Automated Insulin Delivery in the Older Person with Diabetes

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D.T.R.G Diabetes Technology Research Group

ACADI
Australian Centre for Accelerating Diabetes Innovations

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Disclosures

- Honoraria from Medtronic, Insulet, Abbott, Novo and Sanofi
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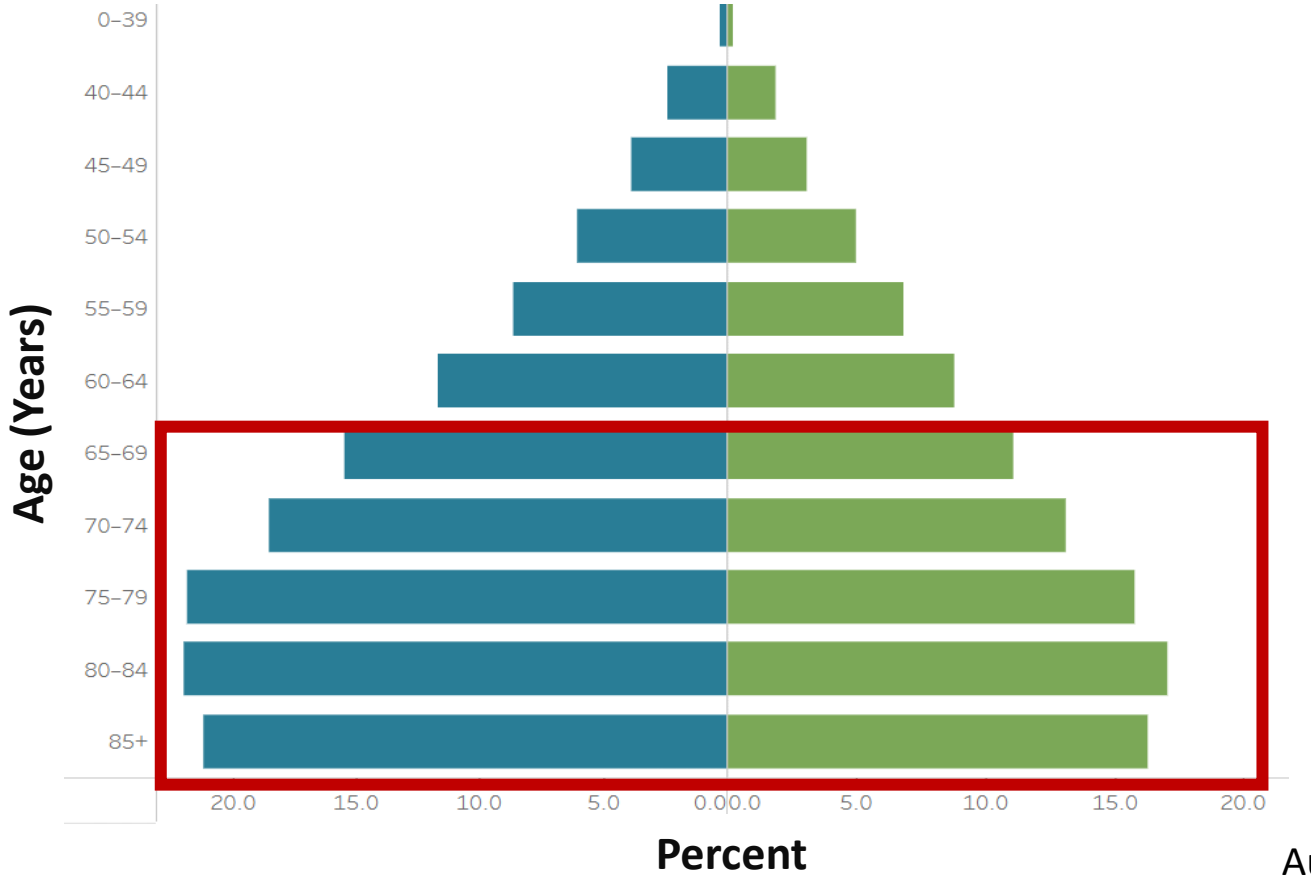
- Advisory Boards for Medtronic, Insulet, Abbott, Ypsomed, Novo, and Sanofi

Type 2 Diabetes vs Age: Australia June 2022

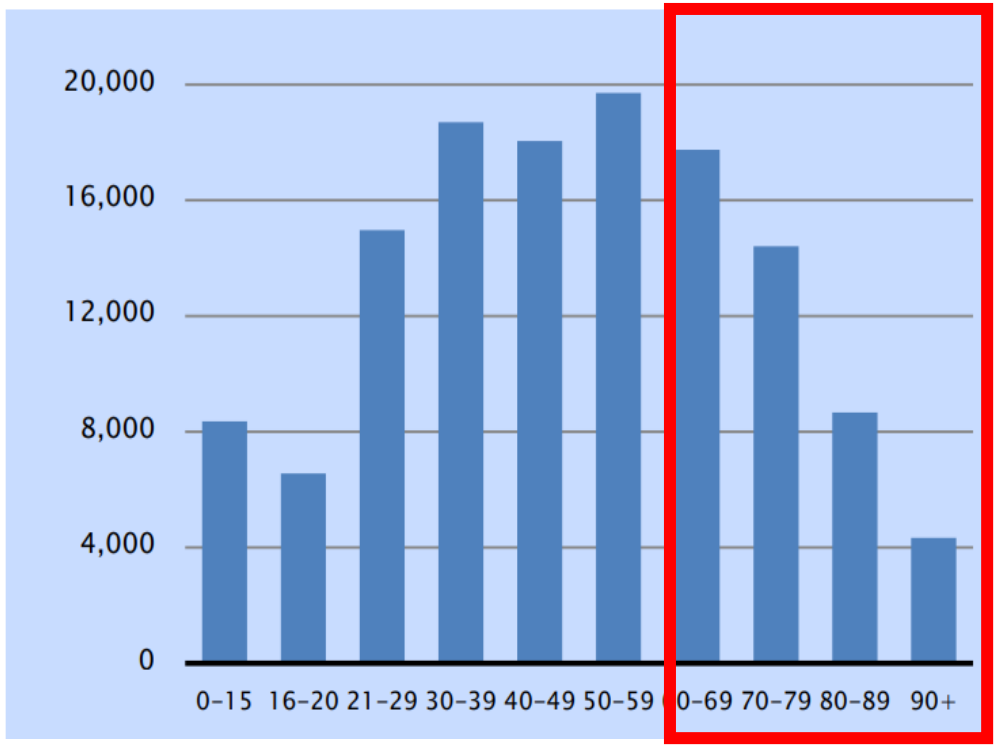
- **1.2 million (4.6% of Total Population)**
- **59% (0.7 million) of T2D aged 65 or over.**



25% Rx Insulin

Australian Bureau of Statistics Website 2024

Type 1 Diabetes vs Age: Australia June 2022



Age Group	Number	%
0 – 20	14,919	11%
21 – 39	33,665	26%
40 – 59	37,754	29%
60 +	45,151	34%
Total	131,489	100%

National Diabetes Support Scheme Website 2024

Hyperglycaemia in Older People with Diabetes: A Threat to Wellbeing

HYPERGLYCAEMIA: PREDISPOSING FACTORS

- Socially isolated
- Impaired cognition
- Erratic diet
- Complex treatment regimens
- Mis-timed insulin / dosing errors
- Presence of complications (eg dialysis)
- Recent Hospitalisation
- Reduced mobility
- Medications (steroids, thiazides, sedatives)

ACUTE/ SUBACUTE CONSEQUENCES

- Dehydration / Hypotension
- Balance, Falls and Fractures
- Polyuria and incontinence
- Infections / slow wound healing
- Electrolyte disturbance
- **Impaired Cognition** / Sleep Disturbance
- DKA / hyperosmolar coma

CHRONIC CONSEQUENCES

- Nephropathy
- Macrovascular Disease
- Cardiomyopathy
- Neuropathy (peripheral / autonomic)
- Vision (retinal / macular / lens)
- **Dementia**
- **Sarcopenia**

