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Diabetes technology and inpatients

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Disclosures

- Payments for Speaking and Advisory boards
  - Abbott Diabetes Care, Dexcom, Insulet, Lilly Diabetes, Medtronic, Menarini, Novo Nordisk, Sanofi
- Institutional Research Support
  - Abbott Diabetes Care, Novo Nordisk
- Positions held
  - Chair, Diabetes Technology Network-UK
  - Clinical Lead National Diabetes Inpatient Safety Audit (NDISA)
  - Advisory board, EXTOD programme

Plan

- Background
- Current guidance
- Future directions

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Setting the scene

Technology use in diabetes

- Increasing numbers of people are using technology to support their diabetes self-management
  - NDA data to March 2022 suggest 11.9% of people with type 1 diabetes in England and Wales using insulin pumps
  - 52.5% using wearable CGM

- Access to CGM expanded to everybody with type 1 diabetes from March 2022 so usage likely higher now

- Technology use likely to expand significantly again soon…

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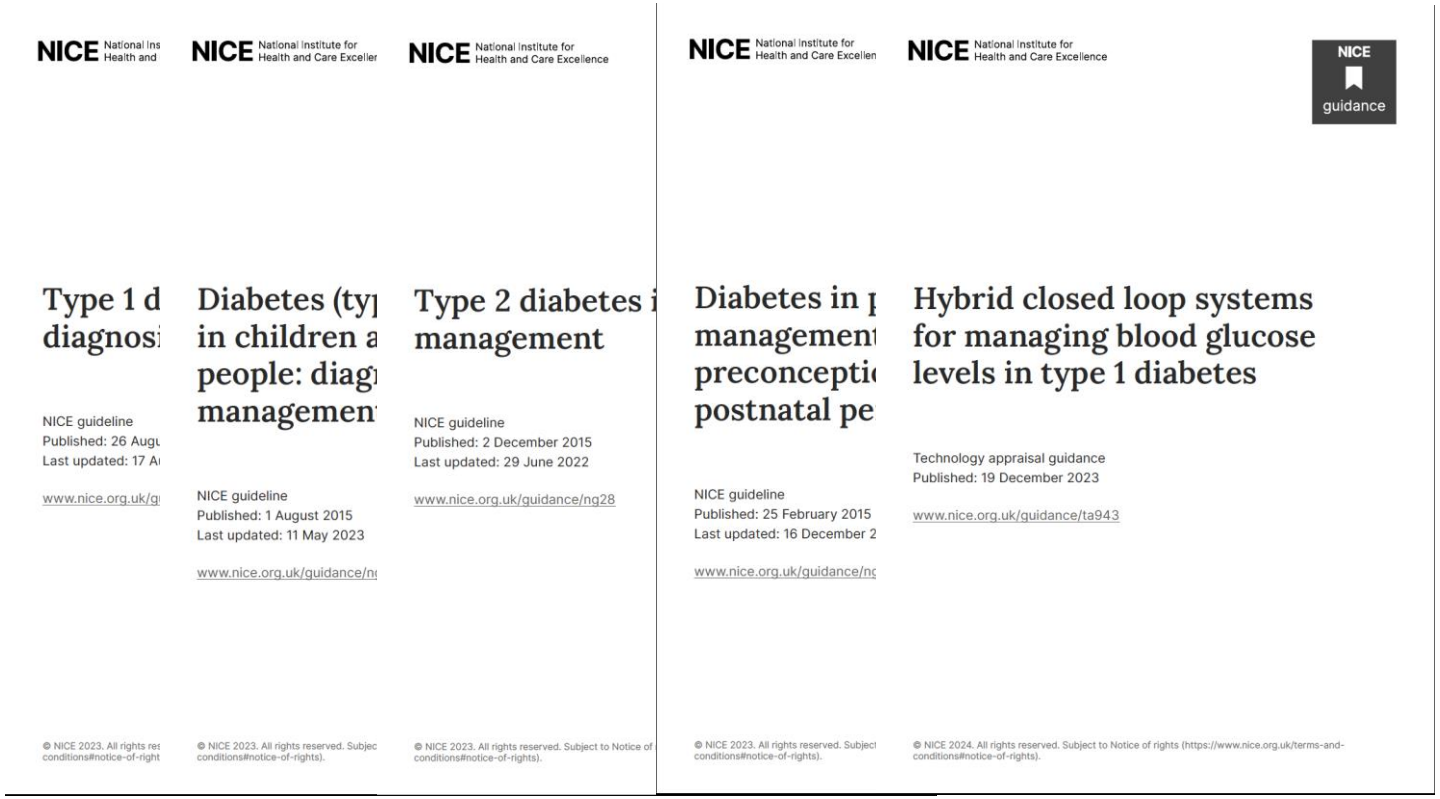
Relevant Guidance



