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HOSPITAL MANAGEMENT OF DIABETES (G UMPIERREZ, SECTION EDITOR)

Diabetes in Long-Term Care Facilities

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Abstract With the aging of the population and longer life expectancies, the prevalence of population with multiple chronic medical conditions has increased. Difficulty managing these conditions as people age (because of changes in physical, functional, or cognitive abilities and the complexity of many treatment regimens), has led to more individuals with multiple medical conditions admitted to the long-term care facilities. Older adults with diabetes residing in the long-term facilities represent the most vulnerable of this cohort. Studies that specifically target diabetes management in older population are lacking and those that target diabetes management in the long-term care facilities are even fewer. The lack of knowledge regarding the care of the elderly residing in long-term care with diabetes may lead to treatment failure and higher risk of hyperglycemia, as well as hypoglycemia. In aging populations, hypoglycemia has the potential for catastrophic consequences. To avoid this, the management of older population with diabetes and other medical comorbidities residing in long-term care facilities requires a more holistic approach compared with focusing on individual chronic disease goal achievement.

Keywords Older adults · Long-term care · Diabetes mellitus

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Introduction

Diabetes is a common chronic medical condition affecting the elderly population in the United States with a significant economic and psychosocial impact [1••]. It is a progressive illness that increases the risk of complications, such as cardiovascular disease, peripheral vascular disease, neuropathy, retinopathy, and kidney disease [2••]. In addition, with aging, the presence of diabetes is associated with other medical comorbid conditions (called Geriatric Syndrome) that include conditions such as cognitive dysfunction, depression, and physical disability [3]. Thus, management of diabetes in older adults presents unique challenges. Many aspects of the disease including pathophysiology, diagnostic criteria, dosing, and side-effects of medications, dietary consideration, exercise strategies, and impact of the disease on quality of life require special considerations in this population. Thus, it is important to understand unique aspects of diabetes management in this population and develop better plans of care. There is a paucity of data regarding management of diabetes in long-term care (LTC) populations. There are known and unknown physiological changes that occur with aging making it difficult and probably inaccurate to extrapolate findings from studies done on younger patients with diabetes. Thus, the care of older patients in LTC facilities is often suboptimal and misguided [4]. In this review, we discuss the characteristics of older adults with diabetes in LTC, the unique challenges in managing their diabetes.

Socioeconomic Burden

According to the 2011 National Diabetes Factsheet, 10.9 million seniors (aged ≥65 years) or 26.9 % of the population has diabetes [5•]. This contrasts with 11.3 % of people aged 20 years or older having diabetes. The prevalence of diabetes is

even higher in the elderly population residing in the nursing homes. In a national nursing home survey, prevalence of diabetes increased from 16.3 % in 1995 to 23.4 % in 2004 [6]. The increased prevalence was significant in oldest of old (age ≥85 years) and for those with functional impairment. Cross-sectional data from the survey in 2004 showed that 24.5 % of nursing home residents had diabetes listed as a primary admission and/or current diagnosis. The residents admitted to the nursing home with diagnosis of diabetes were younger, were more likely to be admitted from acute care hospitals, and were more likely to utilize Medicare and Medicaid than those without diabetes [7]. According to the National Center for Health Statistics, there were 1.6 million nursing home residents in the Unites States as of 2012. The prevalence of diabetes in LTC facilities is thought to be underestimated due to reliance on self-reporting and use of inconsistent methods of identification

The economic impact of this disease in older adults is enormous. Nursing home costs for people with diabetes were estimated at 18.5 billion dollars in 2007 [8]. The updated estimates from data sources such as national surveys, medical standard analytical files, and clams databases for the commercially insured population in U.S in 2012 showed that the total cost of diabetes in the United States is approximately $245 billion, with $176 billion for direct medical costs and $69 billion in reduced productivity and mortality [9••]. After adjusting for population age and sex differences, average medical expenditures among people with diagnosed diabetes were 2.3 times higher than those without diabetes. The population aged 65 years and older was found to use a substantially higher proportion of health resources for hospital inpatient days, nursing home and residential facility days, as well as for prescription medication use. Approximately 59 % of all health care expenditure attributed to diabetes is for health resources used by the older population, most of which is borne by the Medicare program.

Pathophysiology

Many of the challenges affecting older patients with diabetes stem from the pathophysiology of aging and its interaction with genetics, lifestyle, and medications. As a part of aging, progressive alteration occurs in all aspects of glucose metabolism, including insulin secretion, insulin action, and hepatic glucose metabolism [10]. Glucose intolerance increases with aging due to decline in pancreatic beta cell function. There is also an age-related change in the insulin signaling mechanisms that limit the mobilization of glucose transporters needed for insulin-mediated glucose uptake and metabolism in muscle and fat [11]. Insulin action is further impaired with obesity, sarcopenia, and reduced physical activity [12]. Abdominal obesity is associated with increased circulatory levels of free fatty acids, inflammatory cytokines, and multifunctional chemoattractant proteins leptin and osteopontin [13]. Aging is also associated with low-grade inflammation and higher levels of tumor necrosis factor alpha and IL-6, which indicate morbidity [13]. An altered "inflammatory" environment with aging can contribute to the higher rates of diabetes in the elderly [14]. Medications, such as: diuretics, olanzapine, sympathomimetics, glucocorticoids, and niacin, alter carbohydrate metabolism resulting in increased glucose concentrations. Infections and acute events, like myocardial infarction and stroke, can lead to worsening hyperglycemia. In addition, decreases in the physiological reserves in multiple organ systems, which interact with end-organ damage due to diabetes, lead to increased vulnerability to physiological stressors [14].