Adapted from U-M Vischer et al.
Diabetes & Metabolism. 35, (3): 168-177. 2009

Hypoglycaemia in Older T1D People: Also a Threat to Wellbeing

HYPOGLYCAEMIA: PREDISPOSING FACTORS

- Socially isolated
- Impaired cognition
- Ethanol
- Erratic diet / Weight loss
- Non-insulin medications (eg β-blockers)
- Complex treatment regimens
- Mis-timed insulin / dosing errors
- Complications (eg advanced renal disease / dialysis)
- Recent hospitalisation
- Impaired hypoglycaemia awareness

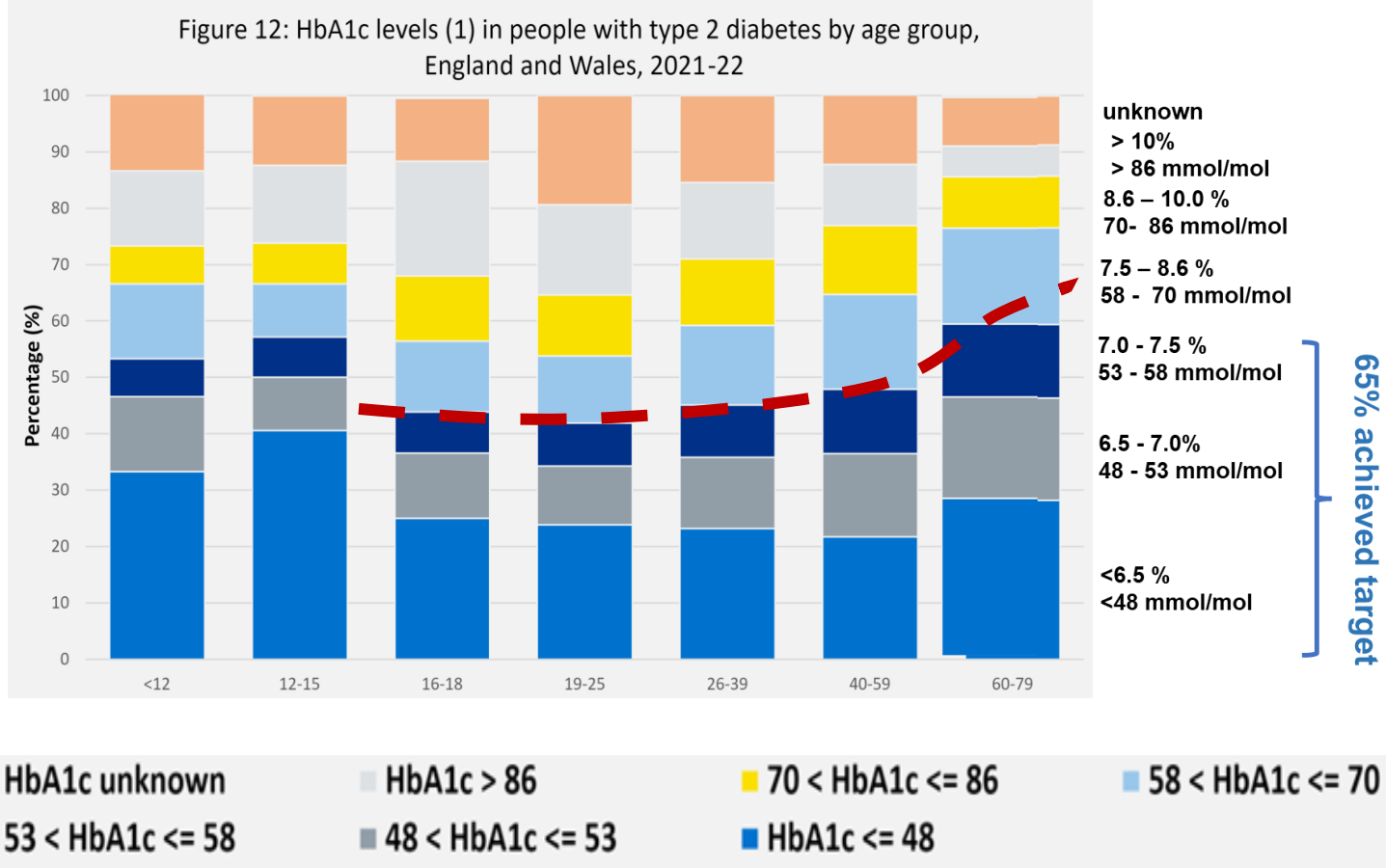
CONSEQUENCES

- Cardiac rhythm disturbances
- Myocardial ischaemia / infarction
- Falls and fractures
- Impact on cognition
- Coma and death

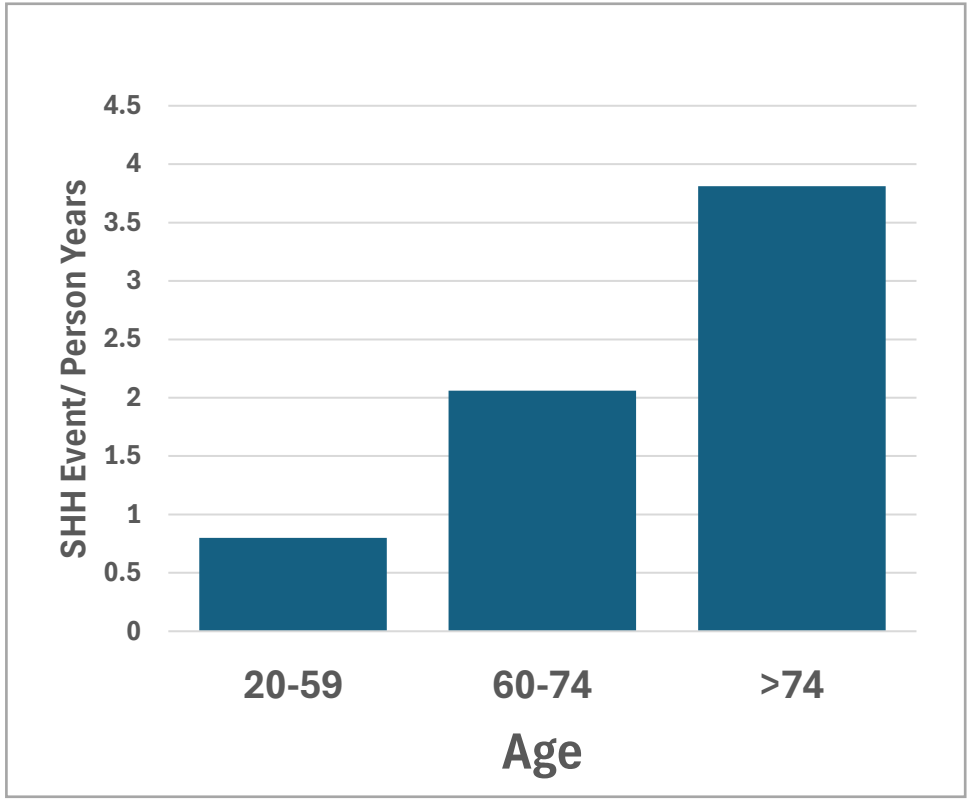
Adapted from M Sircar et al. Canadian Journal of Diabetes, 40, (1), 66-72. 2016

Glucose Control in Older People with T2D: HbA1c Favourable but More Severe Hypoglycaemia

