Identifying the need for simplification of type 2 diabetes mellitus treatment in residents of aged-care facilities: a meta-analysis and systematic review of the literature

LOWRI H THOMAS, 1 PHILIP MS EVANS, 2 ATUL KALHAN 2

Abstract
Background: The management of type 2 diabetes mellitus (T2DM) in frail older adults is made challenging by the impact of physical and cognitive decline on self-monitoring of blood glucose (BG), administration of medications, especially injectable therapies, and risk of hypoglycaemia.

Aims and objectives: (1) To revisit the prevalence of hypoglycaemia in adults with T2DM living in aged-care facilities; (2) to evaluate the impact of simplification of T2DM treatment on quality of life (QOL), morbidity and mortality in this population; and (3) to identify higher risk older adults in whom simplification of therapy will be most appropriate.

Methods: MEDLINE was searched using the following concept areas: aged-care facilities, T2DM, anti-diabetic therapies, morbidity, mortality and QOL. Results (and additional literature identified by citation checking) were screened and assessed against pre-defined eligibility criteria. Standardised structures for extracting, appraising and reporting the literature were used.

Results: Hypoglycaemia is common in adults with T2DM in aged-care facilities. Glycated haemoglobin (HbA1c) needs to be interpreted cautiously in this cohort, with additional capillary BG monitoring needed to identify individuals at risk of hypo- or hyperglycaemia. Simplification of T2DM treatment can reduce morbidity and mortality in frail older adults.

Conclusion: In residents of aged-care facilities, simplification of T2DM treatment can help deliver optimal individualised patient-centred care and improve QOL.

Key words: type 2 diabetes mellitus, aged-care facilities, frailty, dementia

Introduction
Type 2 diabetes mellitus (T2DM) is a significant global healthcare issue – a challenge intensified by our ageing population. By 2030, 5.5 million people in the UK will have T2DM, 2 affecting 17% of those aged over 75 years. 3

For older adults with T2DM, co-morbidities, polypharmacy and decreased functional reserve equates to greater personal and economic burden of disease: older adults are disproportionally affected by disease complications and hypoglycaemia, which can further impair quality of life (QOL) and accentuate physical and cognitive dependence. 4

The global prevalence of T2DM in aged-care facilities (including residential and nursing homes) is estimated at 25–33%. 4 Compared with age- and sex-matched controls, residents with T2DM experience accelerated physical and cognitive decline with increased hospital admissions, rapid acquisition of the frail phenotype and reduced life expectancy. 4 Paradoxically, intensive glycaemic control, especially hypoglycaemia, is known to contribute to this decline. 4

The International Diabetes Federation (IDF) recommends a glycated haemoglobin (HbA1c) of 53–64 mmol/mol in functionally dependent older adults, with lenience to <70 mmol/mol in individuals with frailty or dementia. 5 This less intensive glycaemic target aims to balance vascular benefits against the risk of hypoglycaemia in older adults. 5 HbA1c represents the average glycaemic control over an 8–12-week period and is not an ideal parameter for evaluating day-to-day fluctuation in blood glucose (BG) levels. Additionally, anaemia, haemoglobinopathies and renal impairment are relatively more common amongst older adults, resulting in a less reliable marker of glycaemic control in this cohort.

Hypoglycaemia is common and under-recognised in residents of aged-care facilities. 4 This may reflect the dynamic nature of diabetes: disease and age-related changes to body composition, renal
and hepatic dysfunction, reduced nutrition and cognitive impair-
ment result in an increased risk of hypoglycaemia and an impaired
ability to respond to lower BG levels. A re-evaluation of glycaemic
targets and simplification of treatment can mitigate the risks posed
by intensive therapeutic regimens.

Over the last decade, novel oral glucose-lowering therapies
have offered simplified treatments and additional cardiovascular
and renovascular benefits. However, long-term data outcomes on
their safety and efficacy in frail older adults are still to be robustly
established.