Clinical Presentation and Comorbidities

Clinical presentation of diabetes in residents of LTC is impacted by aging as well as the presence of many other medical conditions. Aging impacts some of the physiological processes responsible for initial presentation of diabetes. The renal threshold for glucose increases with age, thus, glucosuria is not seen at usual levels [15]. Polydipsia may be absent because of impaired thirst mechanisms in the older adults and consequently, the classic symptoms of hyperglycemia (polyuria, polydipsia, and polyphagia) are often not present. In fact, dehydration is more common because of altered thirst perception. As a result of all of these factors, diabetes in older adults may present with weight loss, fatigue, infections, neuropathic pain, nocturia, failure to thrive, falls, or even nonketotic hyperosmolar coma. These atypical symptoms are frequently unnoticed or attributed to old age leading to delay in diagnosis of diabetes.

The clinical presentation of diabetes in older residents of LTC facility also varies with duration of the disease. Some older patients develop diabetes years earlier and may have significant complications at the time of LTC admission, while the others may present with newly diagnosed diabetes at an older age. In addition, some older adults are frail and have other underlying chronic conditions or limited physical or cognitive functioning while others have a few co-morbidities and are active. Most of the older adults with diabetes at the LTC facility are dependent on caregivers for their daily activities.

Management of diabetes in LTC becomes increasingly complex with the burden of functional disability and multiple comorbidities found in the residents. LTC residents in general have more cardiovascular morbidities [2••]. They often take multiple medications, experience frequent infections delayed wound healing, dehydration, hospitalization, higher fall risk, and hyperosmolar states [2••]. A national nursing home

survey carried out between 1995–2004 showed high burden of cardiovascular diseases and renal symptoms in residents with diabetes (76.5 % and 16.9 %) compared with those without diabetes (68 % and 12 %) [6]. In addition, elderly with diabetes have a higher prevalence of cognitive dysfunction, depression, physical disabilities, polypharmacy, urinary incontinence, and chronic pain [3]. Some of these conditions, such as: depression, pain or incontinence, can be treated and improves symptoms as well as quality of life. Others, such as cognitive dysfunction or disabilities are not reversible. Their presence is important to identify as they may interfere with diabetes management task such as identifying and treating hypoglycemia accurately, consistency in time and quantity of diet, or allowing glucose monitoring.

Goals of Management

The goals of treatment in patients in LTC settings have not been well studied. Most of the large studies have been conducted in the younger population and results have been extrapolated to this population. However, when developing goals of care in older patients in the LTC, we need to be cognizant of the patients' chronological age vs actual health status, duration of disease, presence of complications and comorbidities, variable life expectancy, and complexity of the treatment regimen. The primary goal of diabetes management in older adults is to achieve optimal glycemic control and to prevent and/or slow the onset and progression of acute and chronic complications associated with this disease. An additional goal in this population is to prevent treatment related complications especially hypoglycemia, which can be more harmful then the disease itself.

Glycemic Goals

Poor glycemic control may synergistically interact with other age-related pathology to accelerate diabetes complications in older adults. On the other hand, hypoglycemia can lead to worse outcomes in frail elderly in the form of traumatic falls, worsening of chronic conditions such as cognitive dysfunction, and increased morbidity and mortality. In the past few years, large prospective randomized studies evaluating the benefits of intensive therapy on cardiovascular outcomes were carried out. None of these studies showed benefits of tight glycemic control to improve cardiovascular outcomes in patients with type 2 diabetes [16, 17]. In fact 1 study suggested possible harm with tight glycemic control [18]. Subgroup analyses of these studies have shown that subjects who were older, had multiple comorbidities, had longer duration of diabetes, and who had macro and/or microvascular disease at the onset of the study were more likely to be harmed by the intensive control [19]. These characteristics are most prevalent in the population residing in LTC. In a recent consensus paper supported by the American Diabetes Association, goals of care for glycemic control are based on severe comorbidities, functionality, and cognitive status. As seen in Table 1, the residents of LTC should have liberal goals of maintaining A1C <8.5 % [1••].