HbA1c



Severe Hypoglycaemia

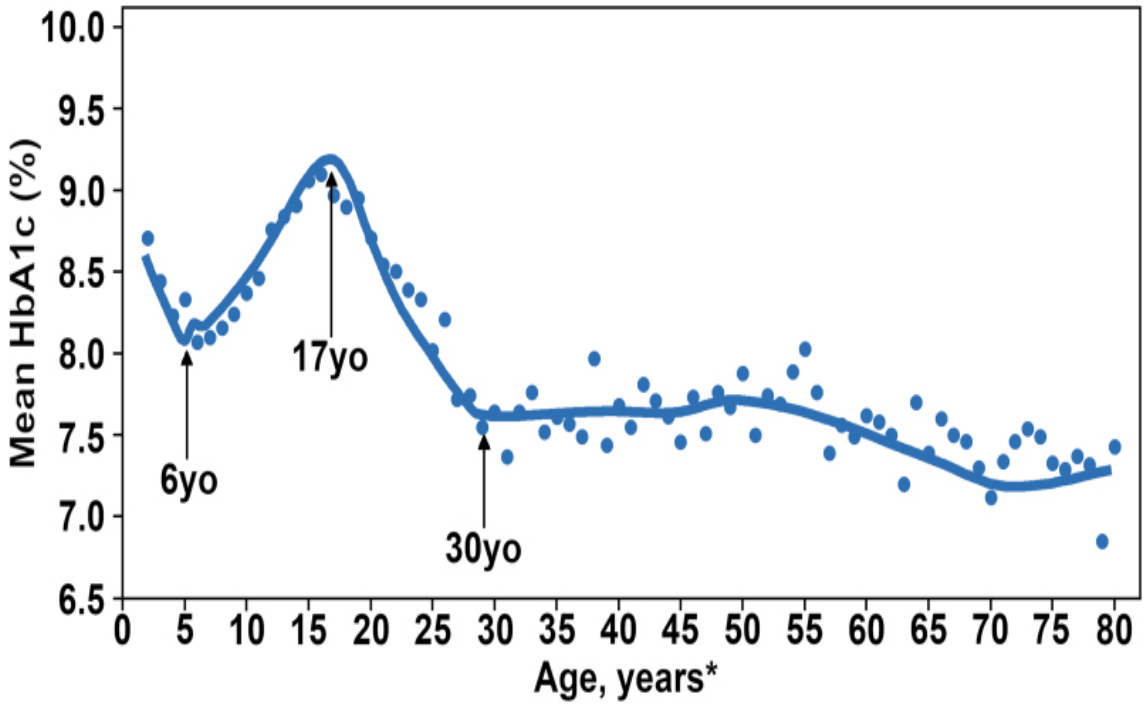


UK National Diabetes Audit 2024

Berthon W et al Diab Research and Clin Practice 2024

Glucose Control in Older People with T1D: HbA1c Favourable but More Severe Hypoglycaemia

HbA1c



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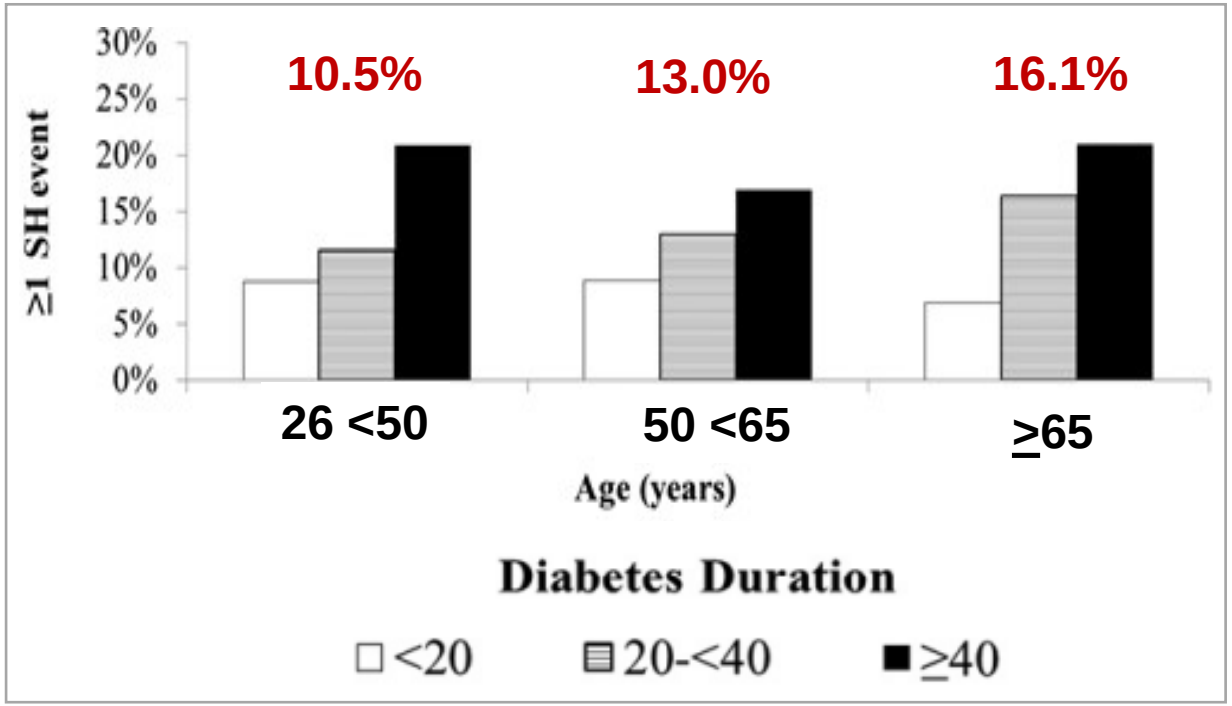
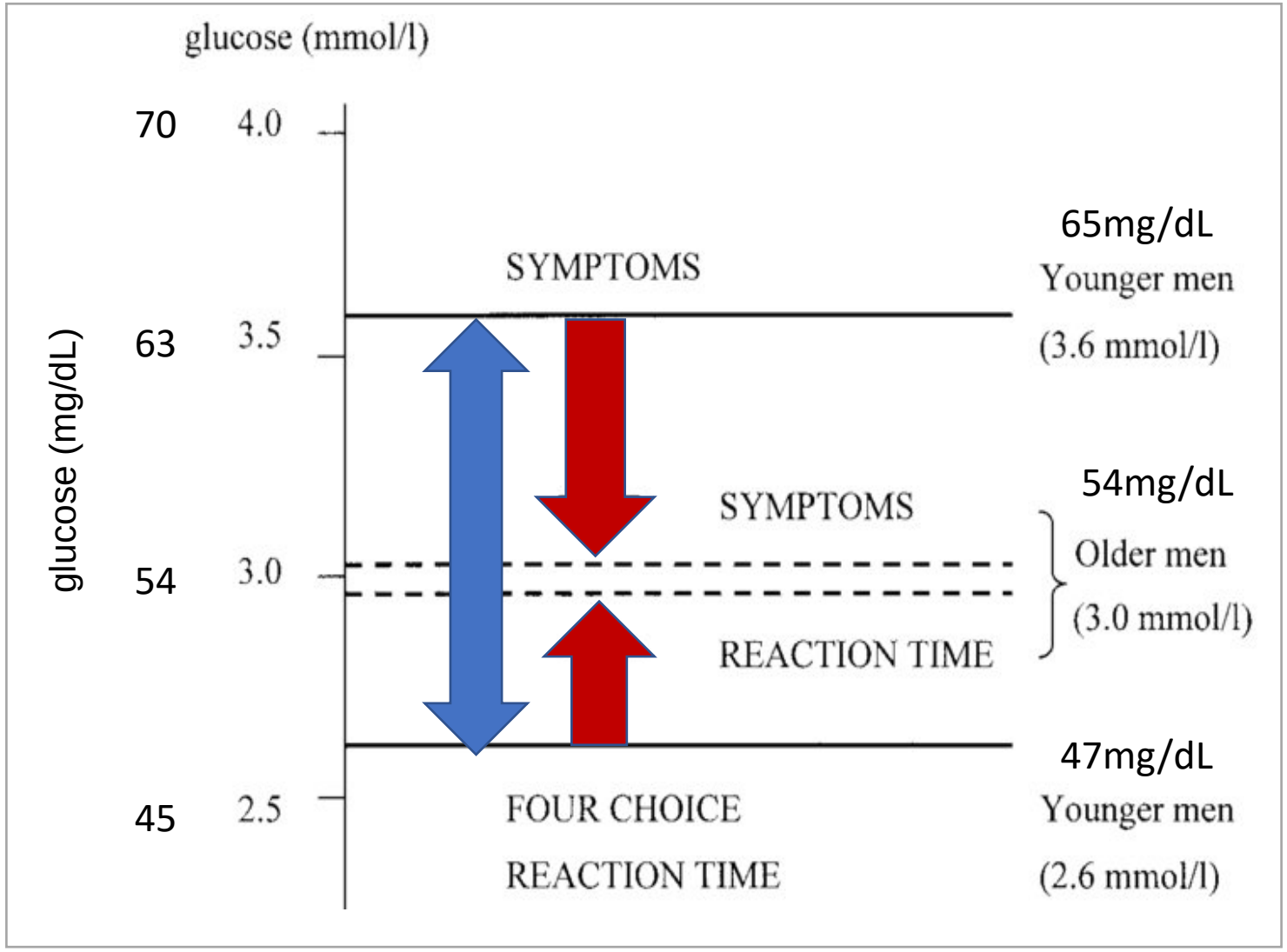