Aims and objectives
We aimed to evaluate hypoglycaemia prevalence and HbA1c levels
as semi-quantitative evidence of overtreatment in residents of
aged-care facilities. In addition, we carried out a retrospective re-
view of the literature to evaluate the impact of simplification of
T2DM treatment on morbidity, mortality and QOL in this popula-
tion. Finally, we suggest a possible approach to identify higher risk
older adults in whom simplification of therapy will be most ap-
propriate.

Methods
Searching the literature
In April 2020 the MEDLINE database was searched using text
word and subject heading functions. The search incorporated the
following concept areas: aged-care facilities, T2DM, anti-diabetic
therapies, simplification of therapy, morbidity, mortality and QOL.
Aged-care facilities include both residential and nursing homes.
Appendix 1 (online at www.bjd-abcd.com) details the full search
strategy used.

Selecting the literature
Results and additional literature identified through citation check-
ing were screened by title and abstract to exclude literature clearly
irrelevant to review. Thereafter, full-text articles were assessed
against the following pre-defined eligibility criteria.

Inclusion criteria:
• Evaluates T2DM treatment in residents of aged-care facilities
• Observational or interventional study exploring the impact of
  simplification of T2DM treatment on morbidity, mortality and
  QOL
• Observational or interventional study exploring approaches to
  identify higher risk older adults in whom simplification of ther-
  apy will be most appropriate

Exclusion criteria:
• Non-English literature
• Non-peer reviewed literature
• Literature reviews, guidelines, opinions or editorials

Extracting, appraising and reporting the literature
Data extraction was guided by the Cochrane Collaboration’s tem-
plate for data extraction. The Critical Appraisal Skills Programme
checklists were used to guide appraisal while the write-up of this
review was supported by the Preferred Reporting Items for Sys-
tematic Reviews and Meta-Analyses (PRISMA) checklist.

Results
The search strategy yielded 88 results. Following screening by title
and abstract, 27 records clearly irrelevant to review were excluded.
The remaining 61 full-text articles were assessed for eligibility
against the criteria detailed above. Of these, 43 records were ex-
cluded. These included 15 records not reflective of review focus,
13 literature reviews, guidelines, opinions or editorials, 10 inac-
cessible records, and 5 non-English studies (see Figure 1). The remain-
ing 18 studies are included in this review.

We identified 18 studies which evaluated the prevalence of hy-
poglycaemia and the need for simplification in residents with T2DM
in aged-care facilities (see Table 1). Based on a retrospective

Figure 1. Adapted PRISMA flow diagram detailing results of methodology.
### Table 1: Evaluating the need for simplification of T2DM treatment in residents of aged-care facilities