Hypoglycemia

Avoiding hypoglycemia is of paramount importance in setting goals for older adults living in LTC facilities. Similar to the difficulty faced with symptoms of hyperglycemia, an elderly person may not exhibit the typical signs of hypoglycemia. Presenting symptoms of hypoglycemia can be primarily neuroglycopenic (dizziness, confusion, weakness) rather than adrenergic (tremors, sweating, palpitations) [20]. The reasons for this phenomenon are the diminished glucose counter-regulation with aging involving glucagon, epinephrine, and growth hormone responses to hypoglycemia [21]. Older adults also have attenuated autonomic warning symptoms of hypoglycemia. Thus, it is easy to miss the symptoms of hypoglycemia or misdiagnose them as other medical problems, such as: weakness, TIA, vertigo, orthostatic hypotension, or dementia. Even mild episodes of hypoglycemia can lead to falls and injuries, increased risk of cardiovascular or cerebrovascular events or worsening of cognitive dysfunction. In a recent observational study looking at 3 community LTC, 43 % of the patients with diabetes had at least 1 episode of hypoglycemia (glucose <70 mg/dL) [22]. The residents with hypoglycemia had longer median length of stay, more emergency room and hospital visits, and higher mortality compared with those without hypoglycemia. Avoidance of hypoglycemia and "do no harm" should be the overarching goal of diabetes management in LTC.

Cardiovascular Risk Factors Management Goals

Older adults with diabetes also need active management of their hypertension and dyslipidemia. Data shows that people with diabetes receive the greatest mortality benefit from treating hypertension first, lipids second, and blood glucose third [4]. The blood pressure threshold for treatment is 140/80 mm Hg and 150/90 mm Hg in those 75 years or older. Recently several studies have shown a "J"-shaped relationship between BP control and mortality and coronary heart disease [23]. One study evaluated relationship between BP control and coronary heart disease in patients with diabetes. The results showed an inverse relationship between BP control and coronary heart disease particularly in older patients with diabetes [24•]. These studies suggests that in older patients lowering SBP too low may not achieve any benefits and may in fact increase risk of adverse outcomes. An acceptable blood pressure target in functionally dependent patients with

Table 1 A framework for considering treatment goals for glycemia, blood pressure, and dyslipidemia in older adults with diabetes

Patient characteristics/health status	Rationale	Reasonable A1C goal (A lower goal may be set for an individual if achievable without recurrent or severe hypoglycemia or undue treatment burden)	Fasting for preprandial glucose (mg/dL)	Bedtime glocuse (mg/dL)	Blood pressure (mmHg)	Lipids
Healthy (Few coexisting chronic illnesses, intact cognitivve and functional status)	Longer remaining life expectancy	<7.5 %	90–130	90–150	<140/80	Statin unless contraindicated or not tolerated
Complex/intermediate (Multiple coexisting chronic illnesses* or 2+ instrumental ADL impairments or mild to moderate cognitive impairment)	Intermediate remaining life expectancy, high treatment burden, hypoglycemia vulnerability, fall risk	<8.0 %	90–150	100–180	<140/80	Statin unless contraindicated or not tolerated
Very complex/poor health (Long-term care or end-stage chronic illnesses** or moderate to severe cognitive impairment or 2+ ADL dependencies)	Limited remaining life expectancy makes benefit uncertain	<8.5 %†	100–180	110–200	<150/90	Consider likelihood of benefit with statin (secondary prevention moreso than primary)

This represents a consensus framework for considering treatment goals for glycemia, blood pressure, and dyslipidemia in older adults with diabetes. The patient characteristics categories are general concepts. Not every patient will clearly fall into a particular category. Consideration of patient/caregiver preferences is an important aspect of treatment individualization. Additionally, a patient's health status and preferences may change over time. ADL, activities of daily living.*Coexisting chronic illnesses are conditions serious enough to require medications or lifestyle management and may include arthritis, cancer, congestive heart failure, depression, emphysema, falls, hypertension, incontinence, stage III or worse chronic kidney disease,MI, and stroke. By multiple we mean at least three, but many patients may have five or more (132). **The presence of a single end-stage chronic illness such as stage III–IV congestive heart failure or oxygen-dependant lung disease, chronic kidney disease requiring dialysis, or uncontrolled metastatic cancer may cause significant symptoms or impairment of functional status and significantly reduce life expectancy. †A1C of 8.5 % equates to an estimated average glucose of ~200 mg/dL. Looser glymeric targets than this may expose patients to acute risks from glycosuria, dehydration,hyperglycemic hyperosmolar syndrome, and poor wound healing.

(With permission from: Kirkman MS, Briscoe VJ, Clark N, et al. Diabetes in older adults: a consensus report. J Am Geriatr Soc. 2012;60:2342–56) [1••]

diabetes is below 150/90 mm Hg [1••]. Only 55 % of the LTC population in one study met the blood pressure goal and only 52 % of them were on ACE inhibitors or ARBs, highlighting even less optimal therapy than among ambulatory elderly [4]. In the same study, lipids were checked in only 31 % of patients, with 58 % of those checked meeting goal [4]. Evidence suggests that the target LDL in patients with diabetes is <100 mg/dL in all adults. However, as with glycemic goal, patient's overall health, burden of comorbidities and medication complexity, financial strain, life expectancy, and individual preferences should be considered in each patient before establishing personal goals of BP and lipids [25, 26•].

