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Approaches to Risk Assessment Among Older Patients With Diabetes

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Abstract

Purpose of Review A patient's prognosis and risk of adverse drug effects are important considerations for individualizing care of older patients with diabetes. This review summarizes the evidence for risk assessment and proposes approaches for clinicians in the context of current clinical guidelines.

Recent Findings Diabetes guidelines vary in their recommendations for how life expectancy should be estimated and used to inform the selection of glycemic targets. Readily available prognostic tools may improve estimation of life expectancy but require validation among patients with diabetes. Treatment decisions based on prognosis are difficult for clinicians to communicate and for patients to understand. Determining hypoglycemia risk involves assessing major risk factors; models to synthesize these factors have been developed.

Summary Applying risk assessment to individualize diabetes care is complex and currently relies heavily on clinician judgment. More research is need to validate structured approaches to risk assessment and determine how to incorporate them into patient-centered diabetes care.

Keywords Aged · Aging · Diabetes mellitus · Risk assessment · Prognosis · Hypoglycemia

Introduction

Guidelines for the care of diabetes in older patients increasingly emphasize individualization: weighing the benefits and harms of treatment decisions based on a patient's individual needs and preferences [1••, 2••, 3••, 4, 5, 6••, 7••]. The two major decisions to be individualized are the selection of a glycemic control target and the choice of specific diabetes medications to achieve that target [1••, 2••, 3••, 4, 5, 6••, 7••]. To make these decisions, guidelines universally call for assessing a patient's health status and future risks [1••, 2••, 3••, 4, 5, 6••, 7••]. A patient's life expectancy and risk of developing adverse effects from diabetes treatment are considered key factors in selecting a glycemic target [1••, 2••, 3••, 4, 5, 6••, 7••], and risk of adverse drug effects, especially hypoglycemia, is critical for choosing between classes of diabetes medications [1••, 2••, 3••, 4, 5, 6••, 7••].

Therefore, in diabetes care, there is the necessity for risk assessment: the process of determining a patient's prognosis or chance of developing future health outcomes [8]. This may

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be achieved through clinical judgment, qualitative assessment of risk factors, or prediction using mathematical models. The process is especially important for diabetes care in older patients who are heterogeneous in terms of health and functional status which are predictors of remaining lifespan and can affect the expected benefits of glycemic control [9–14]. This is critical to consider because the time horizon for diabetes treatment benefit may fall within or outside the remaining lifespan of an individual [15, 16]. Compared with younger patients, older patients are also more susceptible to adverse drug effects such as hypoglycemia, highlighting the importance of considering medication harms [17–19].

Despite the importance of risk assessment in diabetes treatment decisions for older patients, there is little guidance for how this should be accomplished in practice and communicated to patients. This review provides an overview of the evidence for risk assessment among older patients with diabetes and discusses approaches to applying risk assessment in the context of major clinical guidelines. We also discuss challenges in performing and applying diabetes risk assessment and propose areas for future study. This review is targeted to clinicians treating older patients with type 2 diabetes, especially in ambulatory and long-term care settings.

Risk Assessment in Diabetes Clinical Guidelines

Diabetes guidelines for older patients incorporate risk assessment in two ways [1••, 2••, 3••, 4, 5, 6••, 7••]. First, they include assessment of a patient's life expectancy because the benefits of stringent glycemic control on major clinical outcomes take time to accrue. Second, guidelines include assessment of risk of adverse drug effects, especially hypoglycemia, which can occur immediately and can nullify future benefits of stringent glycemic control [20–22]. Guidelines use the concept of life expectancy to set individualized glycemic targets with varying levels of specificity (Table 1). Guidelines from the American Geriatrics Society refer to patients with "limited life expectancy" while guidelines from the American Diabetes Association (ADA) group patients into categories of long, intermediate, and short life expectancy [1••, 3••, 4]. Guidelines from the Endocrine Society use a patient's health status (good, intermediate, or poor) as a proxy for life expectancy [7••, 23]. In contrast, guidelines from the Department of Veterans Affairs group patients according to years of remaining life: 10–15 years or < 5 years [6••]. None of these guidelines specify how life expectancy should be estimated. Guidelines are consistent in their recommended hemoglobin A1c (HbA1c) target for patients with the shortest life expectancy: either 8.0–9.0% or < 8.5% (Table 1) [1••, 3••, 4, 6••, 7••].