<table>
<thead>
<tr>
<th>Study details</th>
<th>Study overview</th>
<th>Study design</th>
<th>Key results</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Niznik et al, 2020</td>
<td>To explore predictors for diabetes treatment deintensification</td>
<td>Type Population Retroactive cohort study Veteran nursing home residents with advanced dementia or perceived to be at end of life n = 6960 Nil Deintensification of diabetes medication; nil</td>
<td>40% overtreated; 46% deintensified at 90 days. Predictors for deintensification: end of life, non-metformin OAD. Predictors against deintensification: high HbA1C, insulin, obesity, peripheral arterial disease.</td>
<td>Quantifies overtreatment and poor deintensification; insulin as predictor against deintensification may reflect type 1 or Latent Autoimmune Diabetes of Adulthood (LADA).</td>
</tr>
<tr>
<td>Umpierrez et al, 2018</td>
<td>To explore outcomes of simplifying diabetes treatment with glargine or linagliptin monotherapy</td>
<td>Type Population Open-label randomised controlled trial Aged-care facility residents on OAD or low-dose insulin and HbA1C &gt;58 mmol/L n = 140 Glargine monotherapy or linagliptin monotherapy Mean daily BG, hypoglycaemia, HbA1C, hospital admission, emergency department visits; baseline, glargine monotherapy, linagliptin monotherapy</td>
<td>Significantly lower mean daily BG with linagliptin and glargine monotherapy compared with baseline. 34% absolute risk reduction in hypoglycaemia with linagliptin compared with glargine. No significant difference in HbA1C at 6 months between linagliptin and glargine. No significant changes to all-cause hospital admissions in any intervention.</td>
<td>Demonstrates safety and efficacy of linagliptin monotherapy for simplification of diabetes treatment.</td>
</tr>
<tr>
<td>McCracken et al, 2017</td>
<td>To evaluate relationship between polypharmacy and overtreatment</td>
<td>Type Population Cross-sectional observational study Aged-care facility residents n = 214 Nil Number of prescribed medications, HbA1C nil</td>
<td>48% met definition for polypharmacy. Those with overtreated diabetes prescribed more anti diabetic treatment than those with higher HbA1C.</td>
<td>Polypharmacy common and contributes to functional decline. No significant relationship between number of prescribed medications and overtreatment.</td>
</tr>
<tr>
<td>Retornaz et al, 2017</td>
<td>To evaluate relationship between HbA1c and hypoglycaemia risk</td>
<td>Type Population Cross-sectional observational study Aged-care facility residents with diabetes n = 236 Nil HbA1C, hypoglycaemia; nil</td>
<td>Intensive glycaemic control in 60%. 19% affected by hypoglycaemia. Hypoglycaemia and sub-optimal glycaemic control more common in those taking insulin therapy. No significant correlation between HbA1C and hypoglycaemia.</td>
<td>Identifies insulin therapy as most requiring review and simplification. HbA1C levels not sufficient for hypoglycaemia risk detection. Capillary BG monitoring warranted in nursing home residents.</td>
</tr>
<tr>
<td>Walfridsson et al, 2016</td>
<td>To investigate clinical characteristics and prevalence of hypoglycaemia</td>
<td>Type Population Cross-sectional observational study Aged-care facility residents with diabetes n = 1350 Nil HbA1C, hypoglycaemia, diabetic complications; nil</td>
<td>Mean HbA1C 56.0 mmol/mol. 43% with HbA1C &lt;52 mmol/mol. 24% affected by hypoglycaemia.</td>
<td>43% overtreated based on IDF HbA1C targets in this population. Hypoglycaemia common.</td>
</tr>
<tr>
<td>Dharmarajan et al, 2016</td>
<td>To compare safety and efficacy of BB and SS insulin regimens</td>
<td>Type Population Randomised controlled trial Aged-care facility residents with diabetes n = 64 SS insulin regimen, BB insulin regimen Fasting BG, hypoglycaemia, hyperglycaemia, adverse events; BB and SS</td>
<td>Significantly lower fasting BG in those on BB insulin regimens compared to SS. No significant differences in the incidence of hypoglycaemia.</td>
<td>Simplified insulin regimen improves fasting BG. Three-day data collection period not adequate for observation of hypoglycaemic events. Evidence of safety and efficacy of simplified insulin regimens.</td>
</tr>
<tr>
<td>Bo et al, 2015</td>
<td>To investigate clinical characteristics and prevalence of hypoglycaemia</td>
<td>Type Population Cross-sectional observational study Aged-care facility residents with diabetes n = 863 Nil Cognitive and functional dependence, HbA1C, hypoglycaemia</td>
<td>Cognitive impairment, functional dependence and co-morbidities are common among residents with diabetes. 55% with HbA1C &lt;53 mmol/mol. 6.6% experience hypoglycaemia.</td>
<td>Individuals who are frail and have dementia are particularly at risk of overtreatment. 55% overtreated based on IDF HbA1C targets in this population.</td>
</tr>
</tbody>
</table>

continued...
### Table 1 Evaluating the need for simplification of T2DM treatment in residents of aged-care facilities (continued)