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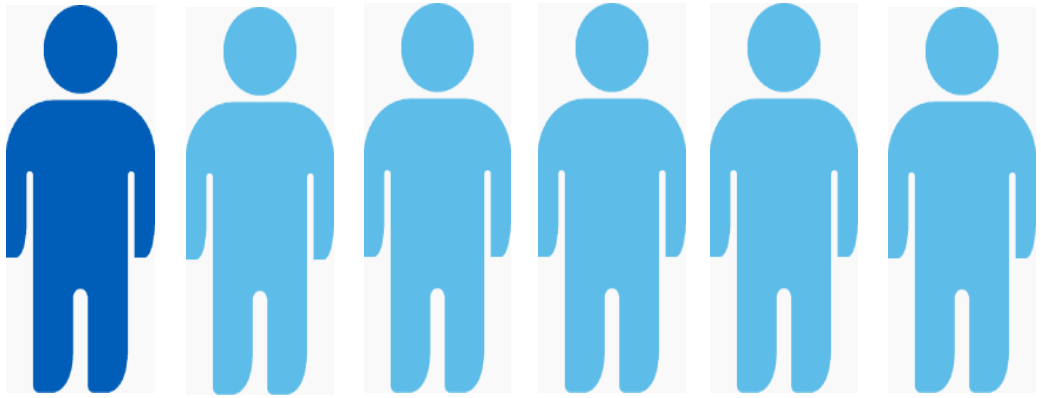
Inpatient cohort

- 1 in 6 inpatients has diabetes
- 7.7% of these have type 1 diabetes
- Approx 8% of admissions are **for** diabetes
- 83.9% of admissions are emergencies
- 71.7% medical, 22.2% surgical, 6.3% other

Total hospital beds occupied by a person…



…with diabetes

…without diabetes

4. Inpatient harms: Trends

Frequency of inpatient harms by type

Chart 4.1: Number of inpatient harms, by harm type, England, May 2018 - October 2021 (rounded[1])

