

Diabetes Technology Update

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Declaration for Peter Hammond

I have the following financial interest or relationship/s to disclose with regard to the subject matter of this presentation:

- Consulting fees: Medtronic, Abbott

Commercial Closed Loop Systems

	Medtronic 780G	Tandem Control IQ	Cam APS	Omnipod 5
Pump				
CGM				
Target	5.5 (default), 6.1 or 6.7 mmol/L		Personalised target: 4.4-11.0 - default 5.8 mmol/L	Personalised target: 6.1-8.3 mmol/L
Variables				Active insulin time I:C ratio Can give manual correction
				Basal insulin adjusted every 5 minutes
				Glooko-Diasend
				>2 years

Pump features	Medtronic 640G*	Omnipod patch pump	Tandem t:slim X2*	mylife Ypsopump	Dan Di
Weight	96 g	25 g	112 g	83 g	
Basal increment	0.025 U (0.025-35)	0.05 U (0.05-30)	0.001 U (0.001-15)	0.01 U (0.00-4)	
Basal rate/d	48	24 @ 30 min	16	24	
Basal profiles	8	0.05 u pulse	6	5 min	
BG target	10m (0.2-60)	Single target + threshold	Single target		
Bolus increments	Range: 0.1 U (max 75)	0.05 U (max 30)	0.01 U (max 2)		
Occlusion alarm @1.0u/h	2-3.8 h	1.5-5.5 h	< 2 h**		
Insulin volume	300 u	200 u	300 u		

	Dexcom One	Freestyle Libre 2/3
Sensor life	10 days	14 days
Real-time CGM	Yes	Yes
Size (cm)	3.8 x 2.3 x 1.2	3.5 diam; x 0.5 (L2) 2.1 diam; x 0.29 (L3)
Site	Arm; abdomen; buttock	Arm
Measurement frequency	5 minutes	5 minutes
Alarms	High/low alert	High/low alert
Calibration	None	None
MARD	8.2% (G7 arm), 9.0%	7.8% (L3), 9.2% (L2)

Harrogate and District NHS Foundation Trust

Hybrid Closed Loop Systems

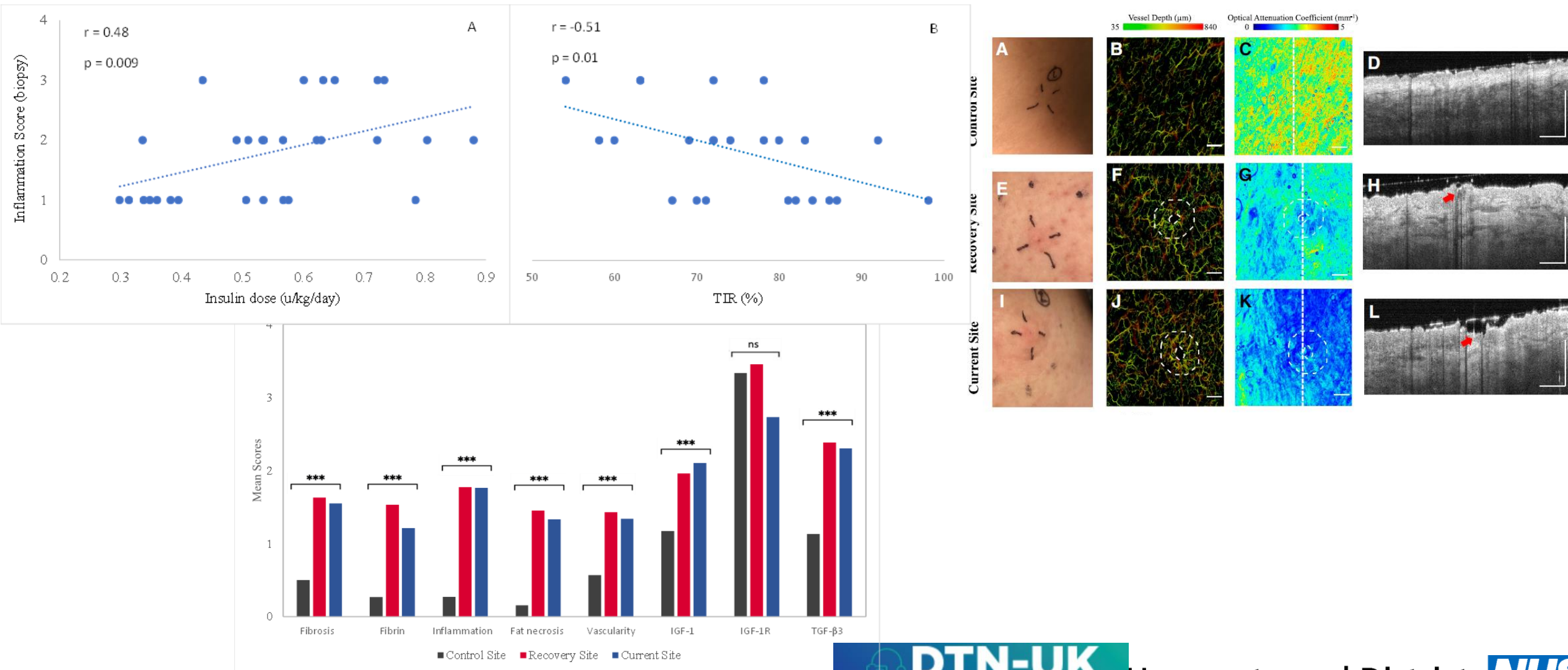


Insulin Pump Therapy

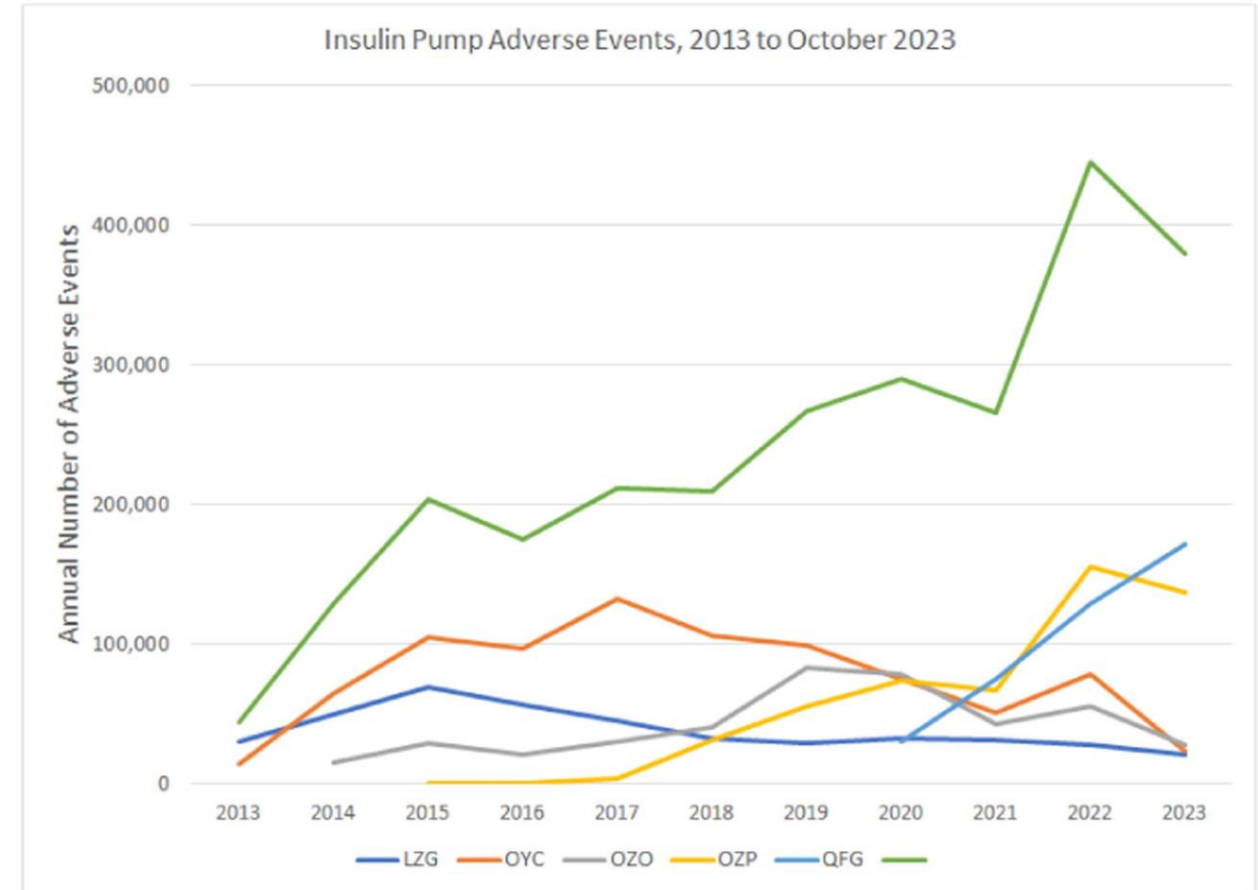
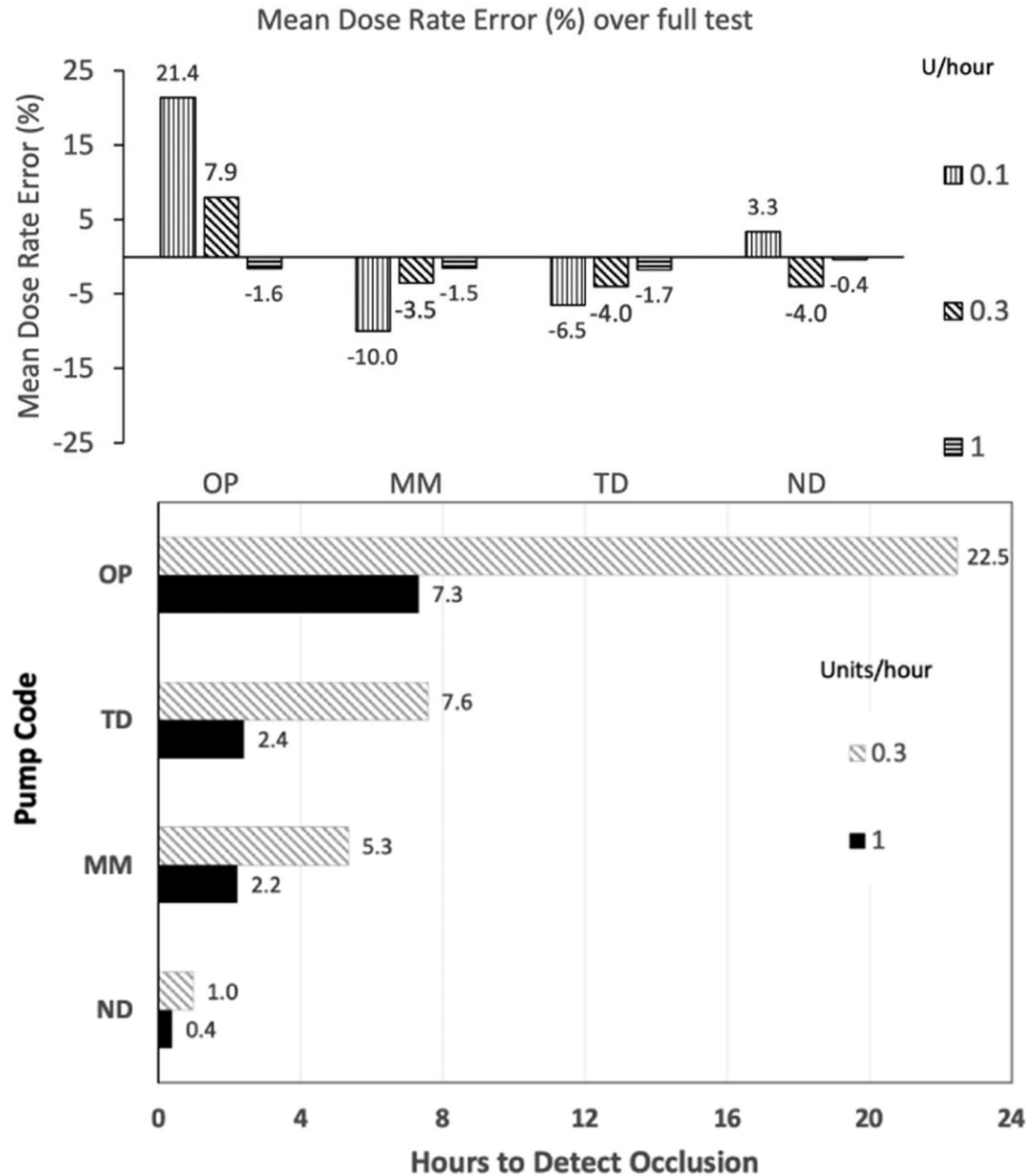
Continuous subcutaneous
insulin infusion (CSII)