<table>
<thead>
<tr>
<th>Study details</th>
<th>Study overview</th>
<th>Study design</th>
<th>Key results</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neumark <em>et al</em>, 2016&lt;sup&gt;17&lt;/sup&gt;</td>
<td>To explore clinical characteristics of older people with diabetes living at home (with and without additional care) and in nursing care homes</td>
<td>Cross-sectional observational study Aged ≥80 with diabetes n = 277 Nil HbA&lt;sub&gt;1c&lt;/sub&gt; residing at home, residing in residential care homes, residing in nursing care homes</td>
<td>Lower HbA&lt;sub&gt;1c&lt;/sub&gt; in residents of nursing homes. HbA&lt;sub&gt;1c&lt;/sub&gt; &lt; 52 mmol/mol in 48% of nursing homes residents. 35% of those living at home with additional care, and 29% of those living at home independently. Insulin use more prevalent in nursing care homes.</td>
<td>48% overtreated based on IDF HbA&lt;sub&gt;1c&lt;/sub&gt; targets in this population.</td>
</tr>
<tr>
<td>Abatecola <em>et al</em>, 2015&lt;sup&gt;18&lt;/sup&gt;</td>
<td>To investigate clinical characteristics and prevalence of hypoglycaemia</td>
<td>Cross-sectional observational study Aged-care facility residents with diabetes n = 2258 Nil Fasting BG, postprandial BG, HbA&lt;sub&gt;1c&lt;/sub&gt;, ADLs; anti-diabetic treatments</td>
<td>Hypoglycaemia observed in 18% of nursing home residents with dementia compared to 8% in residents without dementia. Residents on sulfonylurea therapy had increased odds ratio (8.8, CI 4.2 to 18.2) of severe hypoglycaemia. Rapid and analogue insulin therapy associated with reduced odds ratio (0.333, CI 0.184 to 0.602 and 0.248, CI 0.070 to 0.882 respectively) of severe hypoglycaemia.</td>
<td>Individuals with dementia are particularly at risk of hypoglycaemia. Cautious use of sulfonylurea therapy required. Rapid and analogue insulin therapy relatively safer.</td>
</tr>
<tr>
<td>Andreassen <em>et al</em>, 2014&lt;sup&gt;19&lt;/sup&gt;</td>
<td>To investigate clinical characteristics and prevalence of hypoglycaemia</td>
<td>Cross-sectional observational study Aged-care facility residents with diabetes n = 742 Nil</td>
<td>32% on insulin monotherapy. Mean HbA&lt;sub&gt;1c&lt;/sub&gt; 57 mmol/mol. HbA&lt;sub&gt;1c&lt;/sub&gt; &lt; 53 mmol/mol in 46%. 60% identified at risk of hypoglycaemia based on capillary BG measurement.</td>
<td>Insulin therapy common - proportion who are insulin dependent unknown. 46% overtreated based on IDF HbA&lt;sub&gt;1c&lt;/sub&gt; targets in this population. Capillary BG measurement has a broader reach to identify those at risk of developing hypoglycaemia.</td>
</tr>
<tr>
<td>Bouillet <em>et al</em>, 2010&lt;sup&gt;20&lt;/sup&gt;</td>
<td>To determine clinical characteristics by antidiabetic therapy</td>
<td>Cross-sectional observational study Aged-care facility residents with diabetes aged ≥65 years n = 100 Nil HbA&lt;sub&gt;1c&lt;/sub&gt;; antidiabetic therapy</td>
<td>32% with HbA&lt;sub&gt;1c&lt;/sub&gt; &lt; 47.5 mmol/mol.</td>
<td>32% overtreated based on IDF HbA&lt;sub&gt;1c&lt;/sub&gt; targets in this population.</td>
</tr>
<tr>
<td>Sjolblom <em>et al</em>, 2008&lt;sup&gt;21&lt;/sup&gt;</td>
<td>To compare safety and efficacy of deintensification of diabetes treatment</td>
<td>Open-label non-randomised controlled trial Aged-care facility residents with diabetes and HbA&lt;sub&gt;1c&lt;/sub&gt; ≥42 mmol/mol n = 98 Cessation of OADs, cessation of insulin ≥20 units and halving of insulin ≥20 units HbA&lt;sub&gt;1c&lt;/sub&gt;, hypoglycaemia; baseline 6-month 7 mmol/mol mean HbA&lt;sub&gt;1c&lt;/sub&gt; increase in those undergoing deintensification. 6-month post-intervention mean remained low at 40 mmol/mol. Deintensification caused no significant changes to all-cause hospital admissions or mortality.</td>
<td>Demonstrates safety and efficacy of deintensification of diabetes treatment.</td>
<td></td>
</tr>
<tr>
<td>Meyers <em>et al</em>, 2007&lt;sup&gt;22&lt;/sup&gt;</td>
<td>To investigate variability of HbA&lt;sub&gt;1c&lt;/sub&gt;</td>
<td>Cross-sectional observational study Aged-care facility residents with diabetes n = 168 Nil HbA&lt;sub&gt;1c&lt;/sub&gt;; nil</td>
<td>Mean HbA&lt;sub&gt;1c&lt;/sub&gt; 54.1 mmol/mol. Age correlation with HbA&lt;sub&gt;1c&lt;/sub&gt; lowest among the oldest. Higher HbA1c with insulin use. No correlation between HbA&lt;sub&gt;1c&lt;/sub&gt; and self-perceived health and life expectancy.</td>
<td>Suggests the oldest and frailest at increased risk of hypoglycaemia. HbA&lt;sub&gt;1c&lt;/sub&gt; may not have self-perceived impact on quality of life.</td>
</tr>
</tbody>
</table>
analysis of data from 10 observational studies, our systematic review suggests that hypoglycaemia remains common: hypoglycaemia was reported in 6.6–43%, 10,11,13,14,16,18,19,24,26,27 clearly identifying it as a preventable factor contributing to increased morbidity and mortality in this cohort.