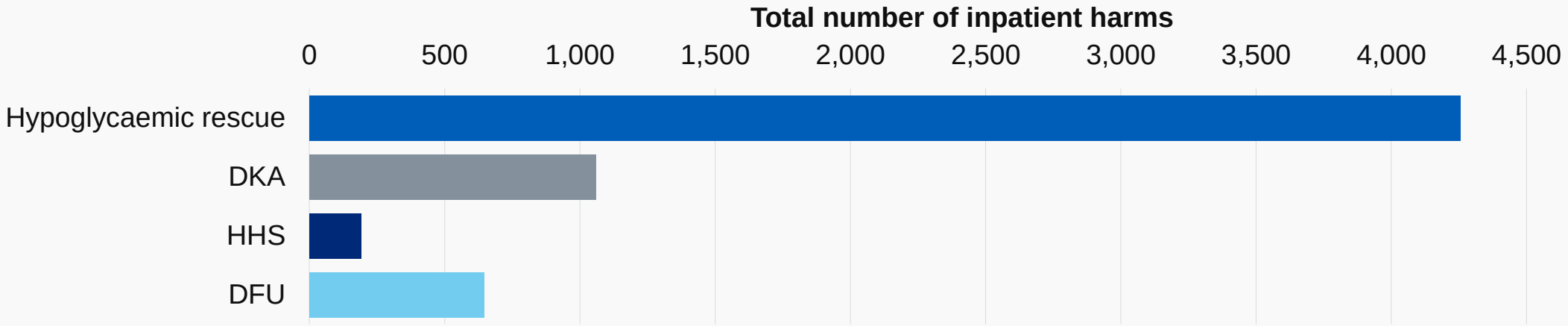


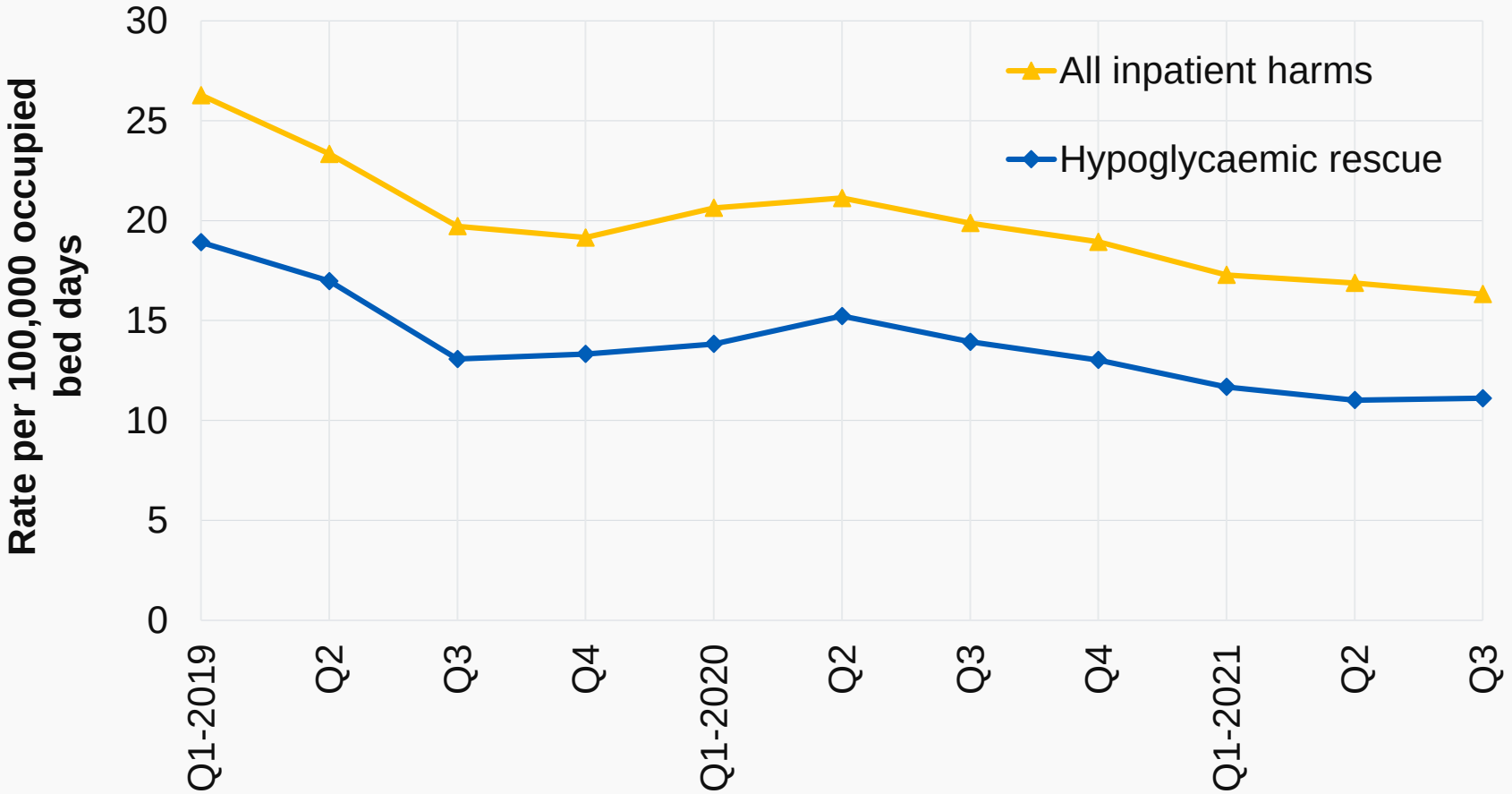
Table 4.1: Number of inpatient harms, by harm type and quarter when inpatient harm occurred,
England, May 2018 - October 2021 (rounded[1])