DERMIS – skin inflammation with CSII



CSII: improving reliability



Butterfield RD & Sims NM *IEEE Open J Eng Med Biol* 2024;5:595-599.

Hybrid Closed Loop Systems



Hybrid Closed Loop (HCL) Systems Comparison Chart

Diabetes Specialist Nurse Forum UK	Medtronic	Tandem	Advanced Therapeutics	Ypsomed	Insulet
HCL algorithm	SmartGuard	Control IQ	CamAPS FX	mylife Loop (mylife CamAPS FX)	SmartAdjust
Location of algorithm	Pump-integrated	Pump-integrated	App based (Android)	App based (Android)	Pod-integrated
Pump	Medtronic 780g	T-slim X2	DANA-i	mylife YpsoPump	Omnipod 5
Pump type	Tethered (tubed)	Tethered (tubed)	Tethered (tubed)	Tethered (tubed)	Patch (tubeless)
Continuous glucose monitor (CGM)	Guardian 4 (no calibration)	Dexcom G6, Dexcom G7	Dexcom G6	Dexcom G6, FreeStyle Libre 3	Dexcom G6, FreeStyle Libre 2 Plus
Control & bolus delivery operation	Pump	Pump	Android smartphone	Android smartphone	Omnipod 5 Controller (PDM)
Pump charging mechanism	AA battery	Rechargeable	AAA battery	AAA battery	Battery within each pod Controller is rechargeable
Target glucose	5.5, 6.1 or 6.7 mmol/L (default 5.5)	6.25-8.9 mmol/L	Customisable from 4.4 to 11.1 (default 5.8)	Customisable from 4.4 to 11.1 (default 5.8)	6.1, 6.7, 7.2, 7.8, or 8.3 mmol/L
Exercise mode target glucose	8.3 mmols/L	7.8-8.9 mmol/L	No specific target. Ease off mode can be used for exercise	No specific target. Ease off mode can be used for exercise	8.3 mmol/L & less insulin delivery
Sleep mode target glucose	No	6.25-6.7 mmols/L	Customisable glucose target can be adjusted overnight	Customisable glucose target can be adjusted overnight	Customisable glucose target or exercise feature (see above)
Bolus calculator based on	CGM value, glucose trend data and bolus calculator settings	CGM value only with bolus calculator settings	CGM value only with bolus calculator settings	CGM value only with bolus calculator settings	CGM value, glucose trend data and bolus calculator settings
Automated correction bolus settings	If predictive glucose > 6.7 mmols/L and if max basal rate is reached	If predicted glucose in 30 mins >10 mmols/L & increasing/max delivery is reached	Incorporated into continuous insulin delivery. Adjusts insulin delivery every 8-12 minutes	Incorporated into continuous insulin delivery. Adjusts insulin delivery every 8-12 minutes	Automated micro-boluses every 5 mins. Plus user initiated correction bolus
Active insulin time	Adjustable	Not adjustable (set at 5 hrs)	Adjustable	Adjustable	Adjustable
Set up requirements	Basal rates, ICR, ISF & AIT	TDD, body weight, basal rates, ICR & ISF	TDD & body weight	TDD & body weight	Basal rates, ICR, ISF & AIT
Learning mechanisms	Uses TDD over past 2-6 days. Requires 48 hours of manual mode to learn user profile	Uses body weight & TDD. Predicts glucose 30 mins ahead	Overall insulin needs, diurnal, post meal	Overall insulin needs, diurnal, post meal	Adapts with each pod using previous TDDs. Predicts glucose 60 mins ahead
Remote monitoring for parents/ carers	Glucose and insulin data via CareLink Connect app	Glucose via Dexcom follow app	Glucose via Dexcom follow app	Glucose and insulin data via 'companion' in mylife CamAPS FX app	Glucose via Dexcom follow app if using G6
Data share with HCPs	CareLink (via app in real-time)	Glooko (download needed)	Glooko (real-time)	Glooko (real-time)	Glooko (real-time)
Minimum and maximum daily dose	8-250 units per day	10-100 units per day	5-350 units	5-350 units	Min 5 units per day Min 85 units to activate pod
Pump capacity	300 units	300 units	300 units	160 units	200 units
Insulin compatibility	NovoRapid & Humalog	NovoRapid & Humalog	Any rapid and ultra-rapid acting	NovoRapid, Humalog, Fiasp, Apidra & Lyumjev	NovoRapid, Humalog & Admelog
Licensed in pregnancy	No	No	Yes	Yes	No
Age Range	7-80 years	6 years & over	1 years & over	1 years & over	2 years & over
Demo pump app/simulator	Yes	Yes	?	Yes	Yes

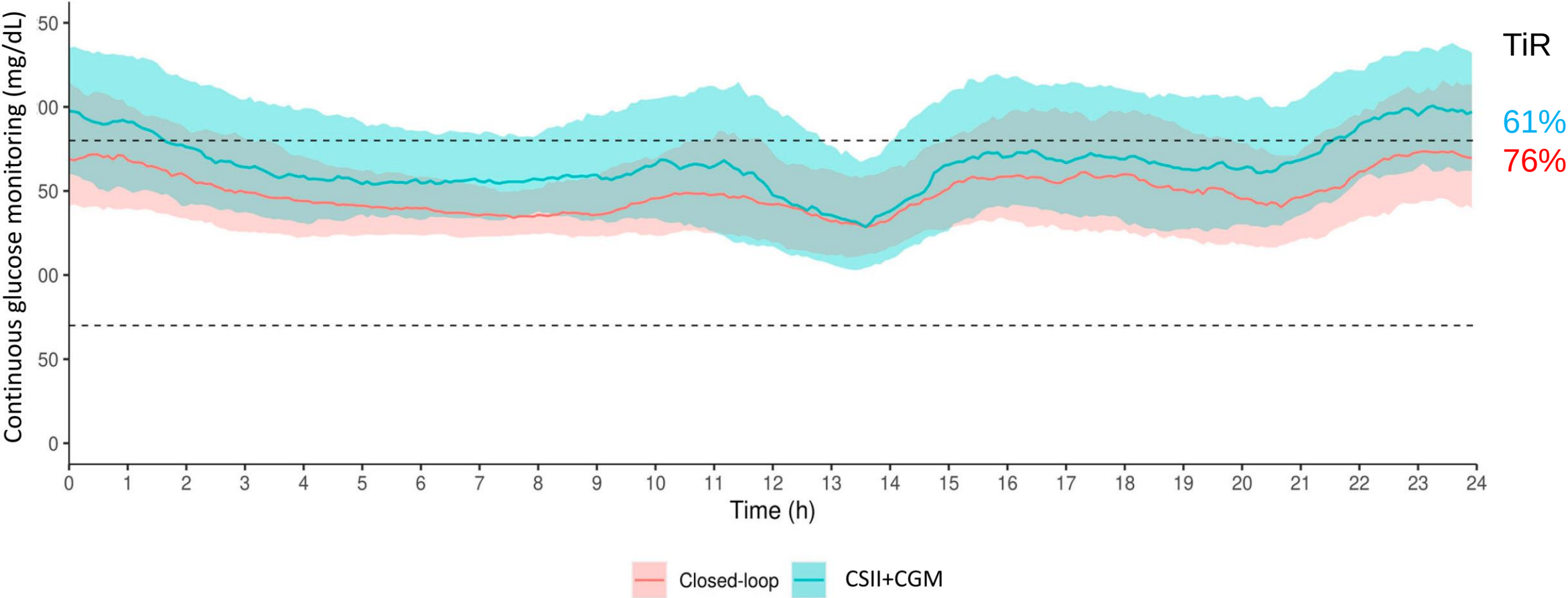
ICR – insulin carbohydrate ratio
ISF – insulin sensitivity factor