We could identify only three studies which evaluated a strategy for simplification of T2DM treatment in residents of aged-care facilities (see Table 2). Based on our meta-analysis, older adults with T2DM were more prone to experience hypoglycaemia at both ends of the HbA1C spectrum. 10,13,14

<table>
<thead>
<tr>
<th>Study details</th>
<th>Study overview</th>
<th>Study design</th>
<th>Key results</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gill et al, 200623</td>
<td>To investigate clinical characteristics and glycaemic control</td>
<td>Type Population</td>
<td>Cross-sectional observational study</td>
<td>Mean HbA1C 56 mmol/mol. Co-morbidities and polypharmacy common. 27% on insulin.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sample size Intervention Outcome; Comparison</td>
<td>Aged-care facility residents with diabetes</td>
<td></td>
</tr>
<tr>
<td>Pham et al, 200324</td>
<td>To investigate clinical characteristics and outcomes</td>
<td>Type Population</td>
<td>Cross-sectional observational study</td>
<td>Insulin treatment in 36%. OAD in 40%.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sample size Intervention Outcome; Comparison</td>
<td>Aged-care facility residents with diabetes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>n = 240 nursing home residents; nil</td>
<td></td>
</tr>
<tr>
<td>Wolffenbuttel et al, 199125</td>
<td>Investigate clinical characteristics and outcomes of aged-care facility residents with diabetes</td>
<td>Type Population</td>
<td>Cross-sectional observational study</td>
<td>Mean HbA1C 58 mmol/mol. No difference between HbA1C in those with diabetes in the community or in aged-care facilities. Those in aged-care facilities more likely to experience general decline: ulcers, necrosis, recurrent infections, peripheral arterial disease.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sample size Intervention Outcome; Comparison</td>
<td>Aged-care facility residents with diabetes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>n = 38 HbA1C, diabetic complications; nil</td>
<td></td>
</tr>
<tr>
<td>Davis et al, 201426</td>
<td>Investigate clinical characteristics and outcomes of individuals receiving basal insulin</td>
<td>Type Population</td>
<td>Retrospective observational study</td>
<td>60% of residents receive insulin therapy. 17% affected by hypoglycaemia.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sample size Intervention Outcome; Comparison</td>
<td>Aged-care facility residents with diabetes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>n = 2096 Nil Hypoglycaemia; nil</td>
<td></td>
</tr>
<tr>
<td>Newton et al, 201327</td>
<td>To determine clinical characteristics by antidiabetic therapy</td>
<td>Type Population</td>
<td>Cross-sectional observational study</td>
<td>34% received insulin, 26% received insulin and OAD, 5% on OAD alone, 10% diet-controlled.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sample size Intervention Outcome; Comparison</td>
<td>Aged-care facility residents with diabetes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>n = 1409 Nil Antidiabetic therapy</td>
<td></td>
</tr>
</tbody>
</table>