Use of Glucose-Lowering Agents

Pharmacological treatment of diabetes and its comorbidities in older adults residing in LTC often goes beyond understanding how to use different pharmacological agents. When managing multiple chronic medical conditions, drug-to-drug and drug-to-disease interactions are common and can be harmful to patients if each chronic condition is managed independently. This scenario is often seen when multiple consultants are treating individual diseases like: heart disease, diabetes, kidney disease, neuropathy, and nephropathy. It is important to check the medication list carefully and keep it updated. Unnecessary or ineffective medications should be promptly discontinued. Table 2 lists commonly used glucose-lowering agents in LTC facilities along with its advantages and disadvantages.

Metformin

Metformin remains a suitable first-line therapy to lower glucose levels even in frail older adults. If patients are carefully selected, metformin is well tolerated and is useful therapy due to low risk of hypoglycemia and possible benefits on cardiovascular outcomes with its use. Although, use of metformin specifically in LTC population is not studied, an analysis of older participants (60–80 years; n=10,559) of the Reduction of Atherothrombosis of Continued Health (REACH) registry, showed overall lower 2-year mortality in patients with atherothrombosis treated with metformin vs without metformin [27]. Another multi-center longitudinal cohort study evaluating body mass in older man showed that older men with diabetes using insulin sensitizers (metformin or thiazolidinediones) lost

Table 2 Commonly used glucose lowering agents in LTC

Drug	Advantages In Ltc	Disadvantages In Ltc	Comments
Metformin	• Well-tolerated • Lower risk of hypoglycemia • Lower frequency of finger-stick monitoring • Improved cardiovascular outcome • Inexpensive • No risk of weight gain • Durable effects	• Gastrointestinal side-effects • Require monitoring of renal function • Fear of lactic acidosis • May cause vitamin B-12 deficiency • Weight loss in frail elderly	• Should be considered first-line of therapy • Use half maximum dose of 1000 mg if eGFR 45–60 mL/min • Discontinue use if eGFR<45 mL/min
DPP-4 inhibitors	• Well-tolerated • Weight neutral • Usable in mild-moderate renal insufficiency • Useful in targeting postprandial hyperglycemia • Lower frequency of finger-stick monitoring necessary	• Lower efficacy • Expensive • Pancreatitis? • Some agents require dose adjustment for • renal function	• May use as first-line of therapy if metformin is not an option
GLP-1 inhibitors	• Lower risk of hypoglycemia when used alone • Weight loss in obese elderly • Extended release (once a week) available	• Only available injectable form • Expensive • Gastrointestinal side-effects • Pancreatitis?	• Second- or third-line of therapy
Alpha-glucosidase inhibitors	• Lower risk of hypoglycemia • Target postprandial glucose levels	• Modest efficacy • Gastrointestinal side-effects • Frequency of dosing • Not recommended with eGFR <25 mL/min	• Second-line of therapy if tolerated
Sulfonylureas	• Available as generic formulations • Inexpensive • Can target both fasting and postprandial glucose • levels	• Hypoglycemia • Weight gain • Low durability in glycemic control • Expensive - rapid acting (repaglinide, nateglinide)	• Second- or third-line of therapy • Glyburide should not be used • Require dose adjustment • depending on renal function
Thiazolidine-diones	• No risk of hypoglycemia • Durable effect • Impact postprandial hyperglycemia	• Fluid retention, leg edema, heart failure • Atypical fractures • Risk of bladder cancer? • Weight gain	• Third-line of therapy
SGLT-2 Inhibitors	• Low risk of hypoglycemia • Decreases blood pressure • Weight loss in obese elderly	• Polyuria • Hypotension • Hyperkalemia • Genital/urinary tract infections • Expensive	• Third-line of therapy
Insulin	• No ceiling effect • Regular/NPH - inexpensive	• Risk of hypoglycemia • Weight gain • Frequency of finger-stick monitoring • depends of type of insulin used • Analog insulins—expensive	• Usually second- or third-line of therapy • Could be safer in patient unable to use hypoglycemic oral agents due to side-effects. • Safer to use when LTC staff is performing self-care • Avoid sliding scales

significantly less appendicular or total lean mass compared with those with untreated diabetes or treated with other hypoglycemic agents [28]. Most common contraindication to metformin use in this population is renal insufficiency. Calculated creatinine clearance or glomerular filtration rate (eGFR) is used for dosing and monitoring metformin treatment. In a recent review of literature, metformin was found to be safe for use down to an eGFR of 45 mg/min as long as maximum dose is cut in half [29]. This is important information as the low risk of hypoglycemia and cardio-protective effects of metformin makes it an attractive agent for use in elderly. Metformin also carries the advantage of being inexpensive, which is a significant factor in the total cost of an elderly nursing home patient on multiple medications or subject to the Medicare part D "doughnut hole". It is imperative to look for gastrointestinal side-effects and weight loss with each dose increments especially in the nonobese individuals. These side-effects may be limiting factors in older adults especially in LTC.