Miller KM et al Diab Tech and Therap 2024

Weinstock RS et al JCEM 2013

Increased Risk with Hypoglycaemia in the Elderly



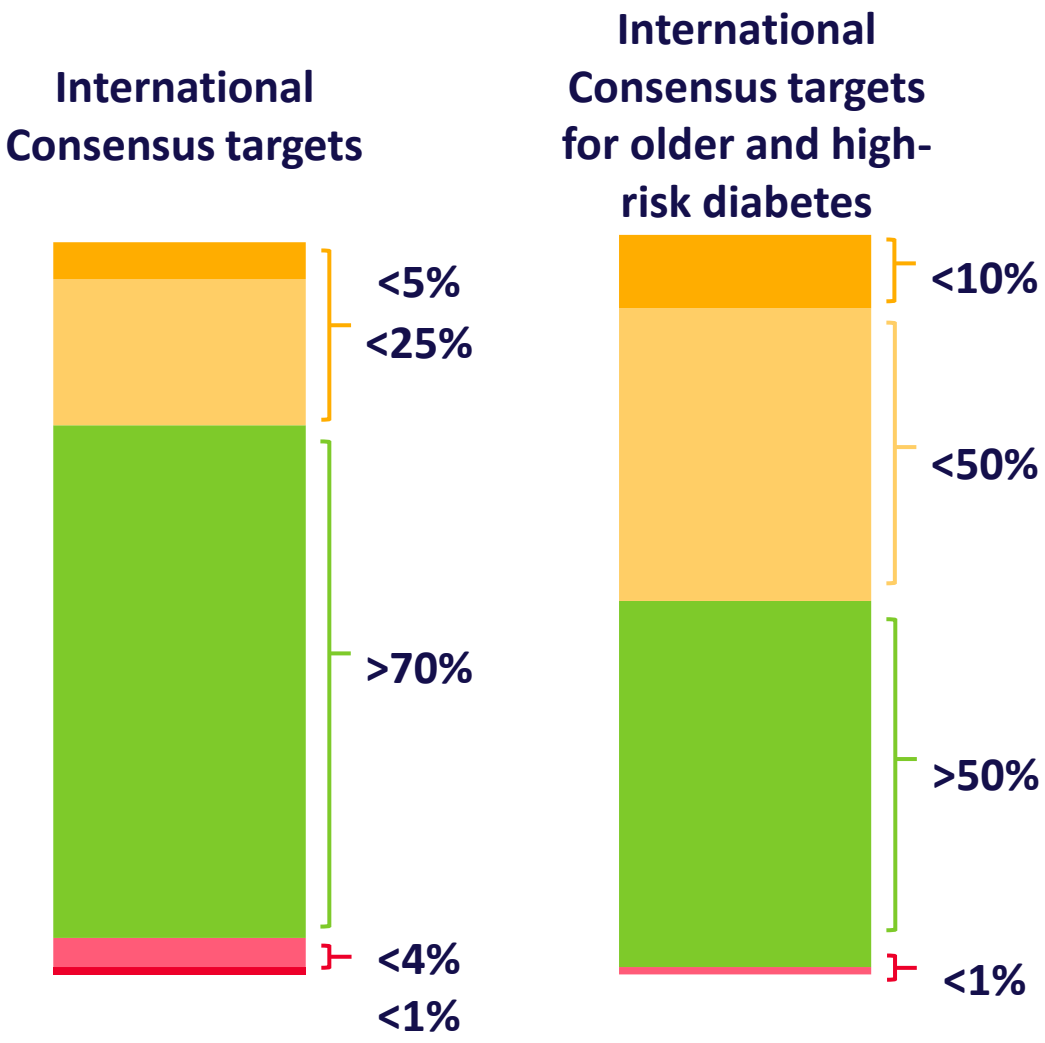
22-26 Y T2D Men (n = 7)

60-70 Y T2D Men (n = 7)

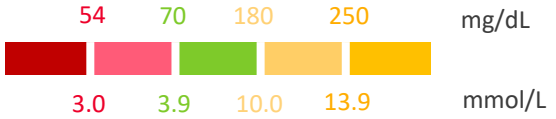
22-26 Y T2D Men (n = 7)

Matyka K, et al Diabetes Care 997; Adapted by Zammitt N., Frier B. Diabetes Care 2005

Modified CGM Targets for the Older Population



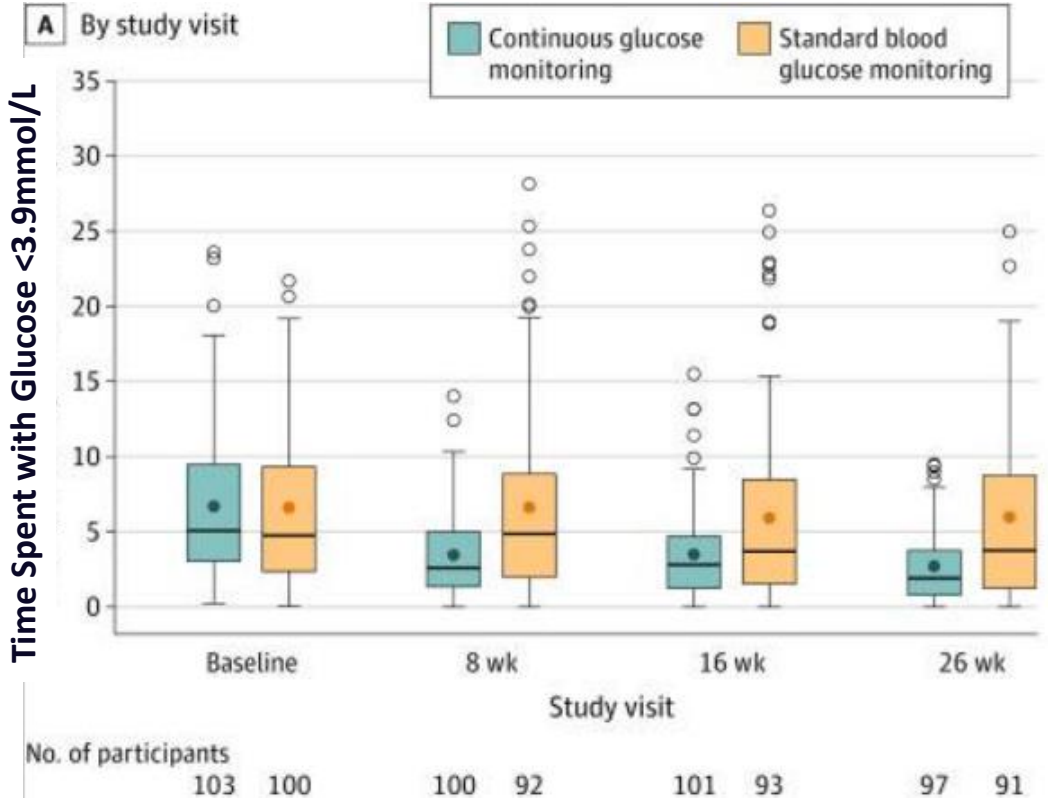
"Therefore, when setting glycaemic targets for high risk and / or elderly people, it is important to individualise and be conservative, with a strong focus on reducing the percentage of time spent <3.9mmol/L and preventing excessive hyperglycaemia."

