minimizing hyperglycemia (time above range [TAR]) and hypoglycemia (time below range [TBR]) while maximizing TIR? Would such a TIR-centric approach to the day-to-day management of diabetes finally prevent or minimize acute and chronic diabetes complications (14)?

In this issue of *Diabetes Care*, an important report by Dr. Elena Toschi and colleagues from the Joslin Diabetes Center starts with an exemplary observation: "Current guidelines for older adults with T1D [type 1 diabetes] recommend less stringent hemoglobin A_{1c} (A1C) targets to mitigate hypoglycemia. . . . However, studies have shown that liberalization of A1C may not protect against the risk of hypoglycemia in the older population" (15). Exactly! One becomes tempted to think that the current guidelines for particularly

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vulnerable populations simply recommend the easiest thing to do—increase the mean glucose—despite the facts that this strategy does not always prevent hypoglycemia (3) and that the resulting increase in hyperglycemia clearly inflicts additional risk. Could we do better than this?

Toschi et al. (15) divided 130 adults aged ≥65 years (mean age 71 years, mean T1D duration 39 years, mean A1C 7.3% [56 mmol/mol]) in a post hoc analysis into two groups, those with percent coefficient of variation (CV%) ≤36% and those with CV% >36%, based on 14 days of CGM data according to the consensus recommendations (16). Both groups had the same mean A1C of 7.3%. Individuals with CV% ≤36% spent significantly less time in hypoglycemia (defined as $TBR^{<70}$ [under 70 mg/dL] and $TBR^{<54}$ [under 54 mg/dL]), confirming the well-established relation between CV and TBR (17), and, importantly, also significantly less time in hyperglycemia above 250 mg/dL ($TAR^{>250}$). If we use these data and present them according to the international consensus on clinical targets for CGM (18), we realize the value of working to improve glucose variability (CV%) in order to achieve our ultimate diabetes management goal of reaching both the consensus targets for TIR and TBR. Note that individuals with CV% ≤36% reached and exceeded targets for TBR and also almost reached targets for TIR and TAR, while individuals with CV% >36% fell short of reaching any of the consensus targets (Fig. 1), both groups having exactly the same A1C.

Furthermore, the glucose management indicator (GMI), the CGM-derived metric reflecting the mean sensor glucose level, differed from the laboratory A1C by more than 0.5% in 46% of participants: 37% of those had a GMI greater than the corresponding A1C, and 63% had a GMI lower than the A1C. When GMI was ≥0.5% higher than the A1C, it correlated significantly with TIR and $TAR^{>250}$, but not with TBR; conversely, when GMI was lower than A1C by ≥0.5%, it correlated significantly with $TBR^{<70}$ and $TBR^{<54}$, but not with TIR and TAR. This additionally delineated the superior sensitivity of GMI versus A1C to the time spent in respective glucose ranges that had already been demonstrated for younger populations (19,20), which may be even more important in older populations. The study by Toschi et al. provides support for the view that CGM data reports might improve management of T1D by identifying high risk through high CV, by setting more confident individual glycemic goals with assessment of the relationship between GMI and A1C, and by using TIR metrics for personalizing regimens to decrease CV. Notably, the use of CGM data reports can also help optimize metabolic control in insulin-treated type 2 diabetes (21).

Some feel that until there is a prospective randomized controlled trial showing that CGM metrics correlate with long-term complications, we are still in the A1C era. Others are encouraged that, while indirect and preliminary, there are data showing that derived CGM metrics like TIR do correlate with long-term complications (22).

We contend that regarding the most effective approach to glucose management we have clearly moved from the A1C era into the CMG management era, but we recognize some will need a transitional time combining both. Our goal in this CGM management era is to embrace the philosophy that it is possible and essential to achieve an optimal TIR, avoiding the harmful effects of acute (23) and chronic (24) hyperglycemia, while at the same time minimizing TBR or hypoglycemia. The CGM management era is just taking shape, and we know there is work to be done on many aspects of CGM implementation into practice, including effective workflow, data integration into the electronic health record, clinical decision support, measurement of quality of life, and reduction of the burden of living with diabetes. Particularly important is ensuring equitable access to and the affordability of CGM.

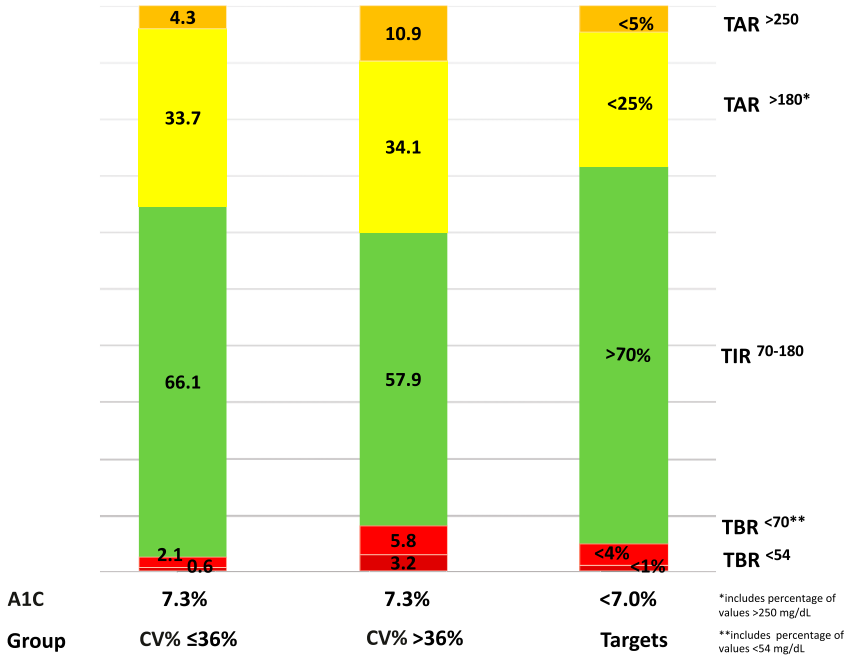

Figure 1—CGM data from Toschi et al. (15) represented as bars of the consensus Ambulatory Glucose Profile (18). Numbers in bars are percentages of the daily time in respective ranges.

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