There is consensus among guidelines that a patient's risk of hypoglycemia should be assessed routinely and used to guide care, though how that assessment should occur is largely not specified [1••, 2••, 3••, 4, 5, 6••, 7••, 24••]. A systematic review published in 2010 found that major risk factors for hypoglycemia are rarely mentioned in diabetes guidelines or quality metrics [25]. The ADA added a table of risk factors for hypoglycemia in its 2019 standards of care, though they do not state the relative weight of these risk factors or how they should inform decision making [24••].

Table 1 Summary of risk assessment in diabetes guidelines for older patients around individualizing glycemic targets

Guidelines	Life expectancy description	Corresponding HbA1c targets	Consideration of adverse drug effects
American Geriatrics Society [4]	• Limited life expectancy	• 8.0–9.0%	No explicit recommendation
Department of Veterans Affairs [6]	• 10–15 years • < 5 years	• < 7.0% • 8.0–9.0%	Consider risk of adverse drug effects when selecting HbA1c target[a]
American Diabetes Association [1, 3]	• Long life expectancy • Intermediate life expectancy • Short life expectancy	• < 7.5% • < 8.0% • < 8.5%	Consider risk factors for hypoglycemia and other adverse drug effects when selecting HbA1c target[a]
European Diabetes Working Party for Older People [5]	No explicit recommendation	No explicit recommendation	Choose higher HbA1c target in those with high risk of hypoglycemia[a]
Endocrine Society [7]	Use Blaum framework[b] to determine:		For insulin, sulfonylurea, or meglitinide users, HbA1c targets are:
	• Good health	• < 7.5%	• ≥ 7.0% and < 7.5%
	• Intermediate health	• < 8.0%	• ≥ 7.5% and < 8.0%
	• Poor health	• < 8.5%	• ≥ 8.0% and < 8.5%

[a] Instructions to determine risk of adverse drug effects are not given

[b] Incorporates comorbidities, functional impairments, and activities of daily living dependencies to estimate health status in three categories (good, intermediate, poor) intended to correspond to increasing mortality risk [23]

An important consideration that forms the basis of these guidelines is the amount of time necessary to accrue benefits from stringent glycemic control. Evidence for the timing of microvascular and macrovascular benefits comes primarily from the United Kingdom Prospective Diabetes Study (UKPDS) 34 [26, 27] and subsequent trials of tight glycemic control: Action to Control Cardiovascular Risk in Diabetes (ACCORD), Action in Diabetes and Vascular Disease (ADVANCE), and the Veterans Affairs Diabetes Trial (VADT) [28–32]. UKPDS enrolled adults aged 25 to 65 years with newly diagnosed type 2 diabetes between 1977 and 1991 who were randomized to conventional treatment (only starting medications for marked hyperglycemia or symptoms) versus intensive treatment (initial treatment with a sulfonylurea, insulin, or metformin in overweight patients) [26]. Over 10 years of follow-up, the intensive arm achieved a median HbA1c of 7.0% versus 7.9% in the conventional arm, though HbA1c rose substantially in both groups [26]. There was a 25% relative risk reduction in microvascular outcomes in the intervention arm, predominantly nephropathy, with a significant effect not observed until 9 years [26]. During 10 years of additional follow-up, the intervention was associated with a significant 15% relative risk reduction in myocardial infarction and 13% reduction in mortality, especially in those who received metformin [27]. The ADVANCE trial randomized middle-aged and older patients (mean age 66 years) with established type 2 diabetes to tight versus standard glycemic control, achieving a median HbA1c of 6.5% versus 7.5% over 5 years. The main findings were a significant 21% relative risk reduction in nephropathy with Kaplan-Meier curves appearing to separate after 2 years [29, 30]. VADT included veterans with type 2 diabetes and achieved a median HbA1c of 6.9% versus 8.4% over 5.6 years; there were no significant benefits of tight control during the intervention period, but a significant 17% relative risk reduction in cardiovascular events was found after an additional 5 years of post-trial follow-up, with no significant effect on mortality [31, 32]. The ACCORD trial was stopped after a median follow-up of 3.5 years due to increased all-cause mortality in the intervention arm [28]. Collectively, these findings suggest that cardiovascular benefits of stringent glycemic control become most relevant after a decade and microvascular benefits appear sooner. These findings may not be representative of older patients with functional impairments or severe comorbid illness who are often excluded from clinical trials of diabetes treatment [33, 34••]. A simulated clinical trial of tight versus standard glycemic control in older patients of varying health status found that the benefits of tight glycemic control become minimal with life expectancy shorter than 5 years [14].