Inpatient harm	May – Jul 18	Aug – Oct 18	Nov 18 – Jan 19	Feb – Apr 19	May – Jul 19	Aug – Oct 19	Nov 19 – Jan 20	Feb – Apr 20	May – Jul 20	Aug – Oct 20	Nov 20 – Jan 21	Feb – Apr 21	May – Jul 21	Aug – Oct 21	Total
Hypoglycaemic rescue	210	335	455	440	360	310	325	305	245	270	260	230	275	230	4,255
DKA	50	85	80	80	70	80	90	75	65	65	90	55	80	85	1,060
HHS	5	15	25	15	15	10	10	15	10	15	20	15	10	10	190
DFU	60	50	65	75	55	65	45	40	40	35	30	25	40	20	645
Total	**325**	**485**	**625**	**615**	**500**	**465**	**475**	**435**	**360**	**385**	**400**	**325**	**405**	**345**	**6,150**

Notes: 1. Counts have been rounded. Counts between 1 and 7 are represented as a 5. All counts greater than 7 have been rounded to the nearest 5. Consequently the total will not usually match the sum of the 4 constituent inpatient harms.

4. Inpatient harms: Rate of inpatient harms by quarter: Hypoglycaemic rescue

Chart 4.2: Inpatients with diabetes, by quarter: rate of all inpatient harms and hypoglycaemic rescue[2,3],
England, January 2019 - September 2021 (rounded[1])



Findings:

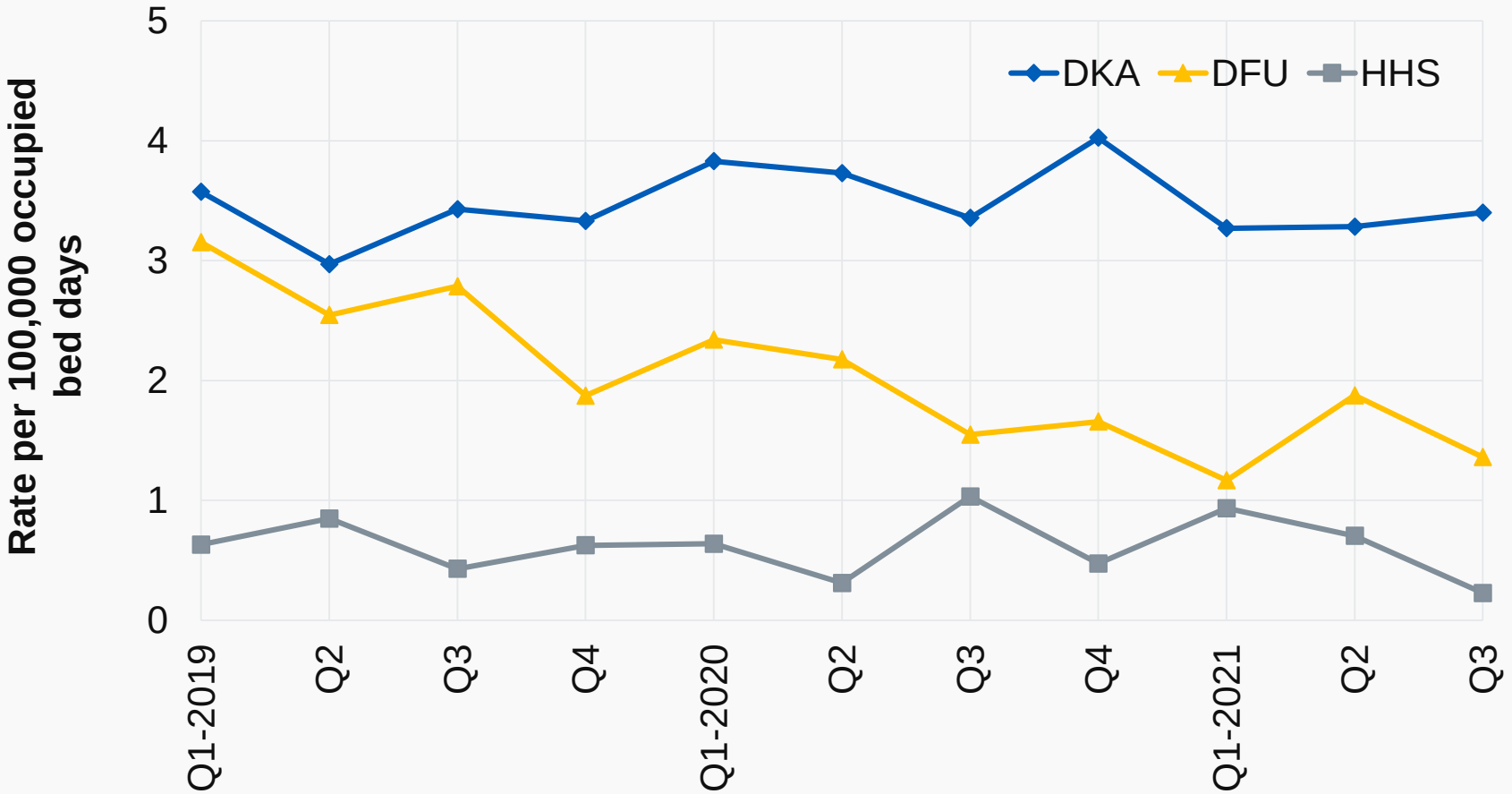
Chart 4.2 (left) shows that the rate of total inpatient harms decreased by almost 40% from Q1 2019 (Jan-Mar) to Q3 2021 (Jul-Sep).