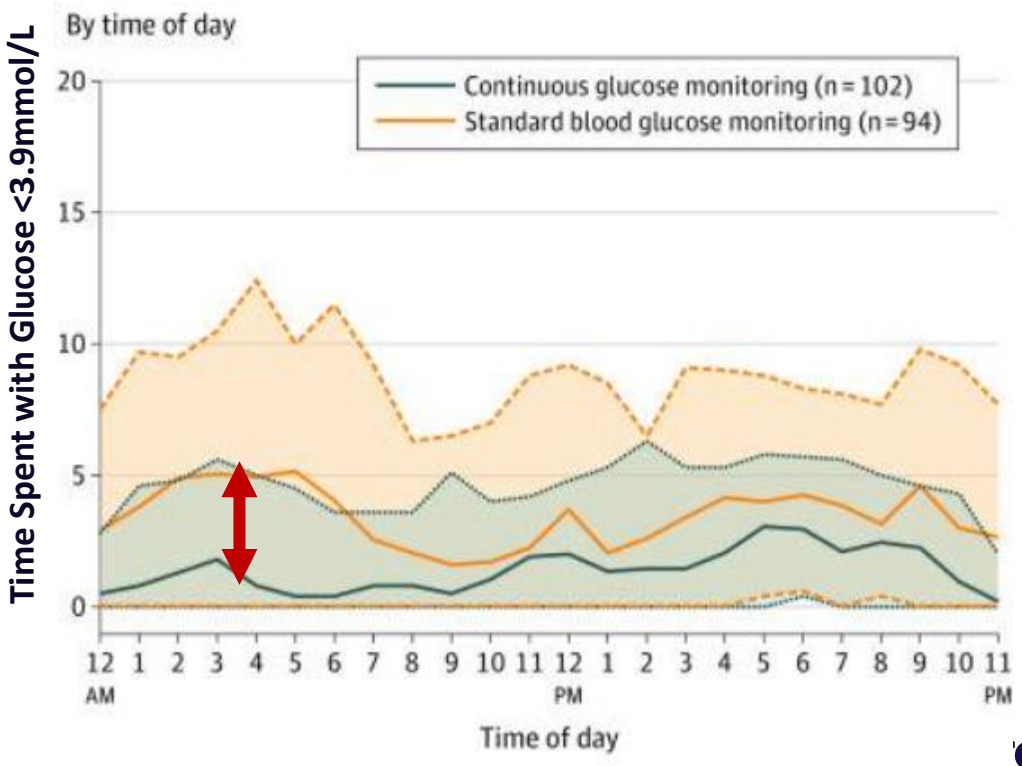


Battelino T, et al. *Diabetes Care.* 2019

High Risk Group: Older People with Diabetes

- N= 203 T1D Mean Age 68Y; HbA1c 7.6% (60 mmol/mol)
- 47% MDI and 53% non-AID pump
- Randomised 1 (Dexcom G5): 1 (SMBG) for 26W
- Time <3.9mmol/L: 2.7% vs. 4.9%; p <0.001
- Time in (3.9 to 10.0mmol/L) range: 63% vs. 54%; p <0.001





Pratley RE et al. JAMA 2020

Three T1D Randomised Crossover Trials: Design and Baseline Characteristics

System	Medtronic 670G[1]	CamAPS FX[2]	Control IQ[3]
Sensor	Guardian 3	Dexcom G6	Dexcom G6
Intervention Duration (Weeks)	16	12	12
Primary Endpoint	TIR	TIR	TBR <3.9 mmol/L
Male / Female [N]	11 / 19	21 / 16	45 / 37
Mean Age (years)	67 [5]	68 [63 – 70]**	71 [4]
Diabetes Duration (Years)	38 [20, 47]**	38 [32–47]**	42 [17]
Baseline HbA1c (%)	7.6 [0.9]	7·4 [0·9]	7.2 [2.0]*
Baseline HbA1c (mmol/mol)	58 [7]	57 [10]	55 [4]*
SAP Time in 3.9 -10.0 mmol/L (%)	69.0 [9.1]	71 [13]	67 [12]
SAP Time < 3.9 mmol/L (%)	1.69 [1.00, 2.54]**	1·7 [0·9, 2·7]**	2.1 [1.2, 3.7]**
SAP Time < 3.0 mmol/L (%)	0.16 [0.10, 0.38]**	0·2 [0·1, 0·3]**	0.48 [0.4]**
SAP CV (%)	35 [33, 36]**	33 [4]	36 [5]

*HbA1c estimated from mean glucose; **Median [IQR] all other results Mean [SD]

[1]McAuley SA, et al. Diabetes Care 2022; [2]Boughton CK et al Lancet Health and Longevity 2022; [3]Kudva YD, et al et al ADA 2024 144-OR

Three T1D Studies: Baseline Functional and Comorbid Status

System	Medtronic 670G[1]	CamAPS FX[2]	Control IQ[3]
Prior Insulin Pump Use (%)	**100**	**100**	**72**
Macrovascular Complications (%)	6	11	N/A
Retinopathy (%)	53	24	41
Nephropathy (%)		11	20
Neuropathy (%)		27	29
Frail (%)	0	N/A	N/A
Charlson comorbidity index	N/A	4 (1)	4(1)
Montreal Cognitive Assessment Score	80% Normal (≥26) 20% Mild Impairment (18-25)	N/A	Mild impairment allowed

[1]McAuley SA, et al. Diabetes Care 2022; [2]Boughton CK et al Lancet Health and Longevity 2022; [3]Kudva YD, et al et al ADA 2024 144-OR