TDD – total daily dose of insulin
AIT – active insulin time

For availability of systems approved by NHS England: www.supplychain.nhs.uk/product-information/contract-launch-brief/insulin-pumps-and-associated-products

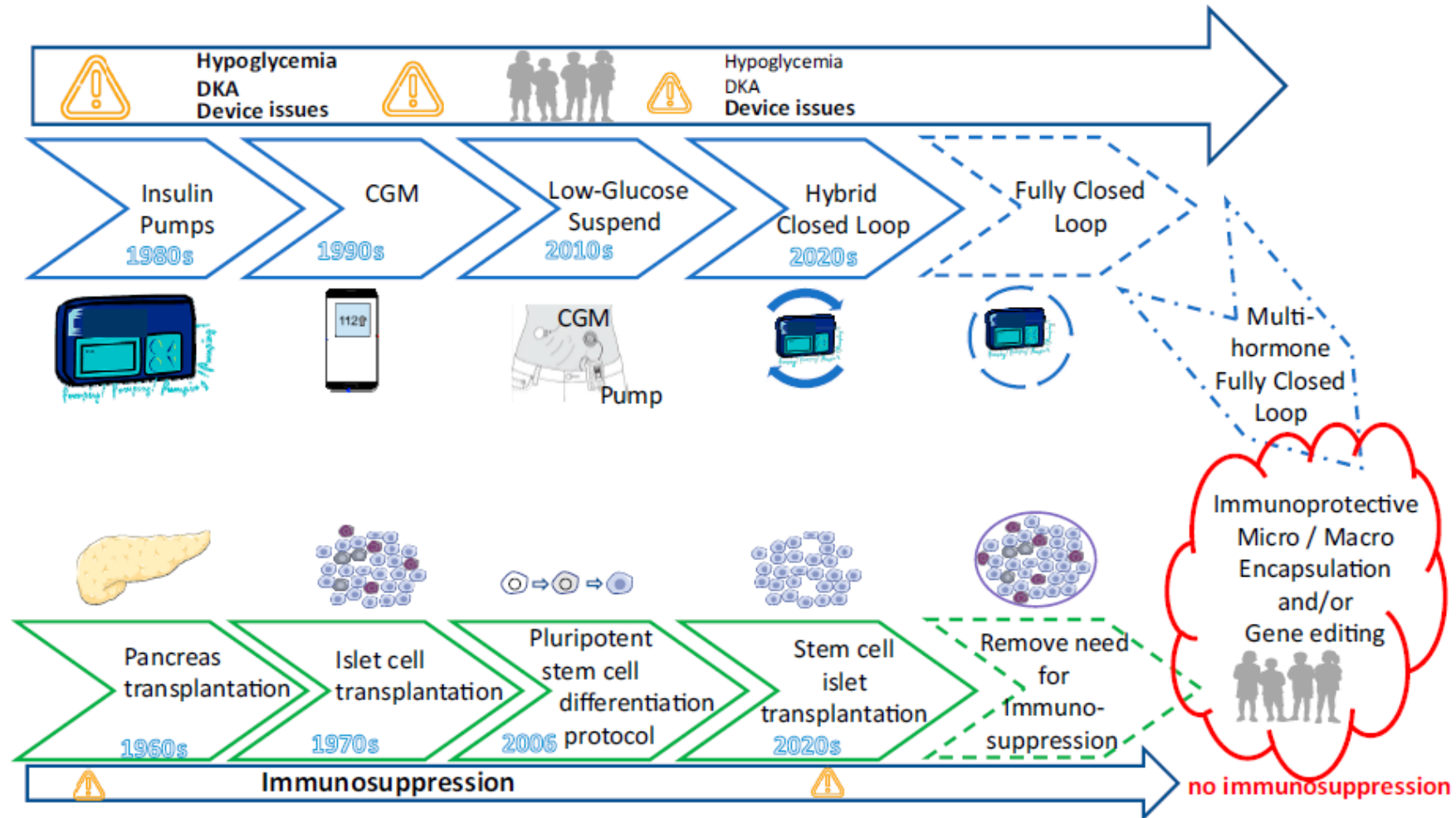
Version 4.0 May 2024: Adapted for health care professionals from Tim Street's Hybrid closed loop systems

AHCL in T2DM

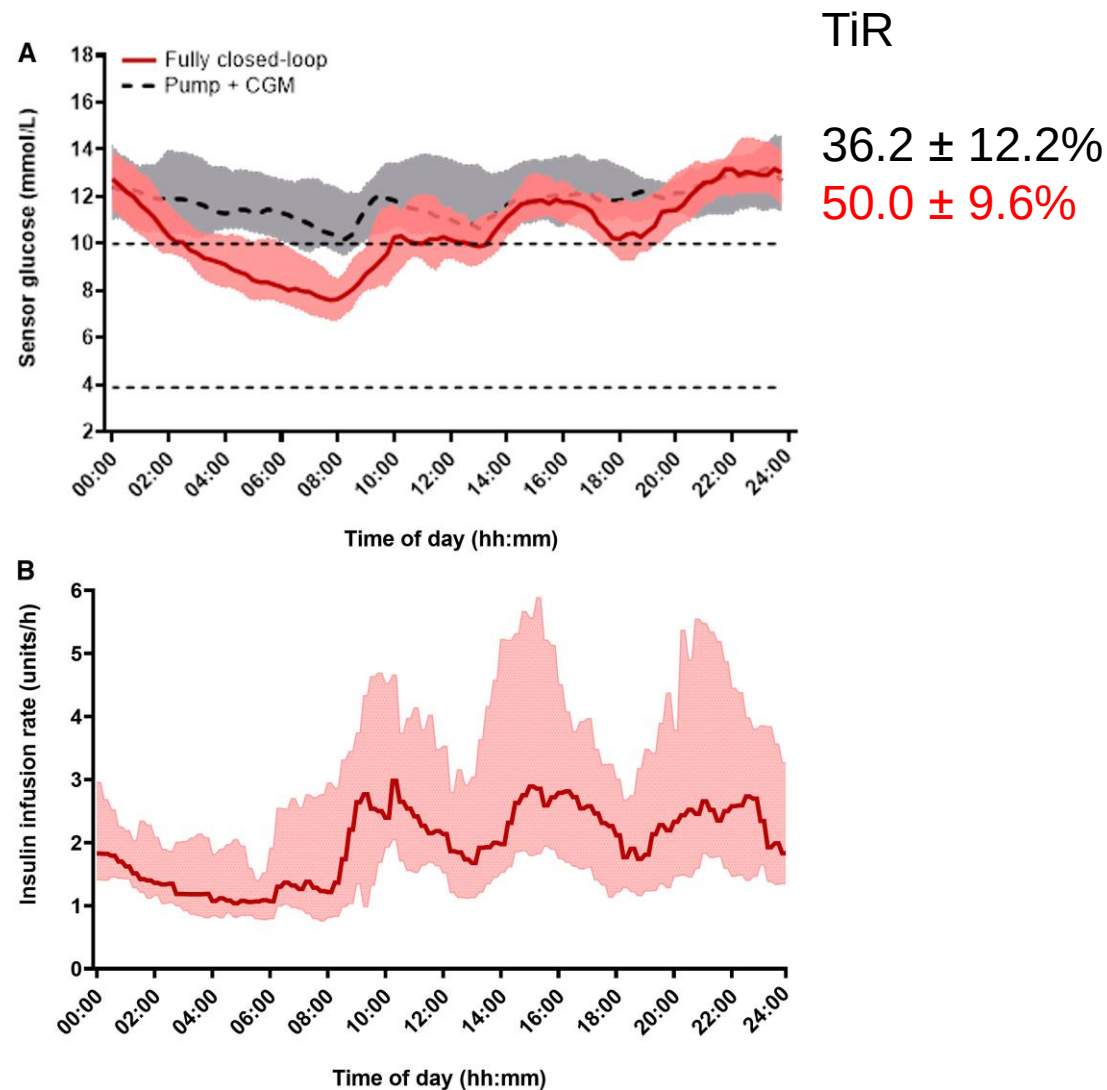


Actimetry								
Mean daily physical activity (METs)	16	1.07 (1.04–1.09)	1.06 (1.05–1.08)	0.01 (–0.01 to 0.02)	0.16	Mann-Whitney	0.044	0.50
Mean daily total sleep time (min)	16	369 (64)	371 (72)	–2 (–51 to 47)	0.93	Student	0.21	0.64
Mean daily sleep fragmentation index	16							0.038