Recent trials of GLP-1 receptor agonists and SGLT-2 inhibitors suggest that cardiovascular benefits of diabetes treatment are achievable in short timeframes [35••, 36••, 37••, 38••]. Trials testing the cardiovascular effects of GLP-1 receptor agonists or SGLT-2 inhibitors against placebo found significant reductions in cardiovascular outcomes after a median follow-up of 2.1 to 3.8 years [35••, 36••, 37••, 38••]. These trials examined specific medications rather than glycemic targets, so the impact of the use of these medications on the timing of benefits of pursuing stringent glycemic control is not clear. However, it is important to acknowledge that the time to benefit of these medications is short, similar to that found with the addition of a statin [39], and that patients with life expectancies as short as 5 years could potentially benefit from the addition of these agents.

Assessing Life Expectancy

To estimate long-term prognosis, several approaches are available which could be used in conjunction: clinical experience, life tables, and tools to estimate prognosis [15, 16, 40]. Use of multiple approaches may be needed because clinicians' subjective estimate of life expectancy is often not accurate [41–47]. Life tables, such as those available from the Centers for Disease Control and Prevention (CDC), provide the average life expectancy for patients of a specific age group, gender, and race/ethnicity [48]. Prognostic tools, also called prognostic indices or calculators, use a patient's clinical features to predict life expectancy or risk of mortality within a certain timeframe [49–51]. Based on a limited number of studies of clinician decision making, it seems that prognostic tools are rarely used; in a qualitative study of 28 primary care providers in a large group practice, none routinely used prognostic tools to assess life expectancy [52•]. Among older patients with diabetes, data suggest that prognostic tools complement a clinician's estimate of prognosis. In a study of 447 older patients with diabetes, estimated 5-year mortality by both their physician and a mortality prediction model had similar, modest accuracy; accuracy improved when using the model and physician estimate together [53•]. Therefore, the best estimate of prognosis among older patients with diabetes may incorporate both subjective and quantitative methods.

There are a number of validated prognostic tools which may be useful to predict life expectancy among older patients with diabetes in clinical practice; these tools vary in their target population and timeframe for prediction (Table 2) [49–51]. The Lee Index and Schonberg Index may be most relevant for diabetes care in ambulatory practice because the underlying models were developed among community-dwelling older patients and can be used to estimate mortality for up to 10 or 14 years, respectively [58–60]. The Lee Index was validated in a sample of the US-based Health and Retirement Study in which there was a 16% prevalence of diabetes, and the English Longitudinal Study on Ageing which had an 8% diabetes prevalence [58–60]. The Schonberg Index was validated in samples of the US

Table 2. Characteristics of tools to estimate prognosis or hypoglycemia risk among older patients who are community -dwelling or residing in long-term care facilities