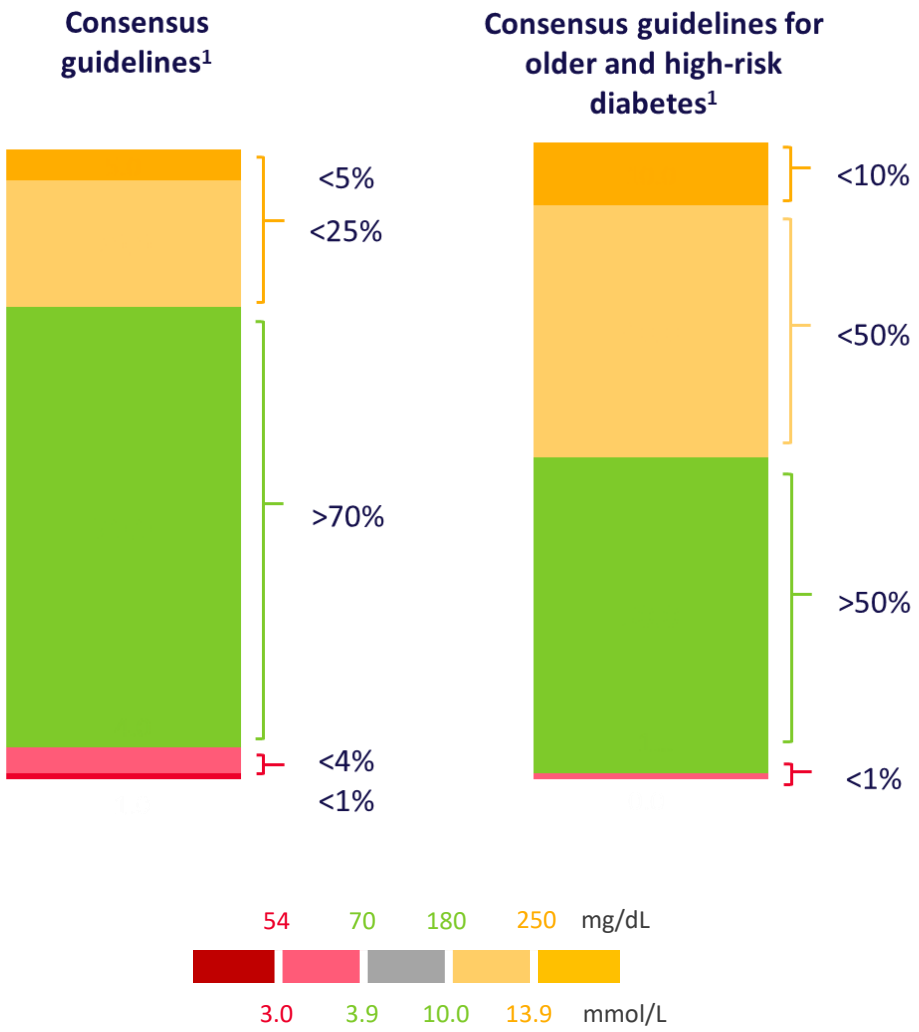
Three T1D Studies: Outcomes

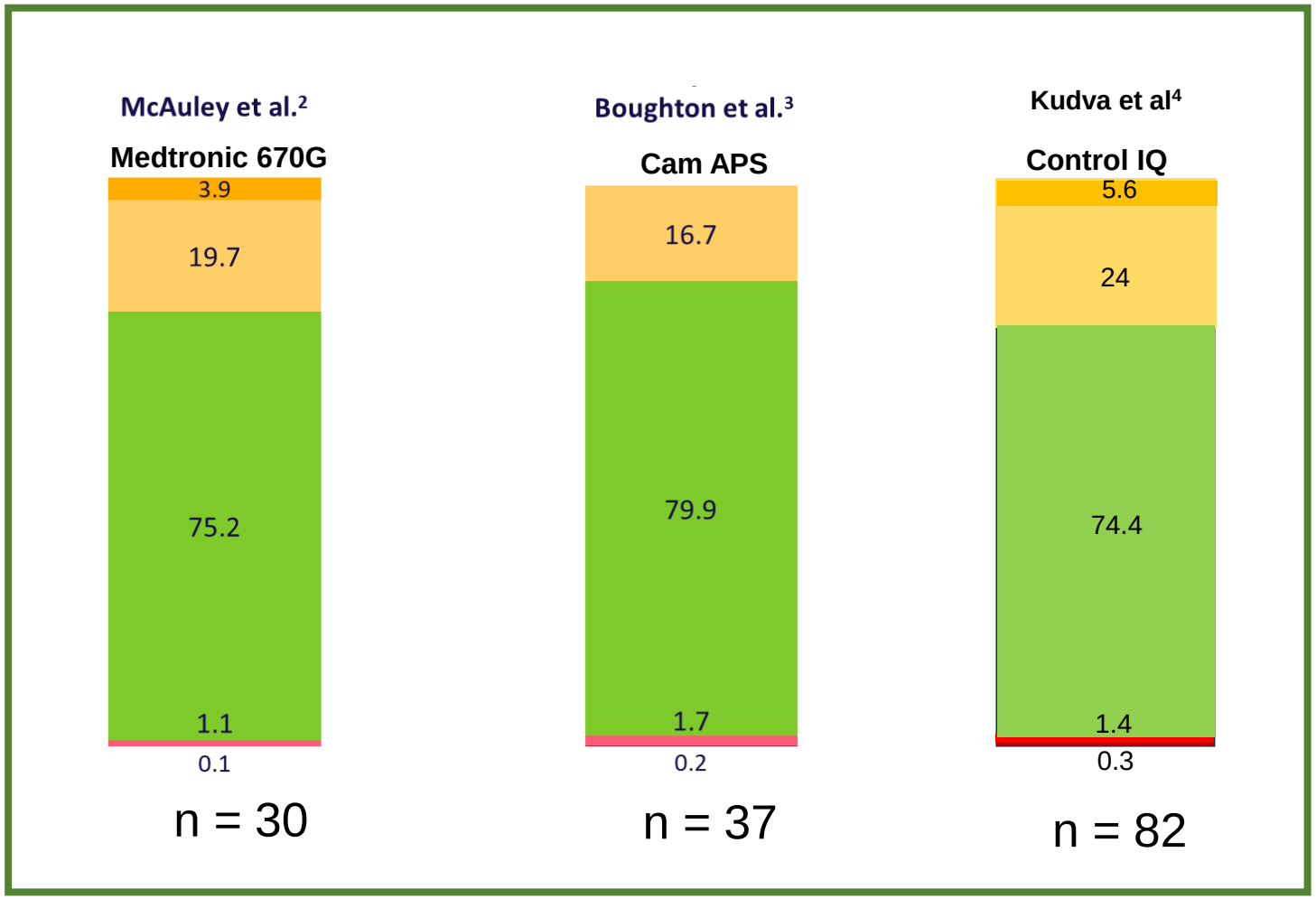
System	Medtronic 670G[1]	p	CamAPS FX[2]	p	Control IQ[3]	p
CGM Use (% time)	97 [94, 98]	N/A	99·7 [99·3, 99·9]	N/A	98 [97, 99]	N/A
HCL Use (% time)	93 [88, 96]	N/A	96·7 [95·1, 98·0]	N/A	97 [94,96]	N/A
Treatment Difference: AID vs SAP						
Time 3.9 -10.0 mmol/L (%)	6.2 [4.4, 8.0]	**<0.0001**	8·6 [6·3, 11·0]	**<0.0001**	8.9 [7.4, 10.4]	**<0.001**
Time < 3.9 mmol/L (%)	-0.47 [-1.05, -0.25]	**<0.0005**	−0·1 [−0·3, 0·2]	0·54	-1.05 [-1.48, -0.73]	**<0.001**
Time < 3.0 mmol/L (%)	-0.11 [-0.16, -0.05]	**<0.0078**	0·0 [-0·1, 0·1]	0.69	-0.21 [-0.32, -0.11]	**<0.001**
CV (%)	-3.4 [-4.5, -1.7]	**<0.0001**	−0·3 [−1·2 to 0·6]	0·49	-3.0 [-3.9, -2.2]	**<0.001**
Mean glucose (mmol/L)	-0.2 [-0.5, -0.1]	**0.035**	−0·7 [−0·9, −0·5]	**<0.0001**	-0.45 [-0.58, -0.32]	**<0.001**

Results; Median [IQR]

[1]McAuley SA, et al. Diabetes Care 2022; [2]Boughton CK et al Lancet Health and Longevity 2022; [3]Kudva YD, et al et al ADA 2024 144-OR

Three T1D Studies: Consensus CGM Targets and Trial Outcomes



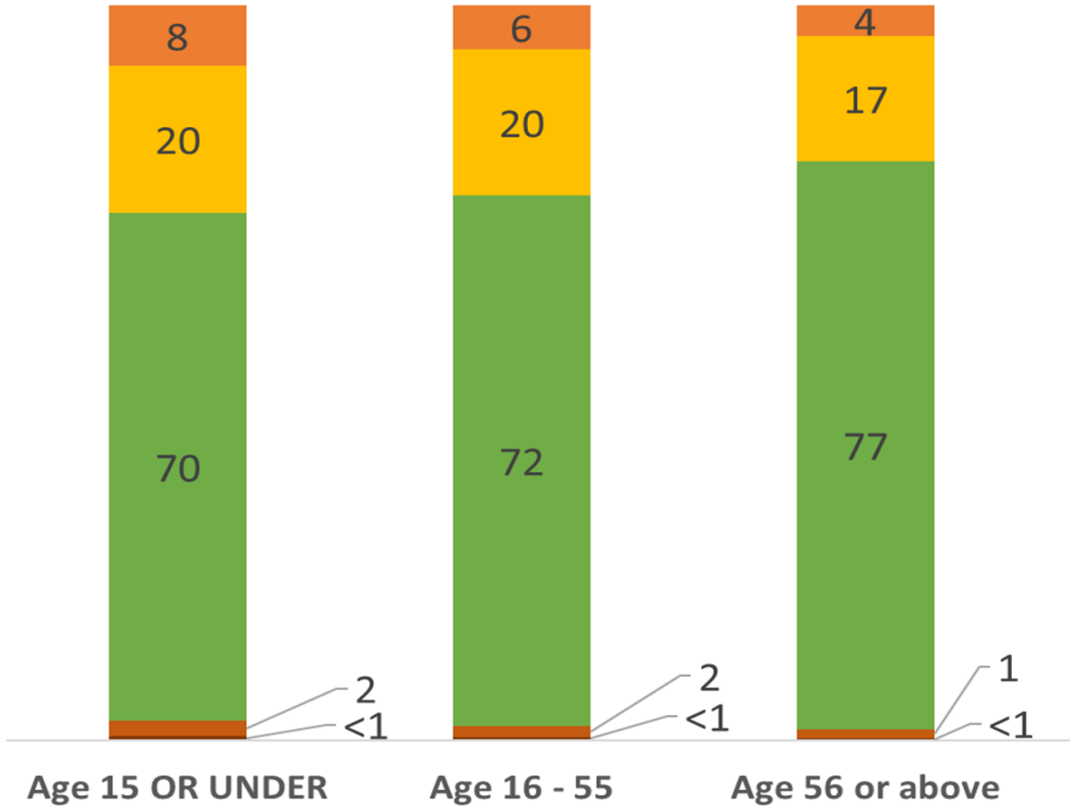


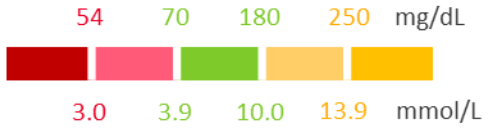
[1]Battelino T, et al. Diabetes Care. 2019.; [2]McAuley SA, et al. Diabetes Care. 2022·; [3]Boughton CK, et al. Lancet Healthy Longev.2022; [4]Kudva Y. al. ADA 2024 144-OR.