Incretin-Mimetic Agents

DPP-4 inhibitors (sitagliptin, saxagliptin, linagliptin, alogliptin) can be considered as second-line therapy in selected older patients not at their glycemic target, at higher risk of hypoglycemia, or who struggle with tolerating other glucose lowering agents [30]. They are useful for targeting postprandial hyperglycemia and have low risk of hypoglycemia [31, 32]. They are weight neutral and their dose can be adjusted for patients with mild to moderate renal insufficiency. However,

they are also expensive, which currently limits their use in LTC. Glucagon-like peptide-1(GLP-1) agonists (exenatide, liraglutide) are incretin-mimetic agents that are available only in injectable forms. As monotherapy, they have a low risk of hypoglycemia and induce weight loss, which is beneficial for some obese elderly. An extended-release formulation, which is administered only once a week is now available, which can be very attractive for LTC residents as it may decrease nursing time and frequent injections as well as monitoring. Pramlintide, a synthetic analog of Amylin, requires multiple subcutaneous injections and may cause significant hypoglycemia; thus, its role in the management of diabetes in the elderly, especially in LTC, is limited.

Insulin Secretagogues

The longer-acting insulin secretagogues, the sulfonylureas (glipizide ER, glimepiride) are commonly used in older people primarily due to its low cost and familiarity for the medical providers. However, these agents have a higher risk of hypoglycemia if patients do not eat on time, skip meals, or do not eat adequate carbohydrates during their meals [33]. Glyburide, due to the presence of an active metabolite, has much higher risk of hypoglycemia in this age group and should be avoided [34]. The shorter-acting secretagogues (repaglinide and nateglinide) act similarly to the sulfonylureas but with more focused action just after meals. The advantage of this group of medications is that they are taken just before the meals so if a meal is skipped or added, a dose of the medication can be skipped or added, respectively. This flexibility is especially important for frail elderly with cognitive dysfunction or variable appetite.

Alpha-Glucosidase Inhibitors

Acarbose and miglitol have a low risk of hypoglycemia, as they inhibit the absorption of carbohydrates [35]. However, the main side-effects that limit their use are flatulence and diarrhea, which are very common, and can be problematic for older frail individuals in LTC.

Thiazolidinediones

Pioglitazone is the only agent in this class still somewhat available for use as rosiglitazone was found to have higher risk of cardiovascular adverse events [36]. Pioglitazone does not pose a risk of hypoglycemia, making them an excellent choice for some older people. However, there are several side-effects of interest in older adults in LTC including: fluid retention, leg edema, heart failure, and atypical fractures [37, 38]. These side-effects decrease the enthusiasm for its use in LTC. In addition recent concerns of increased risk of bladder cancer have significantly decreased its use [39].

Sodium-Glucose Transporter-2 Inhibitors

Canagliflozin is the first agent available in U.S. in this class. There are other agents available in other countries or still in development. This class of medications lowers the glucose threshold that causes glucose to be excreted in the urine. These agents should be considered as an alternative treatment in older adults, as they pose serious risks due to the affects related to osmotic diuresis, such as: hyperkalemia, dehydration, and orthostatic hypotension; and the risk of genital infections. However, they also have a low risk of hypoglycemia and have small shown reductions in systolic blood pressure and weight [40].

Insulin

Insulin is an important agent for used for glycemic control in LTC. The advantages of insulin are fewer side-effects and no ceiling effect. The complexity of insulin regimen and the related self-care activities are often difficult for older community living individual with diabetes. However, the nursing home staff performs self-care for residents including injections, glucose monitoring, providing adequate meals on time, and careful observation for hypoglycemia. Thus, insulin might be a safer agent for this population compared with community living elderly. The biggest concern with insulin use is the risk of hypoglycemia, especially when multiple doses are given. As we understand pathophysiology of diabetes better, we are able to target hyperglycemia more successfully without increasing the risk of hypoglycemia. A recent meta-analysis evaluated contribution of postprandial and fasting glucose to overall hyperglycemia in older vs younger adults [41••]. This study showed that postprandial glucose contributes more to overall hyperglycemia than fasting glucose in older adults with diabetes. With the availability of various types of insulin with different time-action curves, it is possible to target postprandial hyperglycemia in elderly and avoid fasting hypoglycemia. For example, based on the above study, one can start long-acting insulin in the morning in elderly patients to get maximum impact in the afternoon postprandial time and let insulin effects taper down during early morning hours to avoid fasting hypoglycemia. A 3-year multi-center "Treating to Target in Type 2 diabetes" (4-T) study showed that when basal, biphasic, or prandial-based insulin therapy was added to oral hypoglycemic agents in patients with type 2 diabetes, glycemia improved in all treatment groups. However, hypoglycemia and weight gain was less with basal insulin regimen compared with prandial or biphasic regimens [42]. Adding once a day dose of basal insulin can be a good way of initiating insulin therapy in combination with other antidiabetes medications in those with suboptimal glycemic control [43]. Compared with human insulin, insulin analogs provide more consistent glucose control, equivalent or