Index	Target population	Outcome	Characteristics of development cohort (DC) and validation cohort (VC)	Diabetes prevalence in development and validation	Discrimination in validation cohort (c-statistic)
Prognostic tools					
Gagne Index [54]	Adults aged ≥ 65 years with low income	1-year mortality	DC: Medicare beneficiaries in Pennsylvania receiving low-income benefits (2004–2005) VC: Medicare beneficiaries in New Jersey receiving low-income benefits (2004–2005)	DC: 34% VC: not reported	0.79
Mazzaglia Index [55]	Community-dwelling adults aged ≥ 65 years	1-year mortality	DC: primary care patients in northwest Florence, Italy (2003) VC: primary care patients in southeast Florence,Italy (2003)	Not reported	0.75
Carey 2 Year Index [56]	Community-dwelling adults aged ≥ 70 years	2-year mortality	DC: participants in a national cohort study of community-dwelling older adults; eastern, western, and central USA (1993) [54] VC: same, but southern region	D: 13% VC: 14%	0.74
Carey 3 Year Index [57]	Frail, community-dwelling adults aged ≥ 65 years	3-year mortality	DC: nursing-home eligible adults enrolled in PACE [56]; western U.S. (1988–1996) VC: same, but midwestern and eastern USA	DC: 23% VC: 27%	0.69
Lee Index [58–60]	Community-dwelling adults aged ≥ 50 years	4-, 8-, and 10-year mortality; median life expectancy	DC: HRS eastern, western, and central regions (1998) VC #1: same, but southern region VC#2: ELSA (2004)	DC: 14% VC #1: 16% VC #2: 8%	VC #1, 4-year mortality 0.82 VC #1, 8-year mortality 0.78 VC #1, 10-year mortality 0.83 VC #2, 8-year mortality 0.80
Schonberg Index [61–63]	Community-dwelling adults aged ≥ 65 years	5-, 9-, and 14-year mortality	DC: random sample of NHIS (1997–2000) VC #1: same, but a separate random sample VC #2: NHIS (2001–2004)	DC: 15% VC #1: 16% VC #2: 18%	VC #1, 5-year mortality 0.75 VC #1, 9-year mortality 0.75 VC #1, 14-year mortality 0.72 VC #2, 5-year mortality 0.75
Suemoto Index [64]	Community-dwelling adults aged ≥ 60 years in developed and developing countries	10-year mortality	DC: random sample of HRS (1998–2010), ELSA (2002–2013), MHAS (2003–2012), SABE (2000–2010), SHARE (2004–2013) VC: same, but a separate random sample	Full cohort: 13%	0.76
Porock Index [65, 66]	Older adults residing in long-term care facilities	6-month mortality	DC: random sample of long-term care residents in Missouri, MDS data (1999) VC: same, but a separate random sample	Not reported	DC: 0.75 (VC not reported)
Mitchell Index/ADEPT [67, 68]	Long-term care residents aged ≥ 65 years with advanced dementia	6-month mortality	DC: long-term care residents with advanced dementia in the USA, MDS data (2002)	DC: 19% VC: not reported	0.67

Table 2. (continued)

Index	Target population	Outcome	Characteristics of development cohort (DC) and validation cohort (VC)	Diabetes prevalence in development and validation	Discrimination in validation cohort (c-statistic)
			VC: long-term care residents with advanced dementia in 21 nursing homes near Boston, MA (2007–2009)		
Flacker Newly Admitted Revised Index [69]	Newly admitted long-term care residents aged ≥ 65 years	1-year mortality	DC: newly admitted long-term care residents in New York state, MDS data (June, 1994 to December, 1996) VC: same, but December, 1996 to December, 1997	DC: 21% VC: 22%	0.73
Flacker Long Stay Revised Index [69, 70]	Long-term care residents (for at least 1 year) aged ≥ 65 years	1-year mortality	DC: long-term care residents (for at least 1 year) in New York state, MDS data (June 1994 to March 1997) VC #1: same, but March, 1997 to December, 1997 VC #2: a long-term care facility in Missouri (2007)	DC: 20% VC #1: 21% VC #2: 24%	VC #1: 0.71 VC #2: 0.72
Hypoglycemia risk tools					
Karter model [71, 72]	Adults with type 2 diabetes	1-year risk of hospital utilization for hypoglycemia in 3 categories	DC: adults with type 2 diabetes in Kaiser Permanente Northern California (2014) VC #1: DEpiC, Virginia sample VC #2: Group Health Cooperative, a health system in Washing State	Only patients with type 2 diabetes were included	VC #1: 0.81 VC #2: 0.79
Schroeder model [73]	Adults with type 1 or type 2 diabetes	6-month risk of hospital utilization for hypoglycemia	DC: adults with diabetes in Kaiser Permanente Colorado (2007–2015) VC #1: adults with diabetes in Kaiser Permanente Northwest VC #2: adults with diabetes in HealthPartners health system in Minneapolis, Minnesota	Only patients with diabetes were included (~ 95% were type 2 diabetes)	6-variable: VC #1: 0.80 VC #2: 0.80 16-variable: VC #1: 0.83 VC #2: 0.84
Chow model [74]	Community-dwelling adults with type 2 diabetes	5-year risk of severe hypoglycemia	DC and VC: random samples (fivefold validation) of ACCORD trial participants: adults with type 2 diabetes and cardiovascular disease or high cardiovascular risk	Only patients with type 2 diabetes were included	0.78