| ADLs, activities of daily living; BB, basal bolus; BG, blood glucose; CI, confidence interval; HbA1C, glycated haemoglobin; IDF, International Diabetes Federation; OAD, oral antidiabetic drug; SS, sliding scale. |

**Discussion**

**Part A: Evaluating the need for simplification of T2DM treatment in residents of aged-care facilities**

Management of T2DM in frail older adults poses special challenges as a reduction in functional capacity, development of co-morbidities, polypharmacy, cognitive decline and frailty warrants dynamic re-evaluation of glycaemic targets. The vascular benefits of intensive control need to be weighed against risks posed by hypoglycaemia, with focus on simplification of the therapeutic regimen and adaptation of an individualised approach.

Multiple observational and cross-sectional studies have investigated the prevalence of hypoglycaemia and used HbA1C as a marker of glycaemic control. 10–28 We identified 16 studies (collectively involving 7,869 aged-care residents with T2DM) in which data on HbA1C were collected and compared to evaluate glycaemic control. Among these studies, the mean HbA1C was 51.9 mmol/mol (95% CI 52.0 to 51.8 mmol/mol; Figure 2). However, of the five studies reporting grouped values, HbA1C <53 mmol/mol was seen in 43–55%, 14,16,19,22 With the IDF recommending a target HbA1C of
Part B: Simplification of T2DM treatment in residents of aged-care facilities

There is limited literature exploring simplification of T2DM treatment in this population. We identified three such studies which provide a regimen for simplification of T2DM management in residents of aged-care facilities. These studies showed marked heterogeneity in population selection, intervention used for simplification and reported outcomes, making direct comparison non-viable. For example, Sjoblom et al explored different strategies for simplification including switching insulin to oral antidiabetic drugs, cessation of insulin <20 units and halving of insulin >20 units.21 Dharmarajan et al explored simplifying insulin regimens from sliding scale (SS) to

Table 2 Simplification of type 2 diabetes mellitus treatment in aged-care facility residents