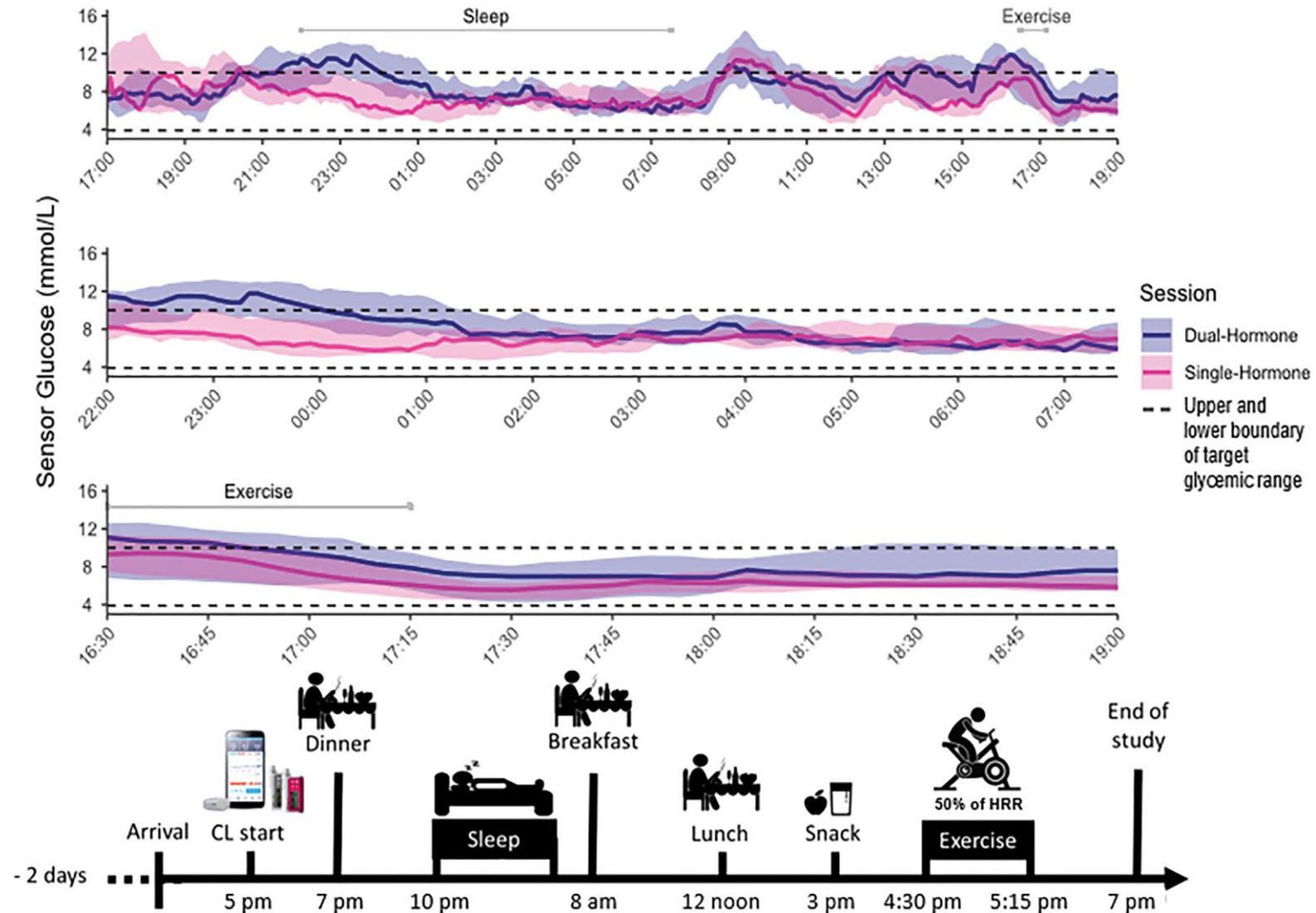
Towards restoring “normal” glycaemia



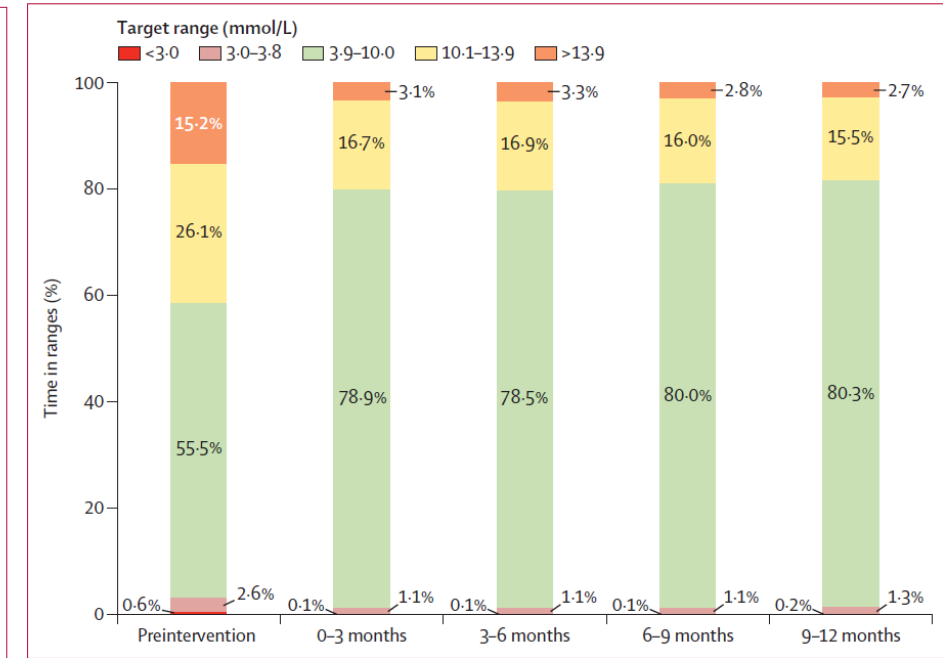
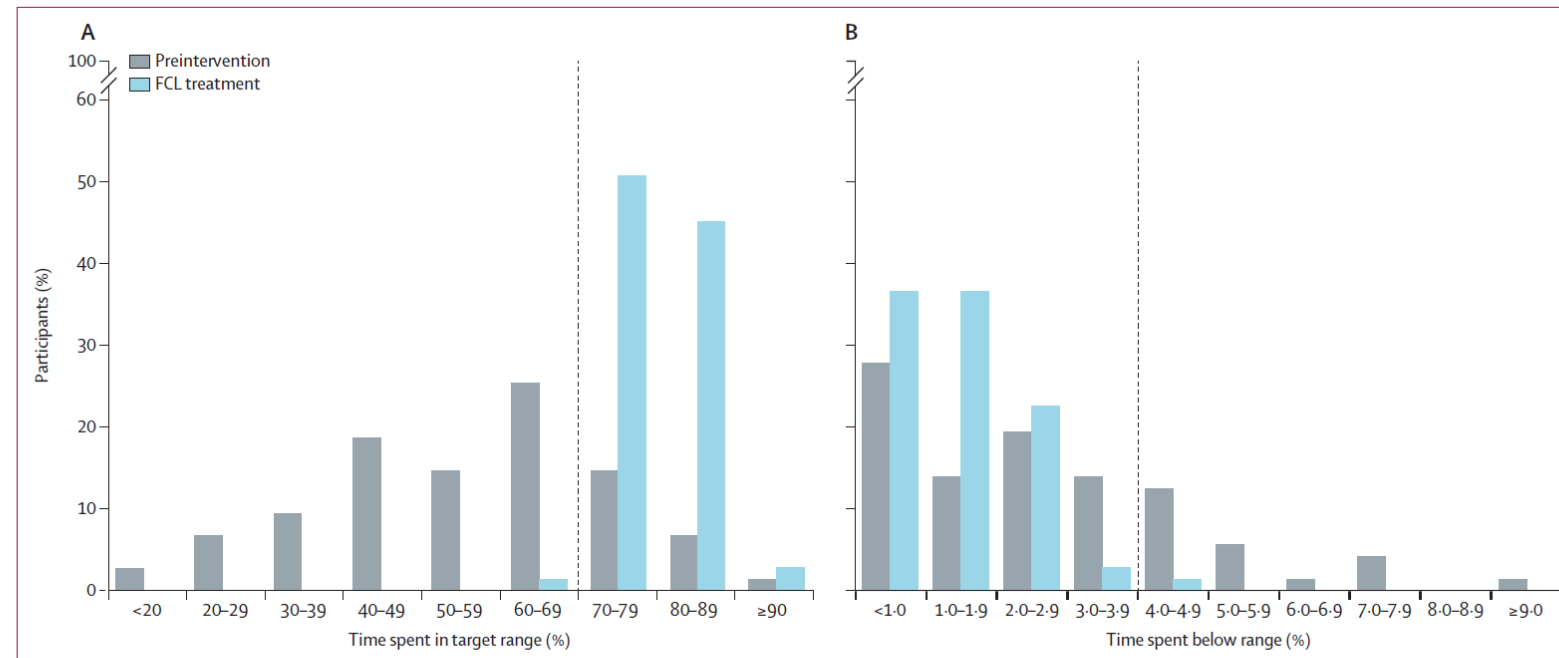
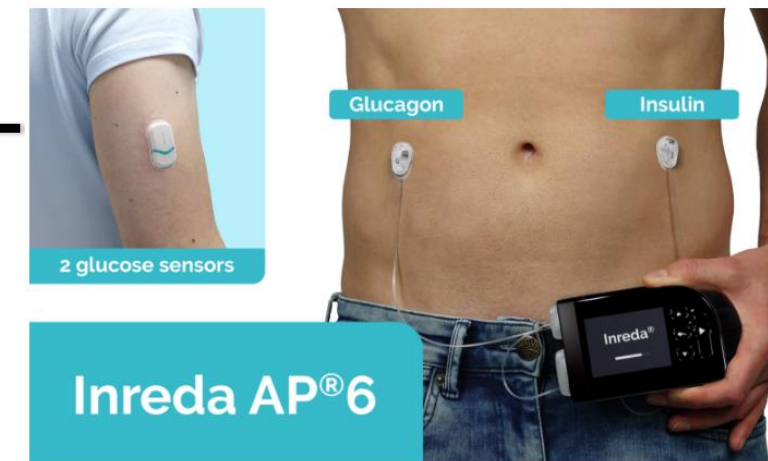
Fully Closed Loop – CAM APS



