

Blood Glucose Meters That Are Accessible to Blind and Visually Impaired Persons

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Abstract

Blood glucose meters (BGMs) that can be used nonvisually or with a visual limitation were introduced in the mid-1990s, but it was not until 2006 and 2007 that a new set of meters with accessibility features were introduced: Prodigy, Prodigy Autocode, and Prodigy Voice (Diagnostic Devices, Charlotte, NC), and Advocate and Advocate Redi-Code (TaiDoc, Taiwan). Accessibility attributes of the newly introduced BGMs were tabulated, and product design features were examined and documented. The Prodigy Voice was found to be the only one of these new BGMs that is fully usable by blind and visually impaired persons.

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Introduction

Blood glucose meters (BGMs) that are accessible to blind and visually impaired persons are important because a significant segment of the population of persons with diabetes are visually impaired, that is, they report problems seeing. In 2005, fully 3.2 million adults with diabetes (aged 18 or older) reported trouble seeing even while wearing glasses or contact lenses.¹ The number of visually impaired adults with diabetes has risen from 2.7 million in 1997 and has increased annually since 1999.¹

Simply stated, a BGM is accessible to a blind or visually impaired person if it is designed so that the person can operate it independently. Accessibility is relative in that product *a* may be more accessible than product *b*. Product design criteria for blood glucose monitoring to be accessible to blind and visually impaired persons

are of two types. First and foremost are criteria that are related to using the device nonvisually or with a visual limitation:

1. Spoken display data.
2. A high-contrast, large-font display.
3. Control buttons that are both tactually identifiable and distinctive in color contrast.
4. Test strip calibration that is accessible (e.g., automatic).
5. An accessible operating manual [i.e., large print and in an electronic format that can be read by personal computer (PC) screen-reading/magnifying software].
6. Accessible PC software (i.e., the format of downloading data can be read by PC screen-reading/magnifying software).

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Abbreviations: (BGMs) blood glucose meters, (FDA) Food and Drug Administration, (PC) personal computer

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Second are design criteria related to overall convenience and ease of use. To the extent that these criteria are compromised, for instance, using an obsolete BGM platform, accessibility results in a product that is inferior in usability, even if a blind or visually impaired person can operate it independently. Examples of convenience and ease of use design criteria include the following:

1. Highly portable.
2. Small blood sample and no cleaning required.
3. Easy-to-use test strips.
4. Fast processing of results.

Older BGMs with Accessibility Features

Blood glucose meters that have met many of the design criteria related to using the device nonvisually or with a visual limitation were first introduced in the 1990s. In a 2003 analysis of BGMs on the market at the time, Uslan and colleagues² identified three LifeScan (Milpitas, CA) BGMs that could be used with a separate speech unit, the Mini-Digi voice module. They were the One Touch SureStep, the One Touch Basic, and the One Touch Profile. Additionally, in the late 1990s, Roche Diagnostics (Indianapolis, IN) introduced the Accu-Chek Voicemate, a speech module into which the Accu-Chek Advantage BGM was docked (**Figure 1**). Because of the addition of the speech module, these four accessible BGM systems are bulkier, more complex, less user-friendly, and more expensive than the other contemporary but inaccessible BGMs on the market.²

New BGMs with Accessibility Features

Although the older meters are no longer being manufactured, they were still on the market in 2007. It was not until 2006 that new products with accessibility attributes were launched. Introduced during the period between 2006 and 2007 were five Food and Drug Administration (FDA)-approved meters with integrated speech output. Three were manufactured by Diagnostic Devices (Charlotte, NC)—Prodigy, Prodigy Autocode, and Prodigy Voice—and two were manufactured by TaiDoc (Taiwan)—Advocate and Advocate Redi-Code (see **Figure 2**). There are a number of distributors of these products in the United States, including Diagnostic Devices Inc., Diabetic Supply of Suncoast, Inc., and Pharma Supply, Inc.

Table 1 presents the physical attributes of the five BGMs launched in 2006–2007 compared to the BGMs



Figure 1. In 2003, accessibility to BGM technology was provided by the Mini-Digi voice module (**top**, with the LifeScan SureStep) and the Accu-Chek Voicemate (**bottom**, with the Accu-Chek Advantage).

introduced in the 1990s. As might be expected, the five BGMs launched in 2006–2007 showed considerable improvement over those of the 1990s in terms of size, weight, blood sample size, and speed. The display font has remained large but contrast has not improved, a serious limitation that has been observed in all BGMs, as well as other health self-management products, such as blood pressure monitors.³

In regard to the speech attributes of the BGMs, only the Prodigy Voice speaks all the information that the display outputs (see **Table 2**). While it stands out as the