<table>
<thead>
<tr>
<th>Study details</th>
<th>Study overview</th>
<th>Study design</th>
<th>Key results</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Umpierrez et al, 201811</td>
<td>To explore outcomes of simplifying diabetes treatment with glargine or linagliptin monotherapy</td>
<td>Open-label randomised controlled trial Aged-care facility residents on OAD or low-dose insulin and HbA1c &gt;58 mmol/mol (n = 140) Mean daily BG, hypoglycaemia, HbA1c, hospital admission, emergency department visits; baseline, glargine monotherapy, linagliptin monotherapy</td>
<td>Significantly lower mean daily BG with linagliptin and glargine monotherapy compared with baseline. 34% absolute risk reduction in hypoglycaemia with linagliptin compared with glargine. No significant difference in HbA1c at 6 months between linagliptin and glargine. No significant changes to all-cause hospital admissions in any intervention.</td>
<td>Demonstrates safety and efficacy of linagliptin monotherapy for deintensification of diabetes treatment.</td>
</tr>
<tr>
<td>Dharmarajan et al, 201614</td>
<td>To compare the safety and efficacy of BB and SS insulin regimens</td>
<td>Randomised controlled trial Aged-care facility residents with diabetes n = 64 SS insulin regimen, BB insulin regimen Fasting BG, hypoglycaemia, hyperglycaemia, adverse events; BB and SS</td>
<td>Significantly lower fasting BG in those on BB insulin regimens compared with SS. No significant differences in the incidence of hypoglycaemia.</td>
<td>Simplified insulin regimen improves fasting BG. Three-day data collection period not adequate for observation of hypoglycaemic events. Evidence of safety and efficacy of simplified insulin regimens.</td>
</tr>
<tr>
<td>Sjoblom et al, 200821</td>
<td>To compare the safety and efficacy of deintensification of diabetes treatment</td>
<td>Open-label non-randomised controlled trial Aged-care facility residents with diabetes and HbA1c ≤42 mmol/mol (n = 98) Cessation of OADs, cessation of insulin &lt;20 units and halving of insulin &gt;20 units; HbA1c, hypoglycaemia; baseline</td>
<td>6-month 7 mmol/mol mean HbA1c increase in those undergoing deintensification. 6-month post-intervention mean remained low at 40 mmol/mol. Deintensification caused no significant changes to all-cause hospital admissions or mortality.</td>
<td>Demonstrates safety and efficacy of deintensification of diabetes treatment.</td>
</tr>
</tbody>
</table>

53–64 mmol/mol in functionally dependent older adults, with lenience to <70 mmol/mol in those frail or living with dementia,9 this suggests significant overtreatment of this population cohort.

Interestingly, higher HbA1c levels were also associated with an increased risk of developing hypoglycaemia,10,13,14 reflecting poor glycaemic control at both ends of the HbA1c spectrum. HbA1c is a poor marker of glucose variability and needs to be interpreted cautiously in older adults (especially those dependent on carers for nutrition and injectable therapy) due to their susceptibility to BG fluctuation. HbA1c levels can also be falsely high or low due to anaemia, polycythaemia or renal impairment, which become more prevalent with ageing. Andreassen et al9 found capillary BG measurements to have a broader reach in identifying older adults at risk of developing hypoglycaemia than HbA1c levels.

We identified 10 observational studies which have reported on the prevalence of hypoglycaemia in aged-care facility residents. The prevalence of hypoglycaemia based on these studies ranged from 6.6% to 60%,10,11,13,14,16,18,19,24,26,27 reflecting it to be a common and avoidable risk factor associated with increased morbidity in this age group. Indeed, of the 44 nursing homes approached by Hurley et al, 19% reported hypoglycaemic even as “frequent” among its residents.28

Insulin therapy was commonly associated with the greatest risk of hypoglycaemia compared with other treatment modalities,10,11,13,14,16,24,27 highlighting this therapy as the most in need of review and simplification. An exception to this was a study by Abbatecola et al who observed a lower risk of severe hypoglycaemia associated with rapid and analogue insulin (OR 0.333, 95% CI 0.184 to 0.602 and OR 0.248, 95% CI 0.070 to 0.882, respectively) compared with sulfonylurea therapy (OR 8.8, 95% CI 4.2 to 18.2).18 This study also reported residents with dementia (18%) to be especially vulnerable to developing severe hypoglycaemia compared with residents without dementia (8%).18 Multiple other studies have reported an increased risk of sulfonylurea-induced hypoglycaemia in residents with dementia.16,18
basal bolus (BB). A study by Umpierrez et al was the only one to compare basal insulin (glargine) with DPP4 inhibitor (linagliptin) monotherapy.11