The decrease is largely driven by reductions in hypoglycaemic rescue, which comprise 69% of total inpatient harms. This trend tallies with the findings from the final NaDIA report (NaDIA 2019, Chart 2.2).

Notes: 1. Proportions and rates are derived from rounded values. Underlying counts between 1 and 7 are set to 5. All counts greater than 7 are rounded to the nearest 5. **2**. Analysis covering April-Oct 2021 uses provisional data from Hospital Episode Statistics (HES) and core National Diabetes Audit (NDA). **3**. Proportions and rates are calculated from the sum of nights in hospital during the period stated for people in the core NDA, where diabetes was diagnosed on or before admission. Day cases and same-day discharges are counted as zero days and are therefore excluded. For further information, see: Further information: Inpatient population with diabetes.

4. Inpatient harms: Rate of inpatient harms by quarter: DKA, DFU and HHS

Chart 4.3: Inpatients with diabetes, by quarter: rate of DKA, DFU and HHS[2,3],
England, January 2019 - September 2021 (rounded[1])



Findings

Chart 4.3 (left) shows that, although the rate of DFUs appears to follow a downward trend, there was no reduction in the rate of DKA and HHS. This also tallies with the findings from the final NaDIA report (NaDIA 2019, Charts 2.3-2.5).

Notes: 1. Proportions and rates are derived from rounded values. Underlying counts between 1 and 7 are set to 5. All counts greater than 7 are rounded to the nearest 5. **2**. Analysis covering April-Oct 2021 uses provisional data from HES and core NDA. **3**. Proportions and rates are calculated from the sum of nights in hospital during the period stated for people in the core NDA, where diabetes was diagnosed on or before admission. Day cases and same-day discharges are counted as zero days and are therefore excluded. For further information, see: Further information: Inpatient population with diabetes.

5. Inpatient harms: Patient profiles

Diabetes characteristics

Table 5.2: Diabetes characteristics, by inpatient harm[2],
England, May 2018 - October 2021 (rounded[1])

Group	Diabetes type			Diabetes duration		Renal function (Estimated glomerular filtration rate – eGFR) (ml/min/1.73m^2)	
	Type 1	Type 2		Median		Median	
	%	%					
Inpatient population with diabetes	**7.7**	**92.3**		**12.0**		**67.7**	
• Hypoglycaemic rescue	34.1	65.9	*	19.0	*	58.8	*
• DKA	63.5	36.5	*	21.0	*	77.2	*
• HHS	13.9	86.1	*	16.0	*	66.8	n
Inpatient population with diabetes[3] (Length of stay – LOS≥3)	**7.5**	**92.5**		**12.0**		**67.2**	
• DFU (LOS≥3)	14.3	86.6	*	16.0	*	58.2	*