Program of All-Inclusive Care for the Elderly (PACE), National Health Interview Survey (NHIS), Health and Retirement Study (HRS), English Longitudinal Study on Ageing (ELSA), Mexican Health and Aging Study (MHAS), Sao Paulo Health, Well-being and Aging Study (SABE), Survey on Health, Ageing and Retirement in Europe (SHARE), Minimum Data Set (MDS), Advanced Dementia Prognostic Tool (ADEPT), Veterans Administration Diabetes Epidemiology Cohort (DEpiC), Action to Control Cardiovascular Risk in Diabetes (ACCORD)

National Health Interview Survey with a diabetes prevalence of 16 to 18% [61, 62, 63••]. Both tools have good discrimination in their validation samples and are well calibrated across risk levels [58, 59••, 60–62, 63••]. Although these tools have not been validated among populations exclusively comprised of patients with diabetes, we suspect they will be accurate because of their good performance in large, diverse samples of older patients. The Suemoto Index was developed to estimate 10-year mortality among older patients including those residing in developing countries and has good internal validity, but has not been externally validated [64••]. There are two prognostic tools for older adults residing in long-term care facilities which have been validated in populations with a high diabetes prevalence, though they only estimate mortality for up to 1 year [69, 70].

Statistical models for predicting mortality and other outcomes among patients with diabetes have been developed, but these are primarily used for research and policy purposes [75, 76]. Attempts have been made to develop clinical tools based on these models, notably the Diabetes PHD tool which is no longer available [77–81]. Diabetes PHD, which was based on the Archimedes model [77–79], was known for producing different outcome predictions from one simulation to the next, despite entry of identical variable information for an individual patient [80, 81].

To incorporate life expectancy into clinical diabetes care, we advocate an approach (Fig. 1) based on the recommendations of the American Geriatrics Society for the care of older patients with multiple chronic conditions [16, 40]. This approach aligns a patient's life expectancy with the expected time to benefit from treatment, grouping each into three categories: short-term (< 1 year), mid-term (1–5 years), and long-term (> 5 years) [16, 40]. As discussed above, the benefits of stringent glycemic control on cardiovascular outcomes are most relevant long-term [26–32]. Microvascular benefits are relevant mid-term [26–32]. Symptomatic hyperglycemia is relevant for all timeframes because treatment should be escalated if this occurs [1••, 2••, 3••, 4, 5, 6••, 7••]. To estimate life expectancy, we advise starting by determining the average life expectancy for the patient's age and gender using life tables available from the CDC (https://www.cdc.gov/nchs/products/life_tables.htm) [48]. While patients with diabetes are at greater risk of mortality than the general population, the difference is small for patients aged 75 years or older; thus, general life tables present a reasonable starting point [82, 83]. Information from life tables should be modified by an understanding of the patient's overall health, especially the presence of poor functional status or end-stage conditions affecting major organ systems which may suggest a high short-term mortality [16, 40]. Use of an appropriate prognostic tool (Table 2) should be considered to complement and refine physician-estimated life expectancy; these tools can be accessed online using the ePrognosis website supported by the Division of Geriatrics at the University of California San Francisco (https://eprognosis.ucsf.edu) [51]. The patient's estimated prognosis should inform discussions about their treatment goals and preferences, acknowledging that there is substantial uncertainty in estimating life expectancy, and it is only one of several factors that should contribute to diabetes treatment decisions. While there is much variation in patient preference for receiving prognostic information, framing the discussion in terms of weighing the benefits and harms of treatment may be more effective than as a decision based on life expectancy [84–86]. The ePrognosis website also includes examples of how to incorporate prognosis into diabetes treatment discussions [51].