Of the two studies reporting BG levels, both showed reduced glycaemic variability with simplified treatment. For example, compared with baseline, linagliptin monotherapy resulted in significantly lower mean daily BG.11 A 34% absolute risk reduction in residents affected by hypoglycaemia was also demonstrated when compared with those receiving insulin.11 Similarly, Dharmarajan et al demonstrated significantly lower fasting BG in those on BB insulin regimens compared with SS.15 Here, there were no significant differences in the incidence of hypoglycaemia, although data collection for this occurred over a three-day period only.15

Two of the studies used HbA1c to report the impact of simplification on glycaemic control. Although Sjoblom et al reported a 7 mmol/mol mean HbA1c increase, the 6-month post-intervention mean remained low at 40 mmol/mol.21 When compared with insulin therapy, linagliptin showed no significant difference in HbA1c at 6 months.11 In addition, simplification caused no significant changes to all-cause hospital admissions11,21 or mortality.21

Our systematic review of the literature provides further evidence to support a well-formed consensus: residents with T2DM in aged-care facilities are often subject to intensive glycaemic control and hypoglycaemia. In older adults with T2DM, intensive glycaemic control, especially hypoglycaemia, contributes to accelerated physical and cognitive decline, hospital admissions, frailty and reduced life expectancy.4 Although limited by scarcity of randomised controlled trials, this review suggests that simplification of T2DM treatment can effectively reduce hypoglycaemia risk without compromising glycaemic control in this population.11,15,21 Additionally, simplification may also benefit QOL by reducing tablet, injection and BG monitoring burden for both residents and carers.29

Part C: Identification of residents most likely to benefit from simplification of T2DM treatment

Identifying aged-care facility residents most likely to benefit from simplification of therapy has not received much focus. Evaluating glycaemic control in this cohort is challenging as factors such as cognitive impairment, frailty, reduced functional reserve and depression may make self-monitoring of BG and reporting of osmotic symptoms difficult.

HbA1c measurement remains a relatively insensitive tool to screen those at risk of developing hypoglycaemia.10,13,14 Capillary BG monitoring should supplement HbA1c monitoring in identifying
older adults most vulnerable to develop hypoglycaemia. Short- or medium-term continuous glucose monitoring in aged-care facility residents deemed at high risk of hypoglycaemia offers a pragmatic approach and a far more comprehensive reflection of glycaemic control.

The number of antidiabetic prescriptions has not been observed to show correlation with hypoglycaemia risk. 12 Care is needed to avoid cessation of insulin in those with type I diabetes mellitus or Latent Autoimmune Diabetes of Adulthood (LADA). As such, further work is needed to explore whether an insulinopenic phenotype as suggested by history, low or low-normal body mass index, previous diabetic ketoacidosis, presence of anti-GAD or anti-isilet cell antibodies or strong personal history of autoimmune conditions correctly identifies those with insulin dependency. Similarly, preserved urinary C-peptide:creatinine can give biochemical reassurance of residual pancreatic β cell function and confidence to simplify diabetic treatment.

Selecting a safe and individualised regimen for simplification remains integral in delivering biological, not chronological, patient-centred care – a principal central to all discussions in this review.

Conclusions
In summary, simplification of treatment should be considered in most residents with T2DM living in aged-care facilities, especially in the presence of dementia and frailty. Treatment regimen needs to be individualised with simplification of the insulin regimen and/or switching to oral glucose-lowering medications wherever possible. At the time of writing this review, the COVID-19 pandemic reminds us that keeping our older adults with diabetes safe, reducing their dependence on caregivers for administration of tablets, injections and BG monitoring, is far more important now than it has been ever before.

Conflict of interest None.
Funding None.

References

Control-IQ™ advanced hybrid closed-loop technology on the t:slim X2™ insulin pump predicts and helps reduce highs and lows to help increase time in range.®

Control-IQ Technology is designed to help increase time in range (3.9-10.0 mmol/L)® using Dexcom G6 continuous glucose monitoring (CGM) values to predict glucose levels 30 minutes ahead and adjust insulin delivery accordingly; including delivery of automatic correction boluses® (up to one per hour).
Appendix 1. Full MEDLINE search