Dual hormone HCL: RCT in adolescents



Dual hormone RCT



<https://www.inredadiabetic.nl/en/discover-the-ap/>

van Bon AC et al. *Lancet Digit Health* 2024;6: e272–80

Continuous glucose sensing



Real-time Continuous Glucose Monitoring Systems Comparison Chart

Diabetes Specialist Nurse Forum UK	FreeStyle Libre 2	FreeStyle Libre 2 Plus	FreeStyle Libre 3	Dexcom ONE	Dexcom ONE+	GlucoRx AiDEX
Real-time CGM	Yes*	Yes*	Yes	Yes	Yes	Yes
MARD (%)	9.2	8.2	7.8	9.0	8.2	9.1
Published accuracy data	Yes (T1 n=133)	No (T1=128)	Yes (T1 n=83)	Yes (T1 n=260)	Yes (T1 n=257)	Yes (T1 n=14)
RCT data	Yes	Yes (FSL/FSL2)	Yes (FSL/FSL2)	Yes (G4/5/6)	No	No
Stand-alone use	Yes	Yes	Yes	Yes	Yes	Yes
Pump/hybrid closed loop (HCL) compatibility	No	Omnipod 5	YpsoPump	No	No	No
Sensor life	14 days	15 days	14 days	10 days	10 days +12 hr grace period	14 days
Sensor warm up time	60 mins	60 mins	60 mins	120 mins	Up to 30 mins	60 mins
Separate transmitter	No	No	No	Yes	No	Yes
Transmitter Life	N/A	N/A	N/A	3 months	N/A	4 years
Smartphone app	LibreLink	LibreLink	Libre 3	Dexcom One	Dexcom One +	GlucoRx AiDEX
Reader available	Yes	Yes	Yes	Yes	Yes	No
Capillary glucose calibration	No	No	No	No	No	No
High & low alarms	Yes	Yes	Yes	Yes	Yes	Yes
Predictive alarms	No	No – stand-alone use	No - stand-alone use Yes - HCL use	No	No	No
Smart pen data connection	NovoPen 6 & Echo Plus	NovoPen 6 & Echo Plus	No	NovoPen 6 & Echo Plus ▲ SoloSmart pen cap ▲	NovoPen 6 & Echo Plus ▲ SoloSmart pen cap ▲	No
Data share HCP	LibreView	LibreView	LibreView	Clarity	Clarity	CGM Viewer
Data share friends/family app	LibreLinkUp	LibreLinkUp	LibreLinkUp	N/A	Dexcom Follow	GlucoRx AiDEX
UK approved wearable site	Back upper arm	Back upper arm	Back upper arm	Abdomen Back upper arm Buttocks ⁺	Abdomen Back upper arm Buttocks ⁺⁺	Abdomen Back upper arm

 = available on prescription (FP10)

 = available via NHS supply chain

* When using LibreLink app on smartphone. 'Scanning' still required with reader device

** Different version of Guardian 4 sensor required

▲ via Glooko

⁺ 2-17 years old as per manufacturers' guidelines.

⁺⁺ 2-6 years old as per manufacturers' guidelines

⁺⁺⁺ 7-17 years old as per manufacturers' guidelines.

Version 7.0 June 2024

Real-time Continuous Glucose Monitoring Systems Comparison Chart

Diabetes Specialist Nurse Forum UK	Dexcom G6	Dexcom G7	Medtronic Guardian 4	Medtronic Simplera	Medtrum Touch Care Nano
Real-time CGM	Yes	Yes	Yes	Yes	Yes
MARD	9.0	8.2	10.6	10.2	9.1
Published accuracy data	Yes (T1 n=260)	Yes (T1 n=257)	Yes	Yes	Yes (T1 n=10)
RCT data	Yes	No	No	No	No
Stand-alone use	Yes	Yes	Yes	Yes	Yes
Pump/hybrid closed loop compatibility	Tandem T:slim DANA-i YpsoPump Omnipod 5	Tandem T:slim	MiniMed 780G **	No	Touch Care Nano pump (Automode)
Sensor life	10 days	10 days +12 hr grace period	7 days	7 days	10-14 days
Sensor warm up time	120 mins	Up to 30 mins	120 mins	120 mins	30 mins
Separate transmitter	Yes	No	Yes	No	Yes
Transmitter Life	3 months	N/A	12 months	N/A	12 months
Smartphone app	Dexcom G6	Dexcom G7	MiniMed mobile	Simplera	EasySense
Reader available	Yes	Yes	No	No	Yes
Capillary glucose calibration	No	No	No	No	No
High & low alarms	Yes	Yes	Yes	Yes	Yes
Predictive alarms	Yes	Yes	Yes	Yes	Yes
Smart pen data connection	NovoPen 6 & Echo Plus ▲ SoloSmart pen cap ▲	NovoPen 6 & Echo Plus ▲ SoloSmart pen cap ▲	No	Medtronic InPen	No
Data share HCP	Clarity	Clarity	CareLink	CareLink	EasyView
Data share friends/family app	Dexcom Follow	Dexcom Follow	CareLink Connect	CareLink Connect	EasyFollow
UK approved wearable site	Abdomen Back upper arm Buttocks ⁺	Abdomen Back upper arm Buttocks ⁺	Abdomen Back upper arm Buttocks ⁺⁺⁺	Back upper arm Buttocks ⁺	Abdomen Back upper arm

 = available on prescription (FP10)

 = available via NHS supply chain

* Using LibreLink app on smartphone. 'Scanning' still required with reader device

** Different version of Guardian 4 sensor required

▲ via Glooko

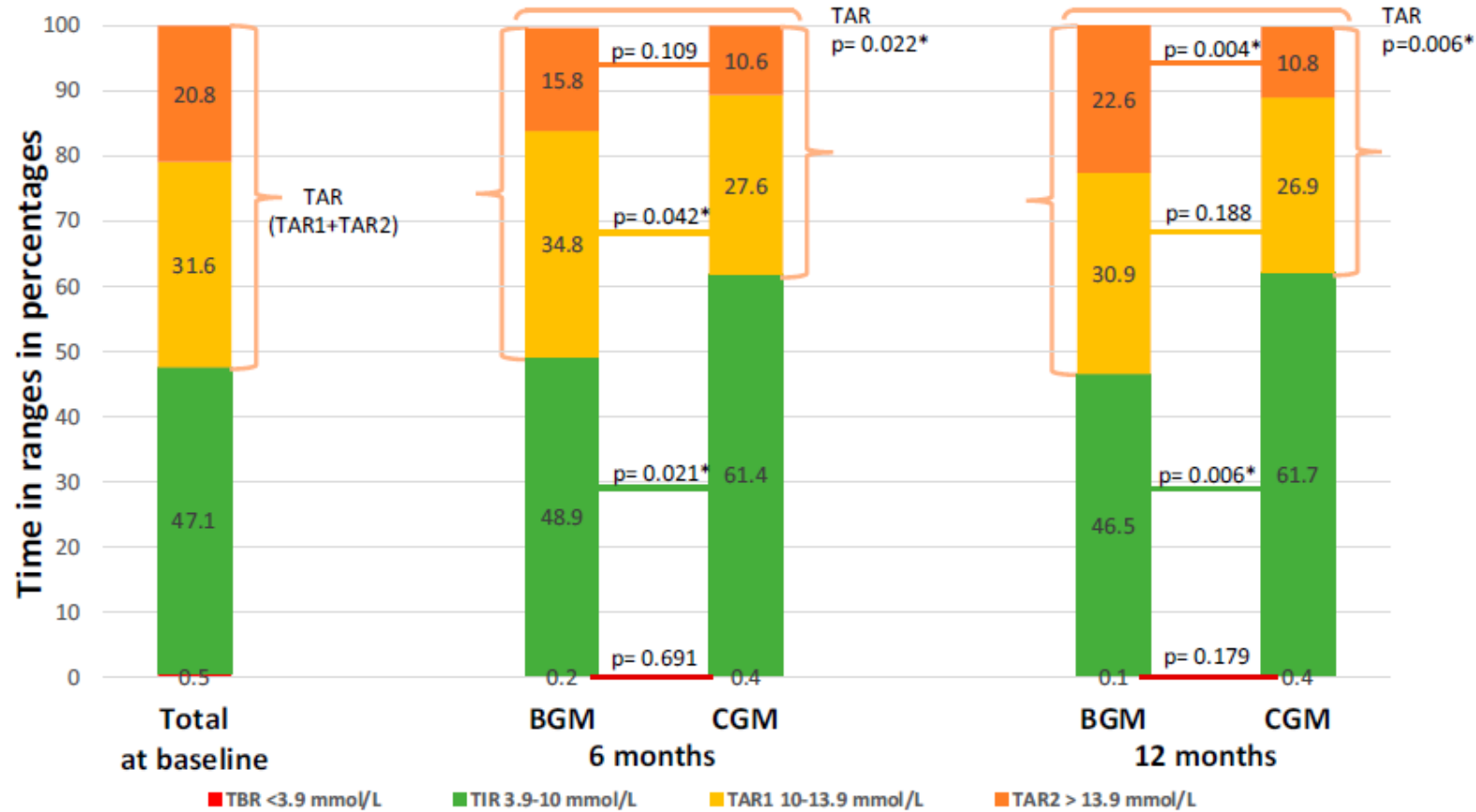
+ 2-17 years old as per manufacturers' guidelines.

** 2-6 years old as per manufacturers' guidelines

+++ 7-17 years old as per manufacturers' guidelines.