Three T1D Studies: Summary

- Non-frail, cognitively intact, health literate, older cohort, good baseline glycaemia, experienced pump users
- Compared with SAP
  - Excellent time in AID
  - TIR targets exceeded by large margin
  - TBR improved, though targets were not reached
  - Improvement rapid and sustained
- Assessment of psychological well-being and functional status not standardised

AID (Medtronic 780G): Real - World Australian Outcomes





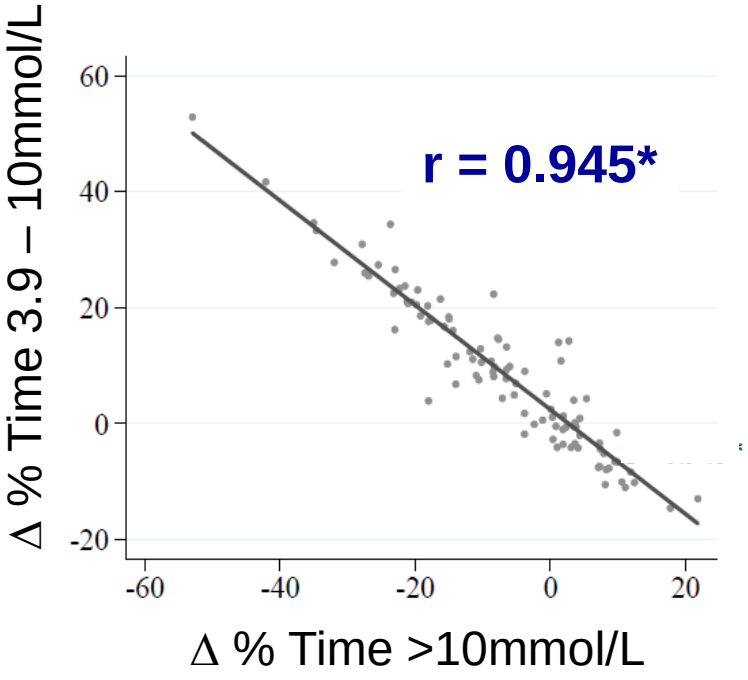
(N)	**591**	**2183**	**572**
% Device Users	**17**	**61**	**16**
% Age in Total T1D Cohort	**8**	**55**	**37**

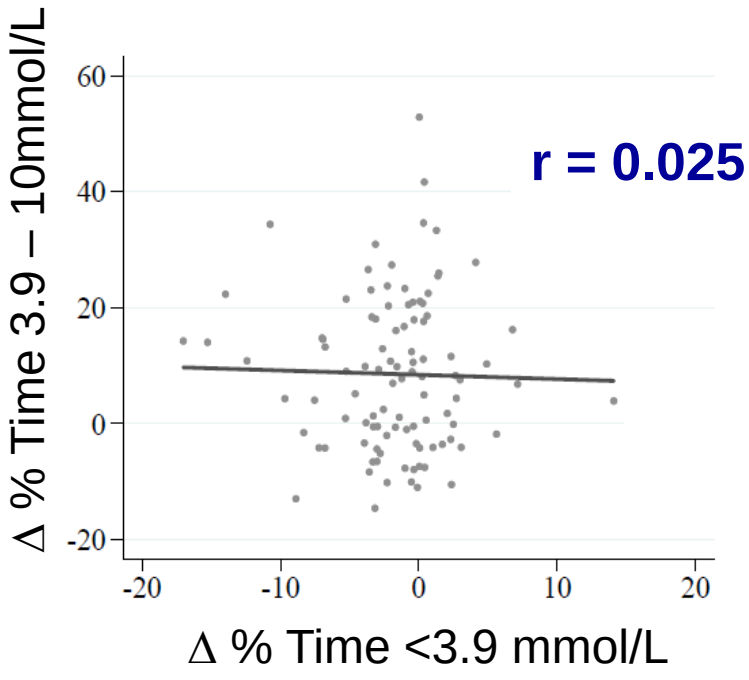
Halim B et al Diabetes Technology and Therapeutics 2024

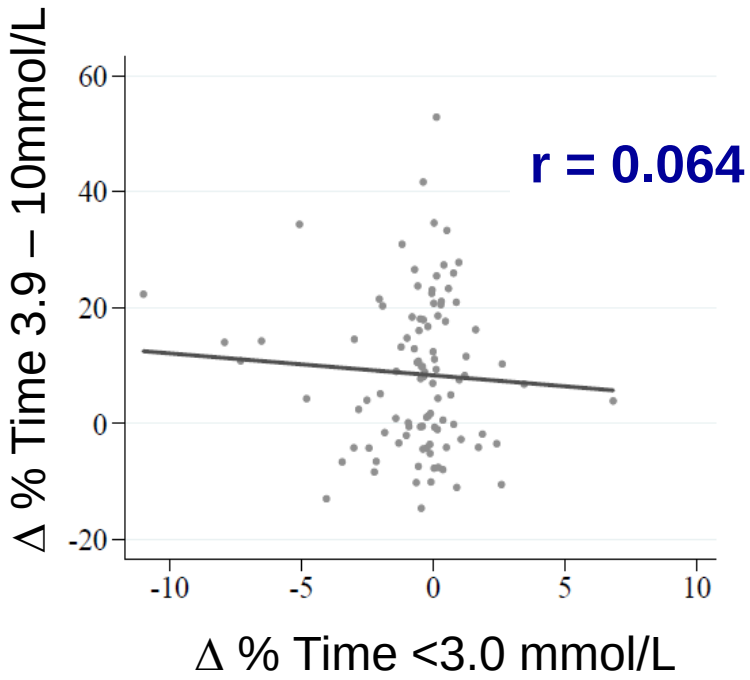
Changes in CGM Metrics Over 6-Months: ΔTIR Correlates with ΔTAR, but not ΔTBR

Change in TIR accounted for:

- **89% of variability of change in > 10.0 mmol/L range**
- 0.07% of variability of change in < 3.9 mmol/L range
- 0.4% of variability of change in < 3.0mmol/L range







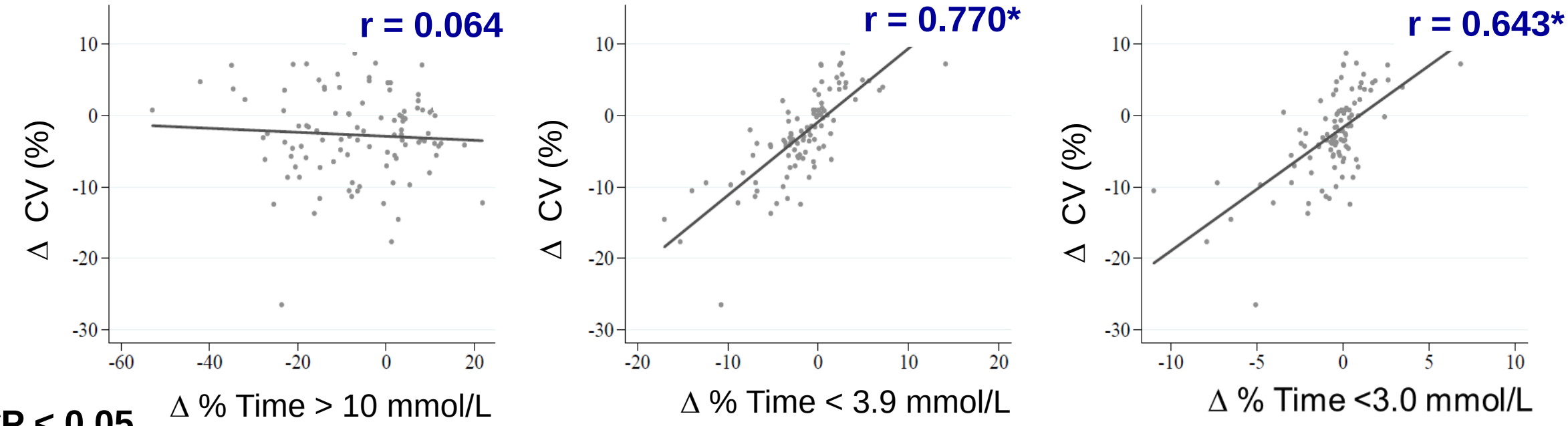
***P < 0.05**

O'Neal DN et al Diabetes Technology and Therapeutics 2023

Changes in CGM Metrics Over 6-Months: ΔCV Correlate with ΔTBR

Change in CV accounted for:

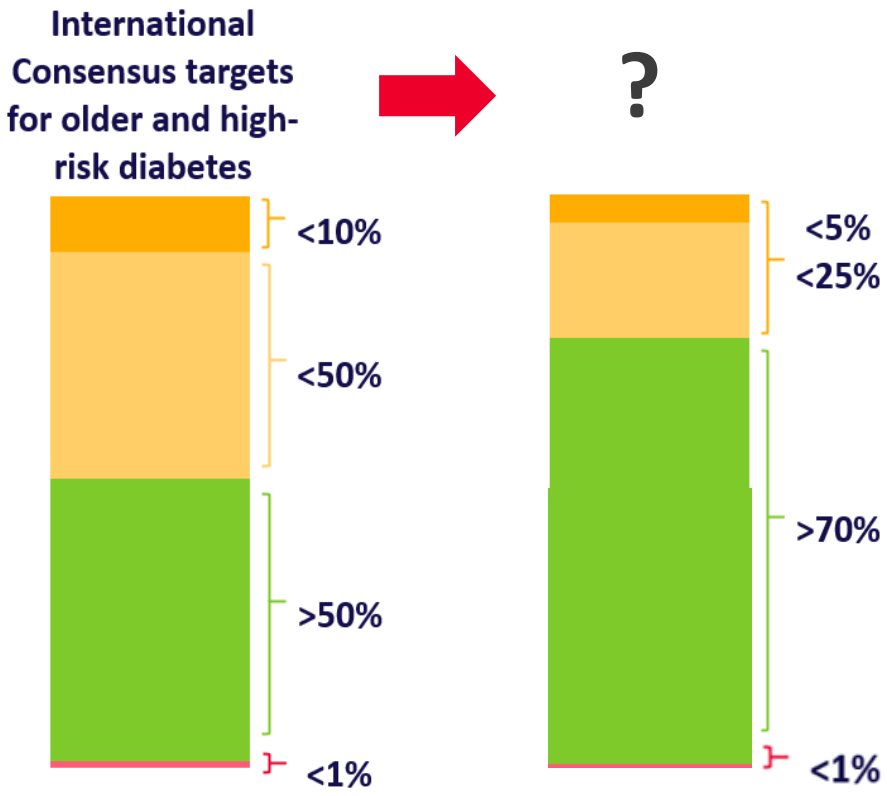
- 0.4% of variability of change in > 10.0 mmol/L range
- **59% of variability of change in < 3.9 mmol/L range**
- **41% of variability of change in < 3.0 mmol/L range**



*P < 0.05

O'Neal DN et al DT and T 2023

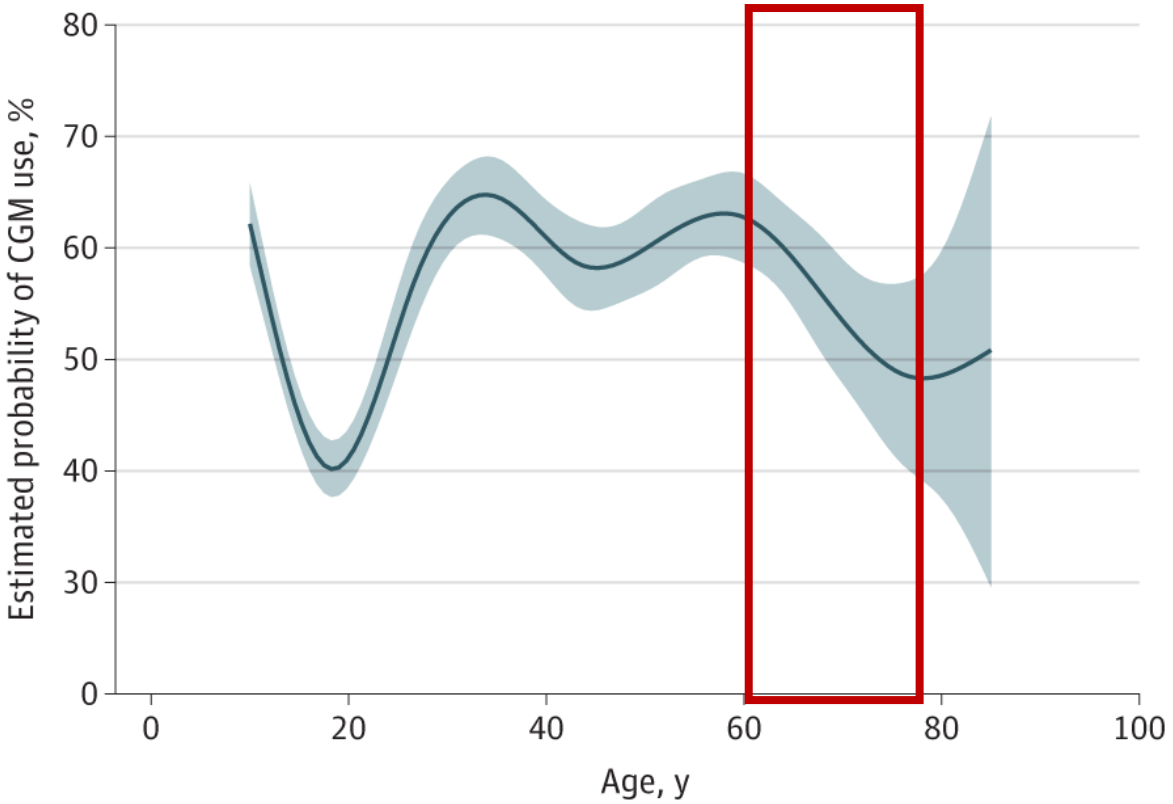
Consensus CGM Targets and The Older Diabetes Population



- **Avoiding hypoglycaemia: A priority in older people**
  - Minimising TBR a means to this end
  - Minimally impacted by reduced TIR
- **Higher TIR has short and long-term benefits**
- **Recognise heterogeneity in older people. TIR**:
  - A trade-off with less demanding regimens
  - Associated with hyperglycaemia

Battelino T, et al. *Diabetes Care* 42(8):1593-1603,2019

Technology Use Lower in Older People



Potential barriers to technology use in older people:

- Prescriber bias
- Access to funding
- Attitudes and perceptions
- Physical and cognitive limitations
- Language

Weinstein JM et al JAMA Network Open 2022

Optimising AID Systems for Older People

- **Current AID systems require:**
  - Intact cognition
  - Manual dexterity
  - Visual acuity

- **Ideal System:**
  - Non-tethered device (patch pump)
  - Insulin preloaded
  - Canula combined with glucose sensor
  - Full closed loop functionality
  - Settings in handset / smartphone (Tamper proof)
  - Remote monitoring
  - Compatible with hospitalisation / procedures
  - Cost-effective and widely accessible

The Research Gaps

- Older people with compromised function and cognition
- People with T2D on insulin
- Person Reported outcomes
- Health economics
- Use in hospitals and aged care facilities
- Engineering advances to improve user interface
- Advanced algorithms
- True ultrarapid acting insulin formulations

Full Closed Loop Functionality

Acknowledgements: Our Team

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To improve the lives of people with diabetes through exceptional research that drives advancement in innovative technologies

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