Findings

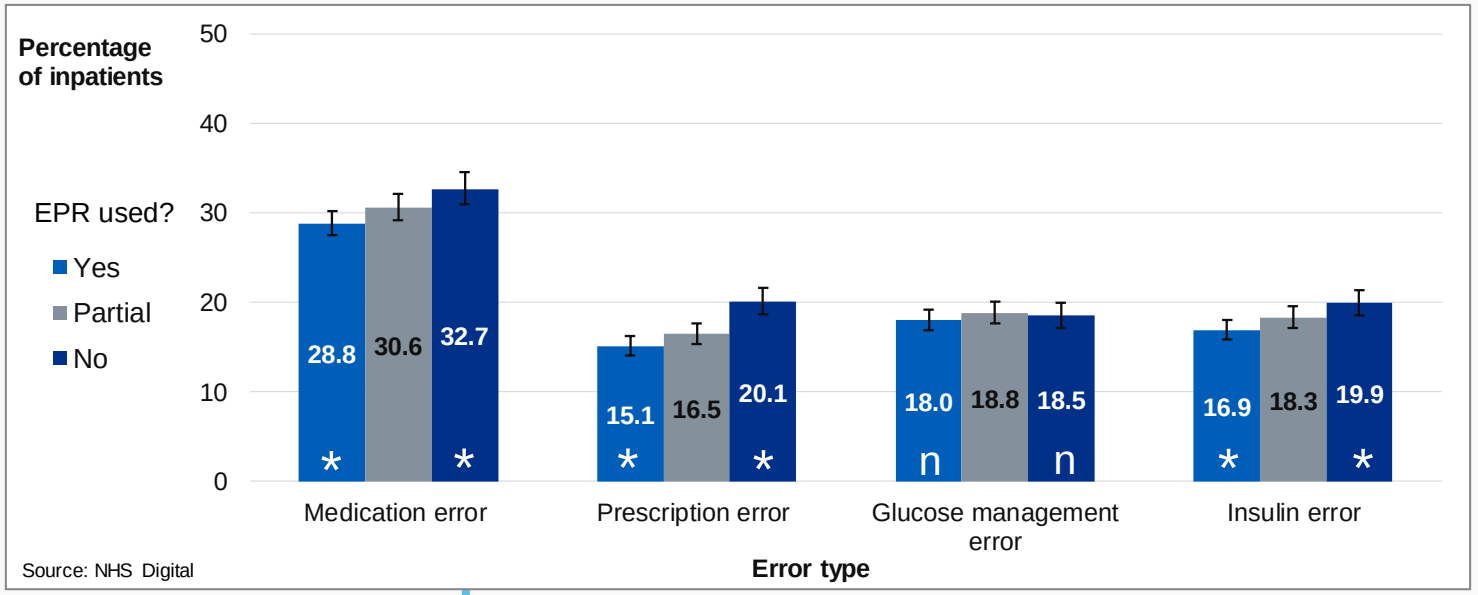
Table 5.2 (left) shows that higher risk characteristics for inpatient harms include:

- Diabetes **type 1**
- Longer diabetes **duration**
- Impaired **renal function** (except DKA and HHS)

Notes: * = statistically significant at the 0.05 level vs. inpatient population. n = not statistically significant. Proportions are tested using the Chi-squared test. Medians are tested using the Mann–Whitney U test. Cases with missing or unknown values are excluded from the calculations. The proportions of the inpatient population (data row 1, all diabetes) with missing or unknown values are: Diabetes type 3.5%; Diabetes duration 1.9%; eGFR 13.2%. **1**. Percentages are derived from rounded values. Underlying counts between 1 and 7 are set to 5. All counts greater than 7 are rounded to the nearest 5. Consequently some percentages may not sum up to exactly 100%. **2**. Proportions are calculated from the sum of nights in hospital during the period stated for people in the core NDA, where diabetes was diagnosed on or before admission. Day cases and same-day discharges are counted as zero days and are therefore excluded. For further information, see: Further information: Inpatient population with diabetes. **3**. See note 2 above, with additional exclusion for admissions that are less than 3 nights due to the audit requirement that new onset foot ulcers must occur more than 72 hours after admission.