improved HbA1c, better control of postprandial hyperglycemia and fasting glucose, reduced rate of hypoglycemia, and weight gain [44]. Consequently, glycemic control improves substantially when insulin treatment is individualized and monitored carefully with regular follow-up. Sliding scale insulin use has been strongly discouraged in the LTC setting for a prolonged period of time [45]. Basal-bolus insulin with additional scale can be used when glucose excursions are high and carbohydrate intake is variable.

Life Style Modifications

Although diet and exercise modifications are critical for managing diabetes in older adults, it has a limited role in management of older adults residing in LTC. Weight loss and not weight gain is more common and critical in frail elderly patients with high risk of morbidity and mortality. There are multiple etiological factors leading to weight loss such as decreased appetite, altered taste sensation, side-effects of medications, and restricted diets (low salt, fat, and/or sugar) that are not palatable. It is prudent to avoid excessive restrictions and encourage consistent carbohydrates at each meal to avoid large excursions in glucose levels. Exercise and physical activities are also difficult for frail elderly in LTC. However, it is important to encourage as much physical activity as they can perform to maintain muscle mass, conditioning, and decrease the risk of falls. It is important to prescribe activity that is consistent with patient's abilities. For example, walking the hallways with help of a walker 5–10 min twice a day may get better results than prescribing 30 min of exercise class.

Pitfalls and Barriers in Care

Table 3 shows the barriers in managing diabetes in the long-term care settings. There are facility associated, staff-associated, and patient-associated barriers. The table also describes some strategies that can be used to overcome these barriers.

Conclusions

The anticipated growth in total U.S. population between 2002 and 2020 is approximately 17 %, while the estimated increase in patients with diabetes is about 44 %; the increase is largely due to the increase in the size of the elderly population [46]. As the number of older adults with diabetes and multiple comorbidities increase, so will the need for LTC and better strategies to manage older and frailer population with diabetes. It is important that the goals for not only diabetes but all chronic disease management are individualized for each resident and strategies are built for comprehensive management

Table 3 Pitfalls and barriers in management of diabetes in LTC

	Barriers and pitfalls	Strategy for management
Resident related	• Multiple comorbidities	• Be aware of the impact of possible confusion between symptoms of other comorbidities and symptoms of hyper- or hypoglycemia • Routine evaluation of complete medication list prescribed by various consultants
	• High risk of drug-drug or disease-drug interaction and side-effects	• Careful assessment for interactions and side-effects by providers and staff • Routine review of medication list by pharmacist
	• Change in overall health may require change in diabetes regimen	• Frequent assessment of glucose control during acute illnesses, treatments of acute situations (such as antibiotics or steroids), or changes to their eating or activity routines • Liberalize glycemic goals if overall health deteriorates
Staff related	• Inadequate knowledge about how different medications and insulin work	• Provide staff and resident in-services as new medications are introduced for treatment of diabetes
	• Inadequate knowledge about how diet and physical activity impact glucose levels	• Provide staff and residents education about impact of quality and quantity of diet and effect of physical activity on glucose levels • Establish guidelines and assessment protocol for appropriate monitoring frequency based on the risk for hyper and hypoglycemia associated with medications • Establish guideline for treatment of hypoglycemia with rapid access to necessary treatments
Facility related	• Difficult to individualize attention to diet and physical activity in different residents	• Encourage providers to assess the ability to convert appropriate residents to regimens that have lower risk of hypoglycemia and decrease dependency on appropriate dietary intake to prevent hypoglycemia • Establish guidelines for administration of insulin in reference to timing of dietary intake (either always prior to meals or immediately post prandial with assessment of percentage of carbohydrates ingested) • Create simple strategies (chair exercises or stretching, walking with walker 5 min prior to 2 meals each day) that don't require significant increase in resources (such as: purchase of specific exercise equipment or need for trained physical therapist)

of these individuals with multiple chronic diseases. In addition, the plans should be reviewed regularly and with adjustments made to goals and strategies if the patient's overall health changes.