Assessing Risk for Hypoglycemia

Hypoglycemia is the most common serious adverse effect of diabetes medications, and is responsible for approximately 25% of emergency hospitalizations for adverse drug events among older patients [19]. Prevention of hypoglycemia is especially important for older patients in whom hypoglycemia is associated with high rates of vascular events, falls, cognitive

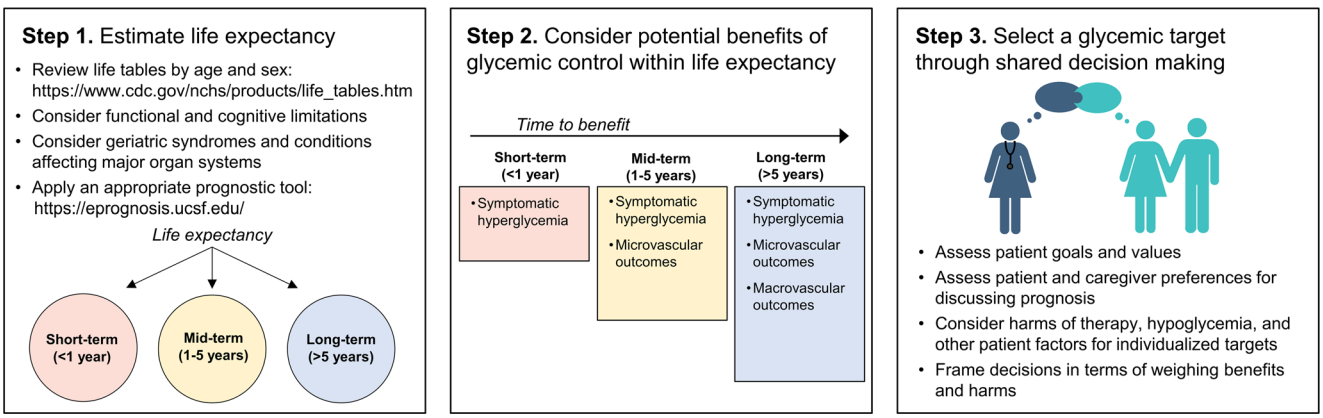

Fig. 1 Approach to applying life expectancy to individualized glycemic targets

impairment, and mortality, and a lower quality of life [87–93, 94••]. In ACCORD and ADVANCE, tight compared with standard glycemic control caused a significant 80–90% relative risk increase of severe hypoglycemic events, though observational studies indicate that severe hypoglycemia can occur at any HbA1c level [22, 28, 30, 93]. Analyses of the cost-effectiveness of diabetes treatment have found that the benefits of more stringent glycemic control are often outweighed by increased rates of hypoglycemia [20, 21].

Little is known about how clinicians are currently assessing hypoglycemia in clinical practice, though existing data suggest that a patient's risk for hypoglycemia is often underrecognized [95–97]. In a recent survey, Veterans Affairs clinicians were presented with the clinical scenario of an older patient at high risk for hypoglycemia and 45% of clinicians stated they would not worry about the harms of tight glycemic control in this patient [95]. This lack of recognition of hypoglycemia risk may stem from the need for more training for clinicians in hypoglycemia assessment, or further clarity in diabetes guidelines for how to apply hypoglycemia risk to treatment decisions.