Version 7.0 June 2024

Steno2Tech: CGM vs SMBG in T2DM

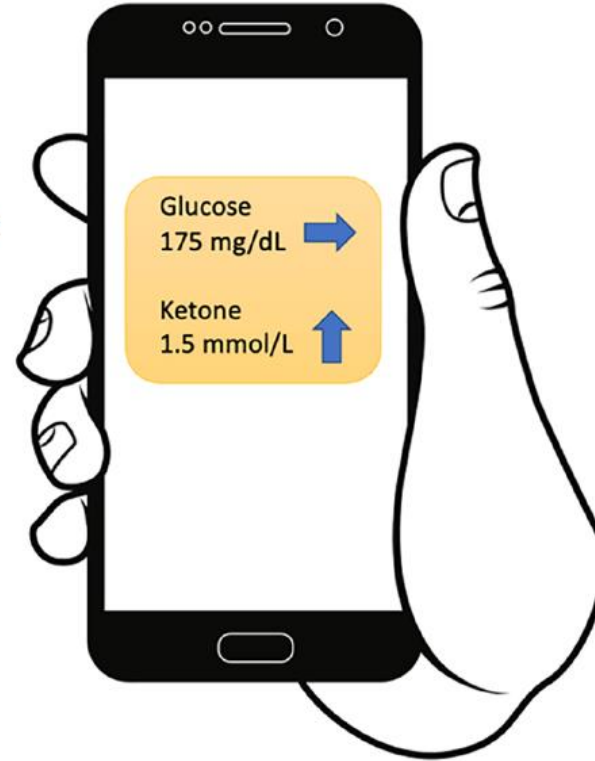


Continuous ketone monitoring

*****IMPENDING DKA*****

Treat as follows or per clinician instructions:

- Ingest 15 -30g rapidly absorbed carbohydrate and a large glass of water hourly
- Administer rapid-acting insulin based on carbohydrate intake hourly
- Monitor ketone levels until ketones < 0.6 mmol/L and symptoms resolve
- Monitor glucose to avoid hypoglycemia
- Seek medical attention if levels and/or symptoms persist



Stay in Your Best ZONE

Do you know there are 4 different ketosis states? Each state renders different benefits. Picking the right one is crucial to achieving your goals.

Nutritional Ketosis (0.5-1.0 mmol/L)

- Mild fat loss
- Improvements in energy and mental clarity
- Appetite control, reduction of cravings

Optimal Ketosis (1.0-2.0 mmol/L)

- Best for consistent and noticeable fat loss
- Improved metabolic health
- Increased physical endurance

High Ketosis (2.0-3.0 mmol/L)

- Therapeutic benefits for managing mental conditions
- Enhanced athletic performance
- Reduced inflammation and risk of chronic diseases

Deep Ketosis (≥ 3.0 mmol/L)

- Maximized mental clarity
- May mitigate the growth of certain cancers
- Potentially slowing the progression of mental diseases



Stay in Ketosis Longer, with Real-Time Insights



Optimize Your Workouts

Discover how different exercises affect your metabolic state.

[Learn More](#)



Optimize Your Nutrition

Discover the best foods that help you maintain ketosis.

[Learn More](#)



Optimize Your Sleep

Understand your ketone fluctuations during sleep.

[Learn More](#)

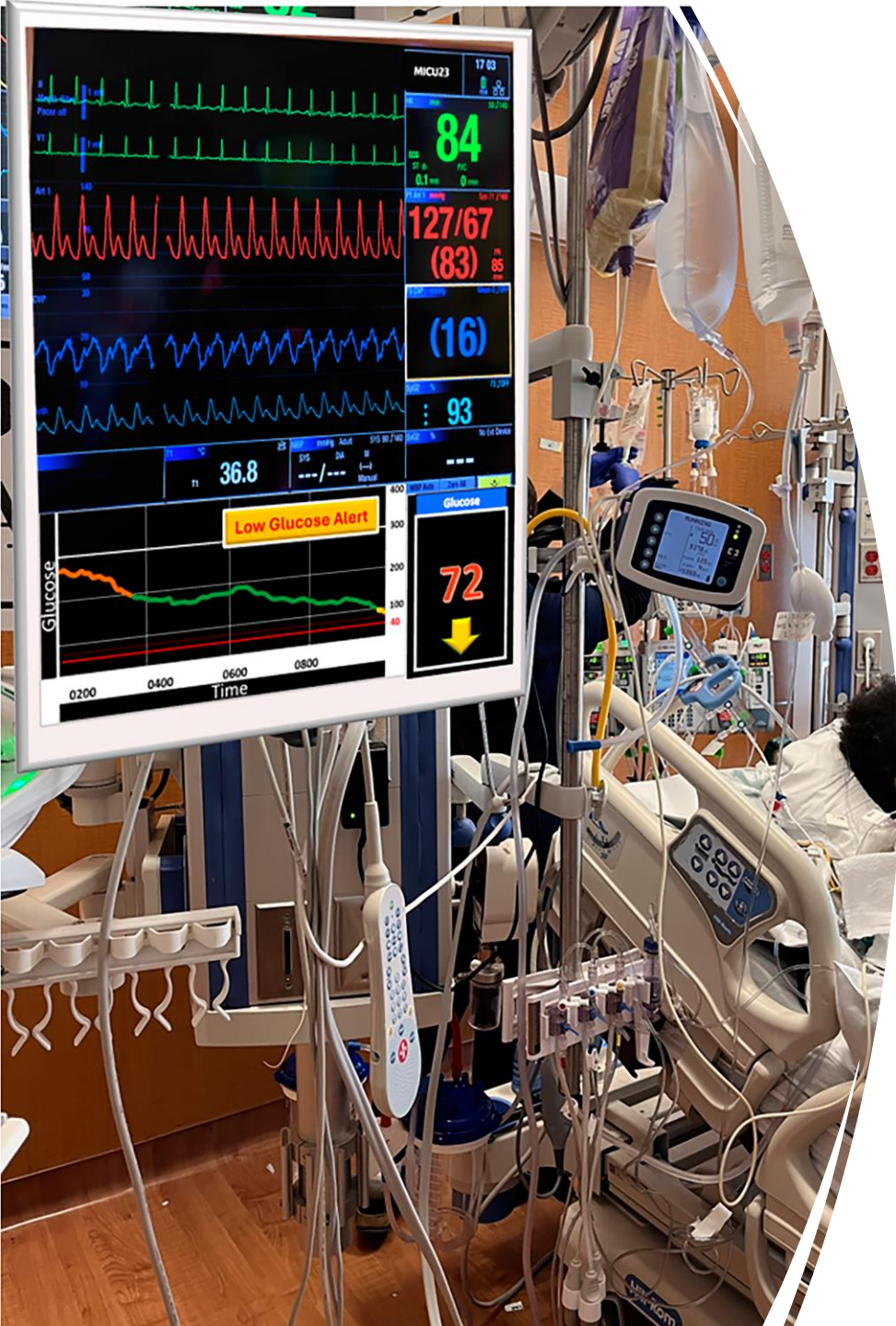


Collaborate • Evolve • Support

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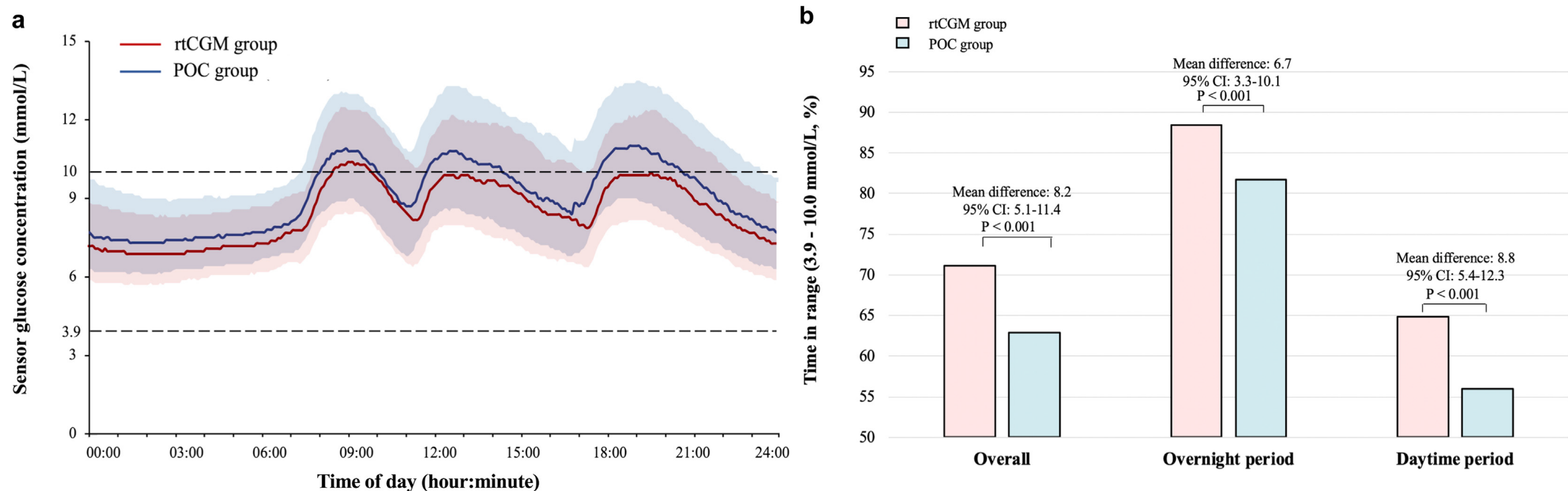