Compliance with Ethics Guidelines

Conflict of Interest Aaditya Singhal declares that she has no conflict of interest. Alissa R. Segal declares that she has no conflict of interest. Medha N. Munshi has received a research grant from Sanofi.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

References

Papers of particular interest, published recently, have been highlighted as:
- • Of importance
- •• Of major importance

1.•• Kirkman MS, Briscoe VJ, Clark N, et al. Diabetes in older adults: a consensus report. J Am Geriatr Soc. 2012;60:2342–56. *This consensus paper delineates available evidence and consideration for issues that may influence treatment decisions in older adults with diabetes.*

2.•• Association AMD. Diabetes Management in the Long-Term Care Setting Clinical Practice Guideline. In: Columbia, MD: AMDA; 2008; revised 2010. *These revised guidelines are the most up-to-date recommendations providing practical guidance for management of diabetes in long-term care settings.*

3. Munshi M. Managing the "geriatric syndrome" in patients with type 2 diabetes. Consult Pharm. 2008;23(Suppl B):12–6.

4. Holt RM, Schwartz FL, Shubrook JH. Diabetes care in extended-care facilities: appropriate intensity of care? Diabetes Care. 2007;30:1454–8.

5.• National Diabetes Fact Sheet. General Information and National Estimates on Diabetes in United States. In: U.S. Department of Health and Human Services CDC (ed.) Atlanta, GA; 2011. *This data sheet has the current prevalence of diabetes in various age groups and shows the burden of the disease and its complications in the U.S.*

6. Zhang X, Decker FH, Luo H, et al. Trends in the prevalence and comorbidities of diabetes mellitus in nursing home residents in the United States: 1995–2004. J Am Geriatr Soc. 2010;58:724–30.

7. Resnick HE, Heineman J, Stone R, Shorr RI. Diabetes in U.S. nursing homes, 2004. Diabetes Care. 2008;31:287–8.

8. Migdal A, Yarandi SS, Smiley D, Umpierrez GE. Update on diabetes in the elderly and in nursing home residents. J Am Med Dir Assoc. 2011;12:627–32 e2.

9.•• American Diabetes Association. Economic costs of diabetes in the U.S. in 2012. Diabetes Care. 2013;36:1033–46. *This article shows the true economical and social impact of diabetes in U.S. It shows the high socioeconomic impact of aging population.*

10. Meneilly GS. The pathophysiology of diabetes in the elderly. In: Medha N, Munshi LAL, editors. Geriatric diabetes. New York: Informa Healthcare; 2007. p. 29–36.

11. Meneilly GS. Diabetes in the elderly. Med Clin N Am. 2006;90:909–23.

12. Elahi D, Muller DC, Egan JM, et al. Glucose tolerance, glucose utilization and insulin secretion in ageing. Novartis Found Symp. 2002;242:222–42. discussion 242–6.

13. Zeyda M, Stulnig TM. Obesity, inflammation, and insulin resistance—a mini-review. Gerontology. 2009;55:379–86.

14. Blaum C. Diabetes mellitus. In: Durso S, Sullivan GM, editors. Geriatric review syllabus: a core curriculum in geriatric medicine. 8th ed. New York: American Geriatric Society; 2013. p. 566–75.

15. Meneilly GS. Diabetes. In: Evans J, Williams TF, Beattie BL, editors. Textbook of geriatric medicine. 2nd ed. Oxford: Oxford University Press; 2000. p. 210–7.

16. Patel A, MacMahon S, Chalmers J, et al. Intensive blood glucose control and vascular outcomes in patients with type 2 diabetes. N Engl J Med. 2008;358:2560–72.

17. Duckworth W, Abraira C, Moritz T, et al. Glucose control and vascular complications in veterans with type 2 diabetes. N Engl J Med. 2009;360:129–39.

18. Gerstein HC, Miller ME, Byington RP, et al. Effects of intensive glucose lowering in type 2 diabetes. N Engl J Med. 2008;358:2545–59.

19. Skyler JS, Bergenstal R, Bonow RO, et al. Intensive glycemic control and the prevention of cardiovascular events: implications of the ACCORD, ADVANCE, and VA diabetes trials: a position statement of the American Diabetes Association and a scientific statement of the American College of Cardiology Foundation and the American Heart Association. Diabetes Care. 2009;32:187–92.

20. Bremer JP, Jauch-Chara K, Hallschmid M, et al. Hypoglycemia unawareness in older compared with middle-aged patients with type 2 diabetes. Diabetes Care. 2009;32:1513–7.

21. Matyka K, Evans M, Lomas J, et al. Altered hierarchy of protective responses against severe hypoglycemia in normal aging in healthy men. Diabetes Care. 1997;20:135–41.

22. Newton CA, Adeel S, Sadeghi-Yarandi S, et al. Prevalence, quality of care, and complications in long term care residents with diabetes: a multi-center observational study. J Am Med Dir Assoc. 2013;14(11):842–6.

23. Denardo SJ, Gong Y, Nichols WW, et al. Blood pressure and outcomes in very old hypertensive coronary artery disease patients: an INVEST substudy. Am J Med. 2010;123:719–26.