Recently, three risk prediction tools have been developed to estimate hypoglycemia risk on the basis of clinical features among outpatients with type 2 diabetes (Table 2) [71••, 72•, 73••, 74••]. The tools developed by Karter et al. [71••, 72•] and Schroeder et al. [74••] are intended to be used with electronic medical record or claims data for population health management strategies. The Karter et al. tool estimates 1-year risk of hypoglycemia-related hospital utilization in three risk categories. Inputs are number of all-cause and hypoglycemia-related hospital utilizations, age, chronic kidney disease stage, and use of insulin or a sulfonylurea. The tool was developed among patients with type 2 diabetes with a mean age of 64 years in the Kaiser Permanente system and externally validated in two populations. Its main limitation is that the patient's number of prior hospitalizations for hypoglycemia must be known, which may not be easy to ascertain. The Schroeder et al. tool [74••], which predicts 6-month risk of hospital utilization for hypoglycemia, included patients with both type 1 and type 2 diabetes in development and validation. Versions were developed using either six or 16 input variables, with both versions having good discrimination in external validation. This tool requires users to enter inputs into a regression equation and has not been validated among populations with only type 2 diabetes. A tool by Chow et al. [73••], which was developed using data from the ACCORD trial, is intended for use during clinical encounters. The outcome was 5-year risk of self-reported severe hypoglycemia (hypoglycemia requiring assistance from another person). Model inputs are 13 clinically measured variables including demographics, clinical characteristics, and laboratory values. Limitations of this model include that it has not been externally validated, and its large set of inputs may be time consuming for clinicians to use.

To perform hypoglycemia risk assessment in the clinical setting, in the absence of an accessible, externally validated tool, we advocate an approach of assessing key risk factors, focusing on those factors that consistently impart the greatest hypoglycemia risk for older patients [24••, 71••, 72•, 73••, 98, 99]. While all diabetes medications can cause hypoglycemia [34••], patients most at risk are those using insulin, sulfonylureas, or meglitinides, but especially insulin which imparts a 2- to 3-fold risk for severe hypoglycemia compared with other diabetes medications [73••, 100, 101]. Diabetes medications on the Beers criteria list, a list of potentially inappropriate medications for older adults, should be given special attention: sliding scale insulin and long-acting sulfonylureas (glyburide and chlorpropamide) [102]. A history of hypoglycemia is consistently one of the strongest risk factors for future hypoglycemia, with a history of recent or severe hypoglycemia imparting a particularly high risk of recurrence [71••, 72•, 73••, 74••]. In addition, the risk of hypoglycemia increases incrementally with age and diabetes duration; other high-risk subgroups are patients with kidney disease, racial/ethnic minorities, and those with lower socioeconomic status [24••, 71••, 72•, 73••, 98, 99]. Lastly, clinicians should consider high-risk states for adverse drug events in older patients that are not well captured in risk models, in particular recent transitions of care or medication changes, and the presence of cognitive impairment, functional impairment, or polypharmacy [17, 103].

Challenges in Applying Risk Assessment

The substantial challenges of utilizing prognosis to individualize glycemic targets are reflected in diabetes treatment patterns. Counter to guidelines, tight glycemic control is common among older patients with limited life expectancy and a greater severity of comorbid illness is associated with more stringent glycemic control [104–107]. This translation gap may be due to barriers in estimating life expectancy, difficulty applying life expectancy estimates to treatment decisions, or difficulty communicating these issues with patients. Beyond the difficulties in estimating life expectancy, a clinician must then weigh that estimate against as many as six other factors to determine a glycemic target without an indication of their relative importance [1••]. Further, clinicians often find it challenging to communicate treatment decisions to patients in terms of prognosis, stemming from its inherent uncertainty and concerns about the patient's reaction [52•, 108]. In qualitative studies, clinicians report concerns that patients will think they are abandoning them, or that estimating prognosis will take

away hope [52•, 108]. Patients and their caregivers have varying preferences for how prognosis should be discussed, and the information they receive often does not align with their preferences [86, 109]. One national survey of older adults found that most respondents did not wish to discuss long-term life expectancy until the last 1–2 years of life [110•]. This may be a gap in clinician knowledge as guidelines and training in communicating prognosis often focus on patients who are seriously ill, with little attention given to addressing long-term prognosis for older patients with stable health status [4, 15, 111].

Using life expectancy to individualize treatment may be a difficult concept for patients to accept. The field of geriatric diabetes may benefit from lessons learned from other areas of medicine such as geriatric oncology where life expectancy has been used to individualize cancer screening decisions. Similar to glycemic control, cancer screening decisions are not optimally individualized, with many older patients being overscreened or ceasing screening when they may have benefited, [112–116]. In qualitative studies, older patients were amenable to using their health status to inform screening decisions but most did not perceive life expectancy as relevant [117••, 118, 119]. Individualized cancer screening decisions were more likely to occur when communicating the decision as a shift in health priorities rather than life expectancy, and when conversations occurred in the context of a trusting patient-clinician relationship [117••, 118, 119]. Overall, there is a need for more research into how life expectancy, which is relevant to many treatment decisions in the care older patients, can best be communicated in the context of individualized treatment.