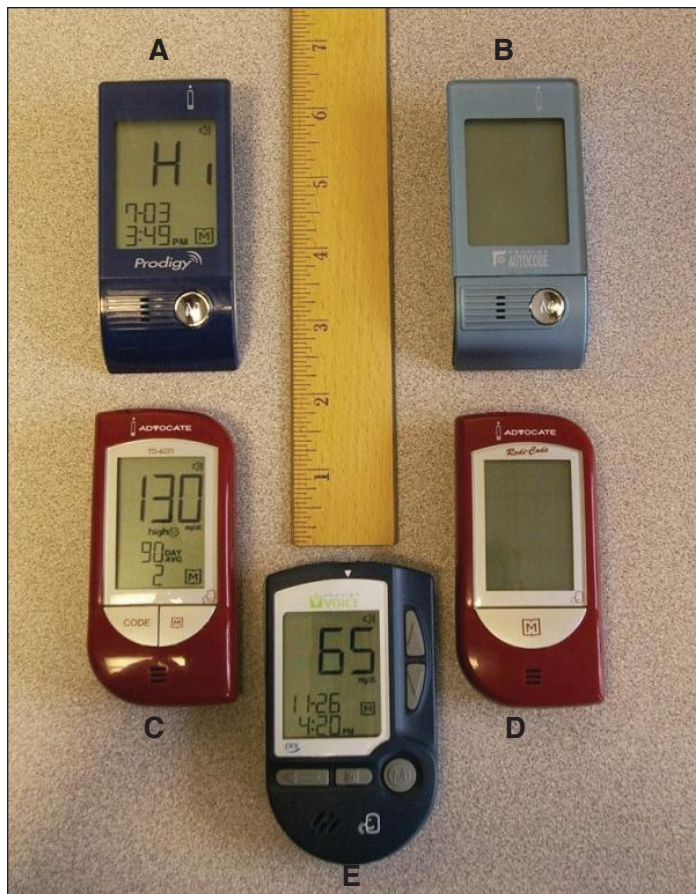


Figure 2. BGMs with integrated speech introduced in 2006–2007: (A) Prodigy, (B) Prodigy Autocode, (C) Advocate, (D) Advocate Redi-Code, and (E) Prodigy Voice.

most accessible BGM of them all, the Prodigy Voice does not yet have a manual compatible with screen-reading software.

Products in the Pipeline

The SensoCard Plus, manufactured for BBI Healthcare (United Kingdom) by Electronica 77 (Hungary), is currently under review by the FDA. While it uses integrated speech and is approximately 50% smaller than the Prodigy Voice, it lacks the autocoding, adjustable volume, and headphone jack features of the Prodigy Voice. Under development by Bay Area Digital (San Francisco, CA) is a speech module designed to be compatible with the FreeStyle Freedom BGM from Abbott Laboratories (Alameda, CA).

Conclusion

Since 2006 there has been considerable improvement in the portability of accessible meters brought about by the introduction of BGM technology with integrated speech. These BGMs have also shown improvement in other design criteria related to convenience and ease of use, such as smaller blood samples and faster processing of results. The Prodigy Autocode and the Prodigy Voice also introduced automatic test strip calibration. The Prodigy Voice is the most accessible of the newly introduced BGMs, comparing favorably to the BGMs first introduced in the 1990s. While that fact is a positive

Table 1.
Physical Attributes of BGMs Introduced in 2006–2007 vs the 1990s

	Prodigy Voice (Diagnostic Devices)	Prodigy and Prodigy Autocode (Diagnostic Devices)	Advocate and Advocate Redi-Code (TaiDoc)	SureStep (LifeScan) with voice module	Accu-Chek Voicemate (Roche Diagnostics)
Test strip calibration	Automatic	Manual for Prodigy, automatic for Prodigy Autocode	Manual for Advocate, automatic for Advocate Redi-Code	Manual	Code key
Blood sample size (μl)	0.6	0.6	0.7	10.0	4.0
Strips with capillary action	Yes	Yes	Yes	No	Yes
Alternative testing sites	Yes	Yes	Yes	No	Yes
Cleaning required	No	No	No	Yes	No
Response time (seconds)	6	6	7	15	26
Approximate meter size (inches: L \times W \times H)	3.74 \times 2.17 \times 0.71	3.75 \times 1.8 \times 1	3.5 \times 1.75 \times 0.75	4.5 \times 2.6 \times 1.8	6.5 \times 3 \times 2.5
Display font height (inch)	0.56	0.63	0.59	0.59	0.50
Weight (ounces)	2.7	2.8	2.5	9.8	12.5

Table 2.
Speech Attributes of BGMs Introduced in 2006–2007 vs the 1990s

	Prodigy Voice (Diagnostic Devices)	Prodigy and Prodigy Autocode (Diagnostic Devices)	Advocate and Advocate Redi-Code (TaiDoc)	SureStep (LifeScan) with voice module	Accu-Chek Voicemate (Roche Diagnostics)
Manual compatible with screen-reading software	No	No	No	No	No
Spoken glucose level	Yes	Yes	Yes	Yes	Yes
Speech support for adjusting settings, i.e., time, date, units of measurement	Yes	No	No	Yes	Yes
Spoken memory data	Yes	No	No	Yes	Yes
Error notifications	Yes	No	No	No	No
Low battery warning	Yes	No	No	No	Yes
Overall speech quality	High-quality recorded human voice	High-quality recorded human voice	High-quality recorded human voice	Lower quality synthetic speech	High-quality recorded human voice

development in the evolution of accessible BGMs, the Prodigy Voice is now the only accessible and up-to-date BGM usable by blind and visually impaired persons on the market. There are a few products in the pipeline. Until they become available, the Prodigy Voice is the one contemporary product that is comparable to the many off-the-shelf BGMs available to sighted persons today.

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