24.• Zhao W, Katzmarzyk PT, Horswell R, et al. Aggressive blood pressure control increases coronary heart disease risk among diabetic patients. Diabetes Care. 2013;36(10):3287–96. *This prospective cohort study contributes to understanding of level of BP control in patients with coronary heart disease and diabetes. The study shows a "U" shaped associated between BP and risk of CHD suggesting that aggressive BP cotnrol is associated with increase risk of CHD in patients with diabetes.*

25. Sinclair A, Morley JE, Rodriguez-Manas L, et al. Diabetes mellitus in older people: position statement on behalf of the International Association of Gerontology. and Geriatrics (IAGG), the European Diabetes Working Party for Older People (EDWPOP), and the International Task Force of Experts in Diabetes. J Am Med Dir Assoc. 2012;13:497–502.

26.• Sinclair AJ, Paolisso G, Castro M, et al. European Diabetes Working Party for Older People 2011 clinical guidelines for type 2 diabetes mellitus. Executive summary. Diabetes Metab. 2011;37 Suppl 3:S27–38. *This positions statement delineates guidelines and opinons by an international panel of experts.*

27. Roussel R, Travert F, Pasquet B, et al. Metformin use and mortality among patients with diabetes and atherothrombosis. Arch Intern Med. 2010;170:1892–9.

28. Lee CG, Boyko EJ, Barrett-Connor E, et al. Insulin sensitizers may attenuate lean mass loss in older men with diabetes. Diabetes Care. 2011;34:2381–6.

29. Lipska KJ, Bailey CJ, Inzucchi SE. Use of metformin in the setting of mild-to-moderate renal insufficiency. Diabetes Care. 2011;34:1431–7.

30. Amori RE, Lau J, Pittas AG. Efficacy and safety of incretin therapy in type 2 diabetes: systematic review and meta-analysis. JAMA. 2007;298:194–206.
31. Pratley RE, Rosenstock J, Pi-Sunyer FX, et al. Management of type 2 diabetes in treatment-naive elderly patients: benefits and risks of vildagliptin monotherapy. Diabetes Care. 2007;30:3017–22.
32. Karyekar CS, Ravichandran S, Allen E, et al. Tolerability and efficacy of glycemic control with saxagliptin in older patients (aged ≥65 years) with inadequately controlled type 2 diabetes mellitus. Clin Interv Aging. 2013;8:419–30.
33. UK Prospective Diabetes Study (UKPDS) Group. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). Lancet. 1998;352:837–53.
34. American Geriatrics Society. Updated beers criteria for potentially inappropriate medication use in older adults. J Am Geriatr Soc. 2012;60(4):616–31.
35. van de Laar FA, Lucassen PL, Akkermans RP, et al. Alpha-glucosidase inhibitors for patients with type 2 diabetes: results from a Cochrane systematic review and meta-analysis. Diabetes Care. 2005;28:154–63.
36. Nissen SE, Wolski K. Effect of rosiglitazone on the risk of myocardial infarction and death from cardiovascular causes. N Engl J Med. 2007;356:2457–71.
37. Yki-Jarvinen H. Thiazolidinediones. N Engl J Med. 2004;351:1106–18.
38. Meier C, Kraenzlin ME, Bodmer M, et al. Use of thiazolidinediones and fracture risk. Arch Intern Med. 2008;168:820–5.
39. Colmers IN, Bowker SL, Majumdar SR, Johnson JA. Use of thiazolidinediones and the risk of bladder cancer among people with type 2 diabetes: a meta-analysis. CMAJ. 2012;184:E675–83.
40. Bode B, Sinclair A, Harris S, Vijapurkar U, Mayer C, Fung A, et al. Efficacy and safety of canagliflozin in older subjects with type 2 diabetes. In: The 73rd scientific sessions of the American Diabetes Association. Chicago, IL: Diabetes. 2013; p. LB-76.
41.•• Munshi MN, Pandya N, Umpierrez GE, et al. Contributions of basal and prandial hyperglycemia to total hyperglycemia in older and younger adults with type 2 diabetes mellitus. J Am Geriatr Soc. 2013;61:535–41. *This meta-analysis provides important information about differences in hyperglycemia patterns in old vs young patients. This information can be used to target hyperglycemia differently in older patients and avoid treatment induced hypoglycemia.*
42. Holman RR, Farmer AJ, Davies MJ, et al. Three-year efficacy of complex insulin regimens in type 2 diabetes. N Engl J Med. 2009;361:1736–47.
43. Karnieli E, Baeres FM, Dzida G, et al. Observational study of once-daily insulin detemir in people with type 2 diabetes aged 75 years or older: a sub-analysis of data from the Study of Once daily LeVEmir (SOLVE). Drugs Aging. 2013;30:167–75.
44. Alissa R, Segal P, Munshi MN. Insulin therapy for older adults with diabetes. Geriatr Aging. 2008;11:357–62.
45. Pandya N, Nathanson E. Managing diabetes in long-term care facilities: benefits of switching from human insulin to insulin analogs. J Am Med Dir Assoc. 2010;11:171–8.
46. American Diabetes Association. Economic consequences of diabetes mellitus in the U.S. in 1997. Diabetes Care. 1998;21:296–309.