Technology Use in Hospital Settings

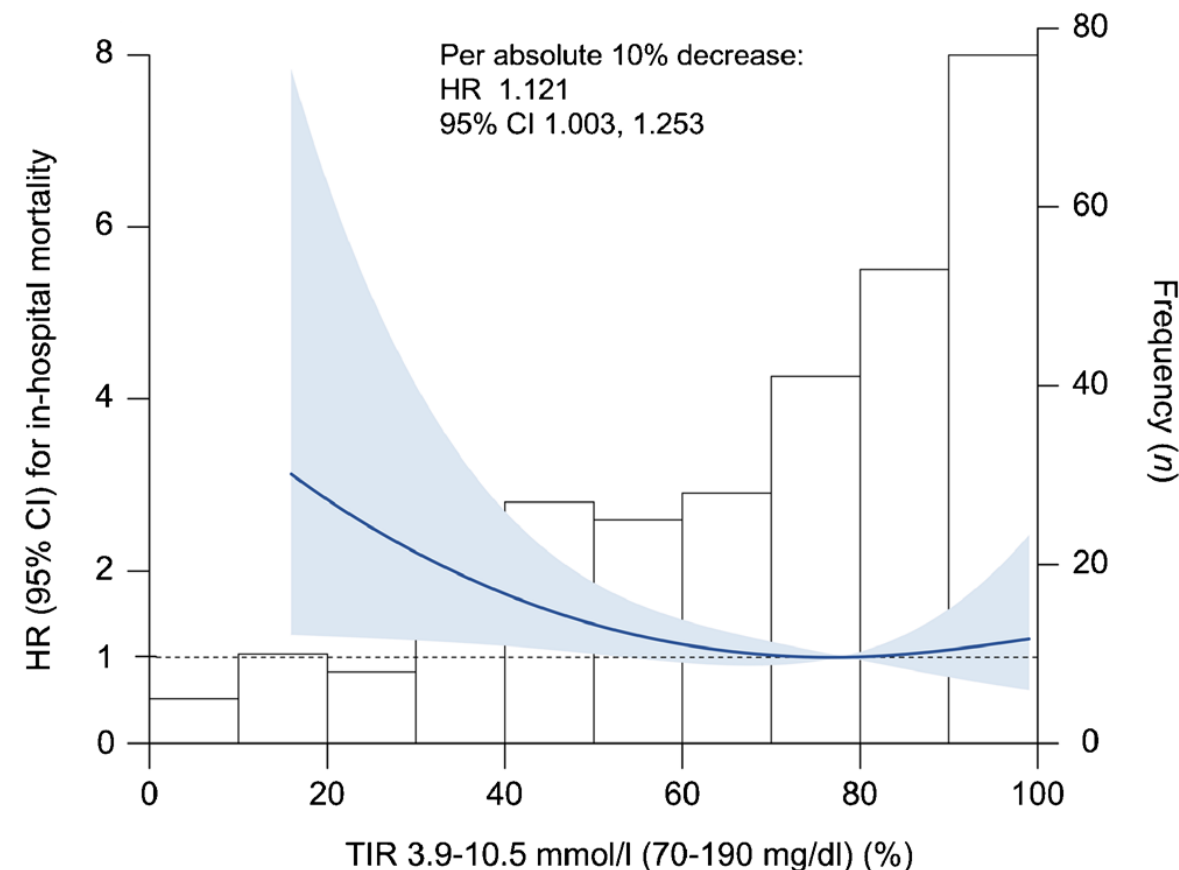
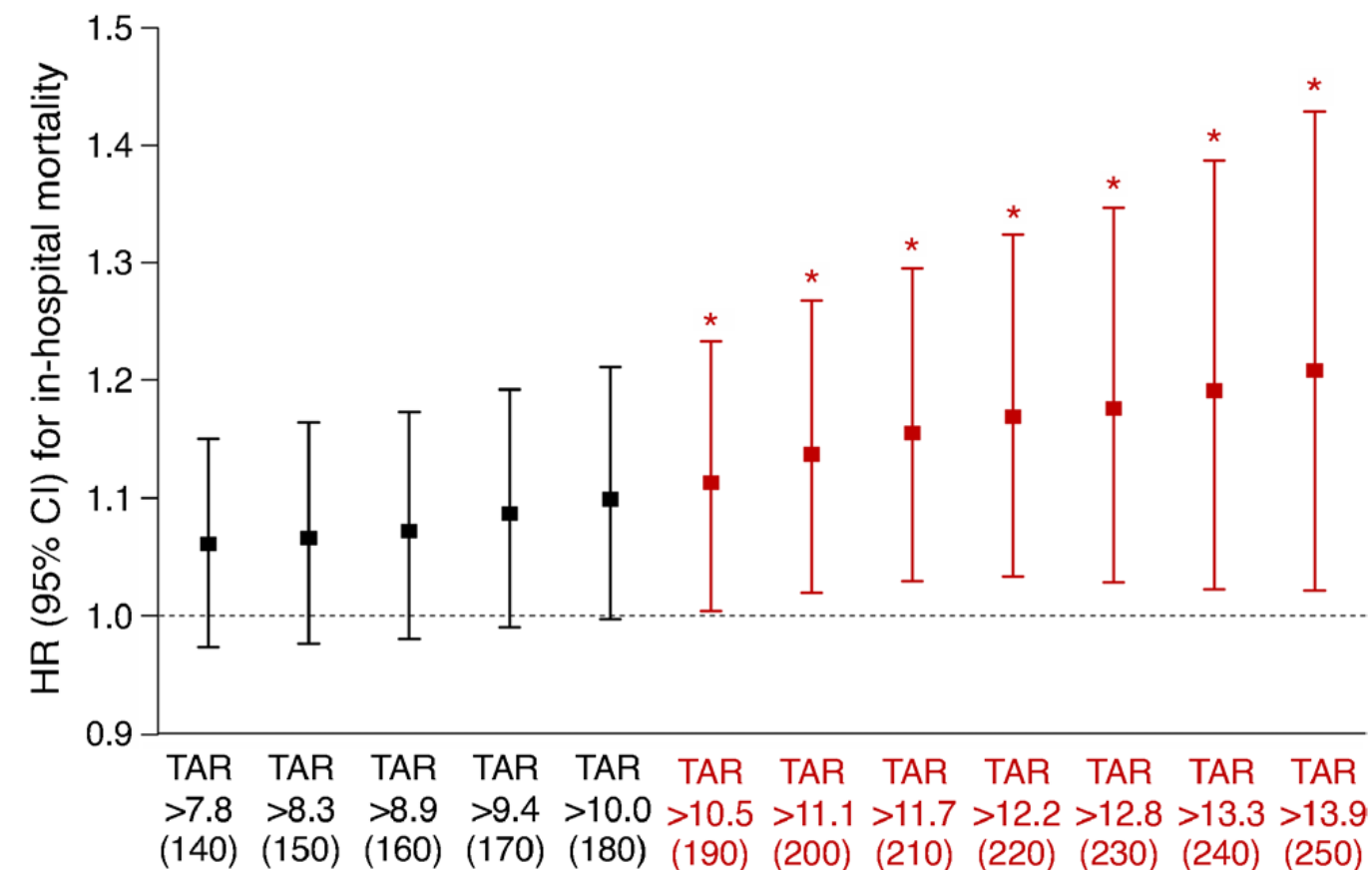
Real-time Continuous Glucose Monitoring in the Intensive Care Unit: The Fifth Vital Sign

Patham B et al. *Diabetes Care* 2024;47:924-6.

CSII + CGM for in-patient glycaemic control

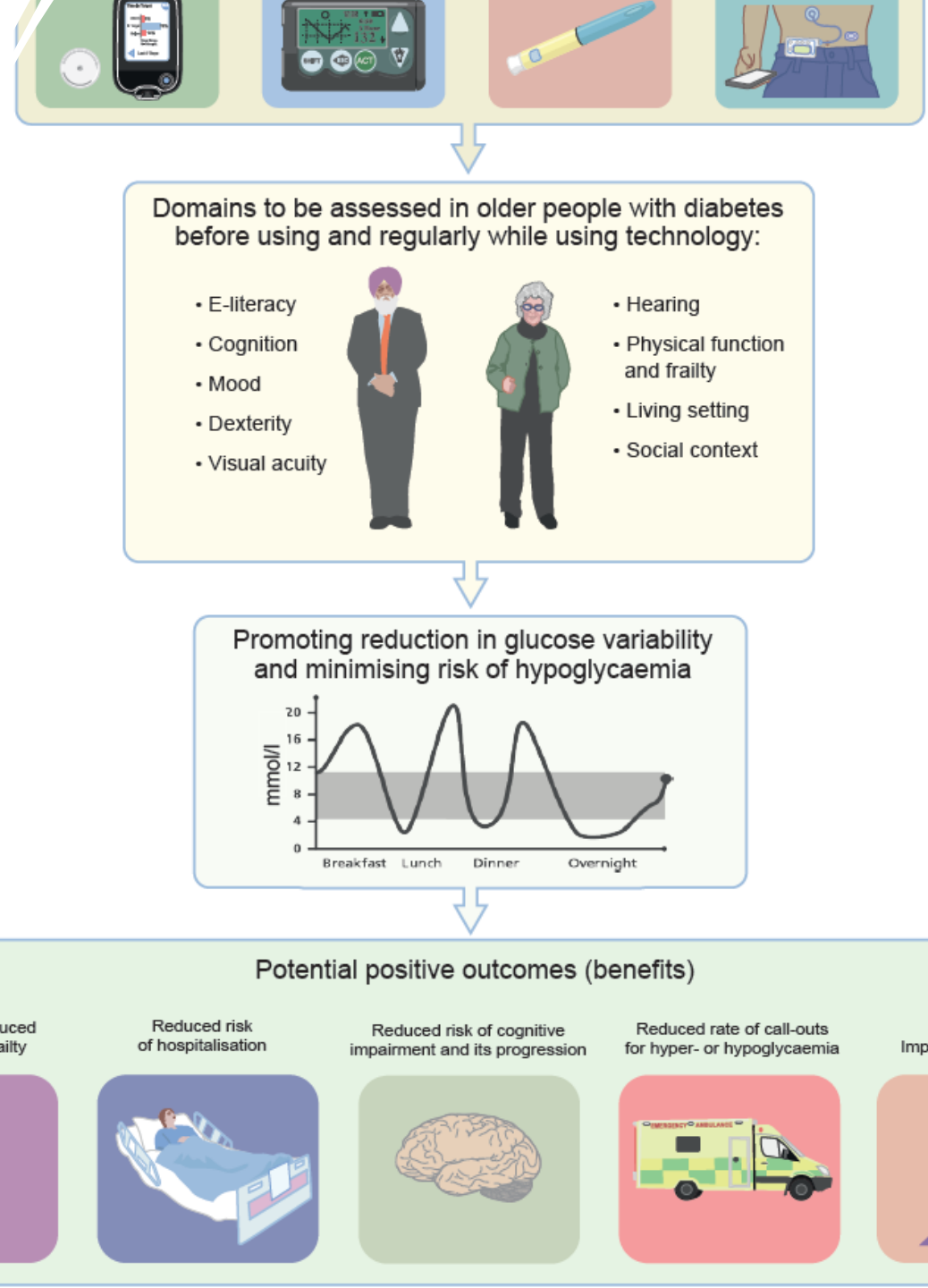


TiR and mortality for critically ill in-patients



Benefits of technology in older people with diabetes

- Maltese et al (2024) Diabetologia DOI 10.1007/s00125-024-06240-2
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Key barriers to the use of technology in older people