Care improvement initiatives:
EPR and medication errors

Chart 4.3: Inpatient drug charts having one or more medication error[1] in the last 7 days of their hospital stay: by electronic patient record (EPR) usage[2], England, 2019



Error type[1]	Significant difference (p <0.05)	
	EPR used	EPR not used
Medication error	Less likely	More likely
Prescription error	Less likely	More likely
Glucose management error	No difference	No difference
Insulin error	Less likely	More likely

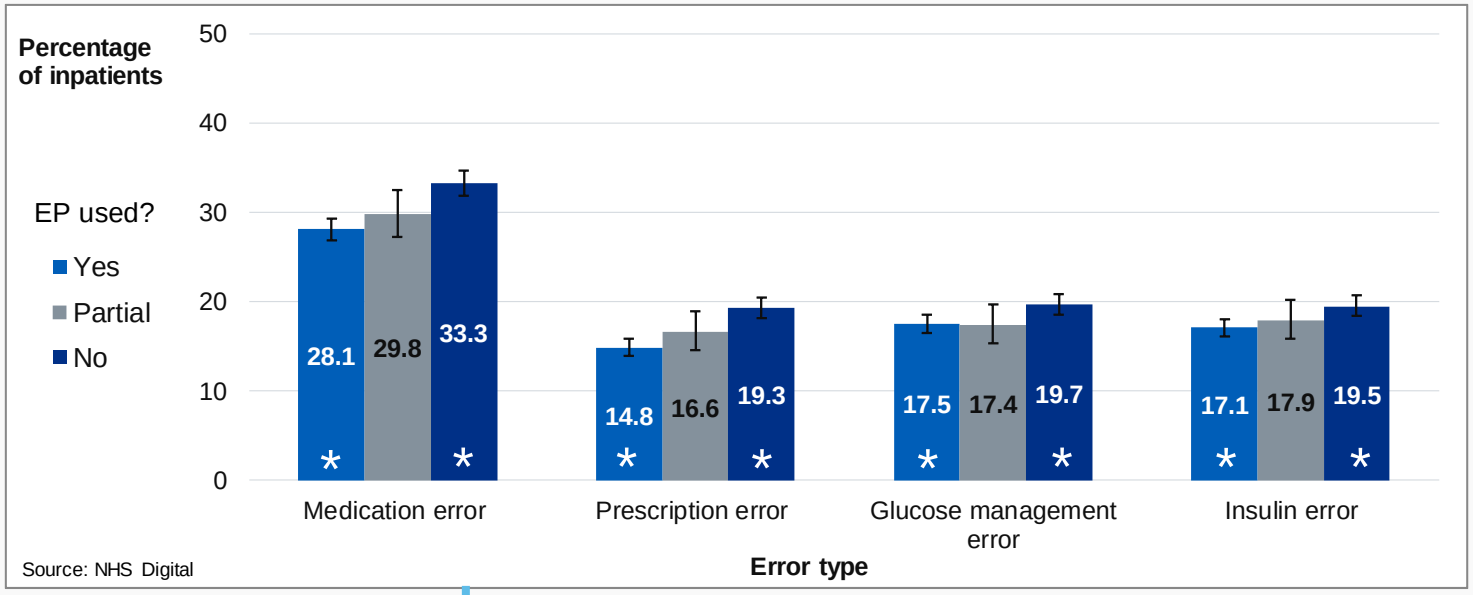
Finding

- Inpatient drug charts are **less likely** to contain medication, prescription and insulin errors if EPR is used.

Notes: ***** = statistically significant at the 0.05 level (EPR used vs. EPR not used in audit year). **n** = not statistically significant (EPR used vs. EPR not used in audit year). **1**. *Medication error* = any prescription or glucose management error. See Medication errors: Definitions for explanation of error types. **2**. See Glossary: Healthcare technologies for information on EPR.