To provide individualized, guideline-concordant care for older patients with limited life expectancy or high hypoglycemia risk, it often becomes necessary to deintensify or deprescribe diabetes treatment, which presents additional barriers. The concept of treatment deintensification has been absent from many guidelines [120] but was recently added to the ADA's standards of care [3••]. In practice, deintensification occurs infrequently among older patients with tight glycemic control [121•, 122, 123•]. This may be due to barriers in how clinicians and patients view deprescribing, and health system factors such as diabetes quality metrics and lack of support for deintensification [124–128]. The fact that there are substantial rates of high-risk diabetes medication use and hypoglycemia among patients on hospice attests to the difficulties in pulling back diabetes treatment [129•]. More research is needed to promote appropriate deprescribing if diabetes risk assessment is to be applied effectively.

Conclusions

Guidelines for diabetes care in older patients are clear that clinicians should perform individualized risk assessment for a patient's long-term mortality and risk of hypoglycemia when considering glycemic targets and diabetes medication selection [1••, 2••, 3••, 4, 5, 6••, 7••]. While such an assessment may seem intuitive to practicing clinicians, we lack an evidence base to support this patient-centered approach. Our review highlights four major gaps in this evidence: (1) how assessment of life expectancy and hypoglycemia risk should be accomplished; (2) how life expectancy and hypoglycemia risk should then be synthesized with other factors affecting diabetes treatment decisions; (3) effective ways to communicate risk to patients; and (4) practical methods and tools for implementing risk assessment and communication into routine clinical care.

Current evidence suggests that diabetes care is not optimally individualized with respect to a patient's life expectancy [104–107]. Risk prediction tools could complement clinical judgment to provide a general estimate to be considered in the context of the time needed to benefit from glycemic control and the patient's goals and preferences. There is a need to validate existing tools among older patients with diabetes specifically, including the incorporation of the lengthening of life expectancy due to improvements in health and health care [48]. Also, there remains substantial uncertainty in the time necessary to accrue benefit from tight glycemic control which may be clarified with well-conducted cohort studies and pragmatic interventions including diverse populations of older patients and newer classes of diabetes medications.

There is a need to develop structured approaches to assessing hypoglycemia risk, which is critical to the safety of diabetes treatment in older patients. While several studies have identified risk factors for hypoglycemia in older patients, there is a lack of recent systematic reviews synthesizing these, which would help to define their relative priorities [24••, 71••, 72••, 73••, 74••, 98, 99]. Risk prediction tools for hypoglycemia may be helpful in clinical practice, but there is a need to simplify these tools and determine their validity and incremental value compared with clinician judgment. In the meantime, diabetes guidelines should incorporate a tiered approach to assessing hypoglycemia risk factors, with a focus on those that impart the greatest risk.

Further research is needed to determine how risk assessment, especially for a patient's life expectancy and hypoglycemia risk, should be incorporated into patient-centered diabetes care in the context of other factors important to treatment selection (e.g., comorbid conditions). Also, communicating treatment decisions based on a patient's long-term prognosis remains a considerable challenge [52•, 86, 108, 109]. More studies are needed to understand how older patients perceive prognosis in the context of diabetes treatment so that clinicians can be trained to communicate these decisions more effectively.

Finally, for risk assessment to be incorporated into routine diabetes care, it must be made accessible for use by clinicians in busy practices. The widespread adoption of electronic health records with increasing computing power may allow health systems to incorporate decision support into clinical operations so that these steps can be carried out with more ease in the future. Attempts are being made to combine diabetes risk prediction models with decision support for patients and clinicians, which show promise for helping to individualize treatment decisions [130•]. Ultimately, risk assessment is critical to individualized diabetes treatment, yet also complex and difficult to implement and integrate into care, making it the ideal target for new and creative approaches to personalized medicine.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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