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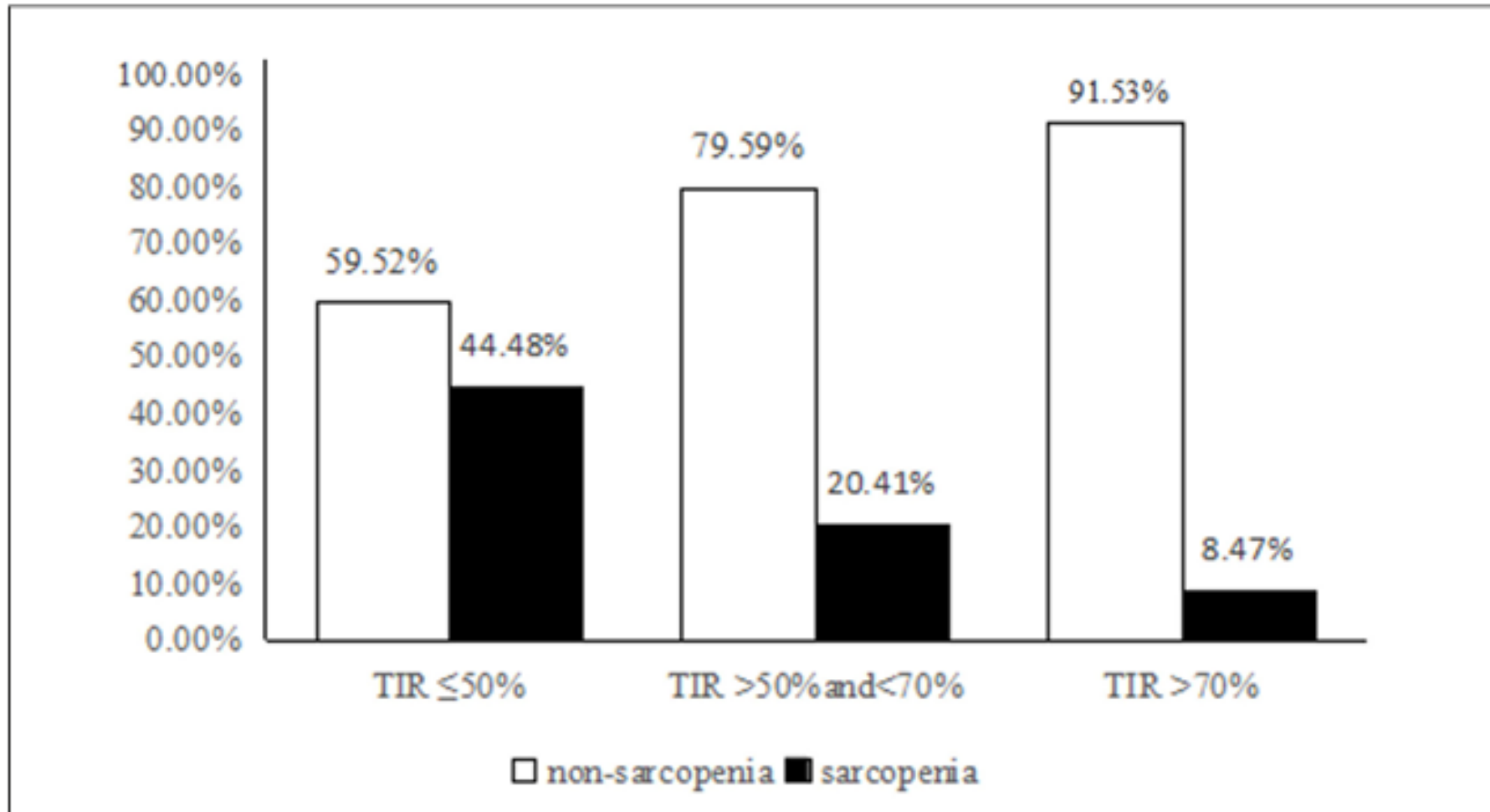
Case report of AHCL in 89 year old with early dementia

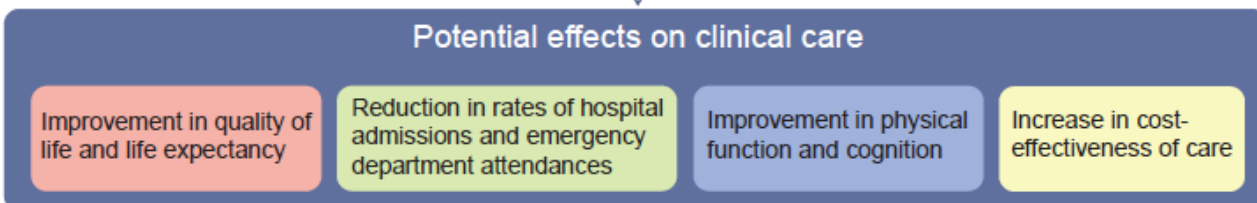
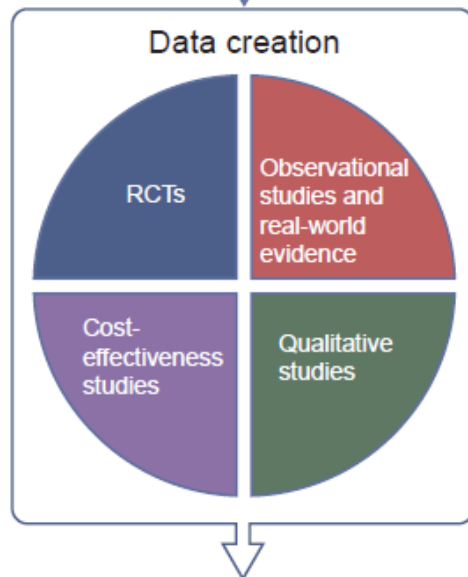
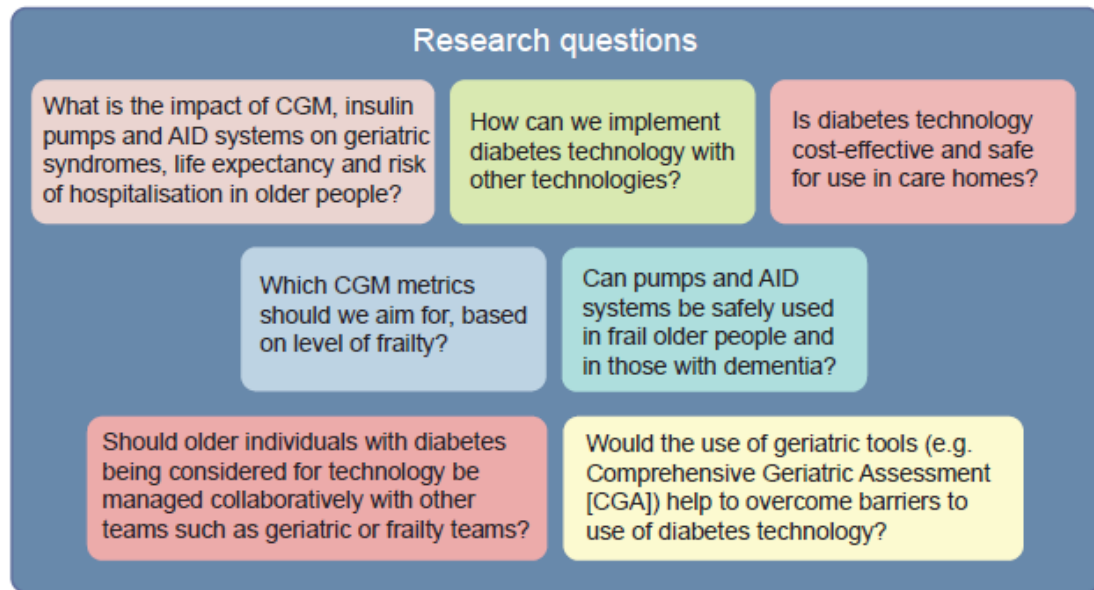
Table 1 Comparison of indices of continuous glucose monitoring using an insulin pump and carbohydrate counting methods

Mode	Manual	HCL
Carb counting	(−)	(+)
TIR (%)	41	70
TAR (%)	59	30
TBR (%)	0	0
Mean glucose (mg/dL)	209 ± 74	162 ± 55
TDD (U)	27.1	28.6
Basal (U)	10.4	13.3
Bolus (U)	16.7	15.3
Glycoalbumin (%)	29.2	26.5
HbA1c (%)	7.6	6.9

Note: Data for the manual mode was extracted for 4 weeks just before the carbohydrate counting was started, and data for the HCL mode was extracted for 4 weeks, 5–9 weeks after starting the HCL mode.

Sarcopenia and TiR





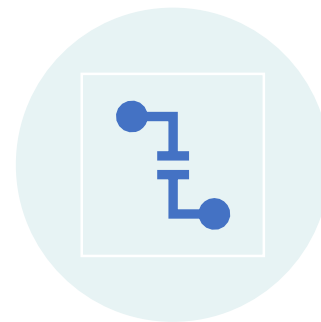
Research questions related to diabetes technology in older people

- Maltese et al (2024) Diabetologia DOI 10.1007/s00125-024-06240-2
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Summary



Hybrid closed loop technology is established as the insulin delivery system of choice for most people with T1DM



Fully-closed loop systems are effective but their superiority is questionable and the place of bi-hormonal systems uncertain



There will continue to be improvements in the component parts of the HCL systems around reliability and usability



Supporting older people to get the most out of diabetes technology is a priority