Care improvement initiatives:
EP and medication errors

Chart 4.4: Inpatient drug charts having one or more medication error[1] in the last 7 days of their hospital stay: by electronic prescribing (EP) usage[2], England, 2019



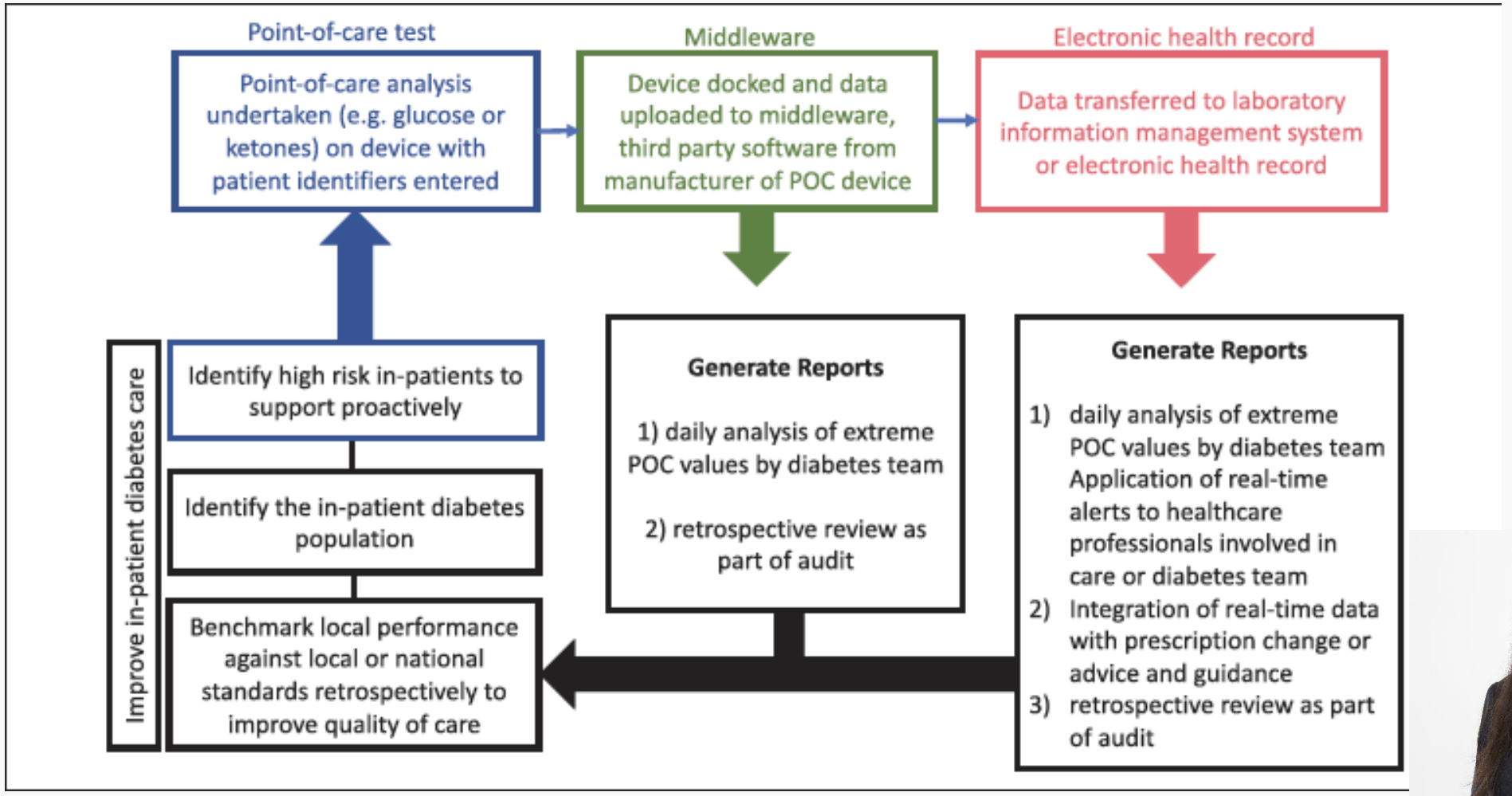
Error type[1]	Significant difference (p <0.05)	
	EPR used	EPR not used
Medication error	Less likely	More likely
Prescription error	Less likely	More likely
Glucose management error	Less likely	More likely
Insulin error	Less likely	More likely

Finding

- Inpatient drug charts are **less likely** to contain all types of medication error if EP is used.

Notes: ***** = statistically significant at the 0.05 level (EP used vs. EP not used in audit year). **n** = not statistically significant (EP used vs. EP not used in audit year). **1**. *Medication error* = any prescription or glucose management error. See Medication errors: Definitions for explanation of error types. **2**. See Glossary: Healthcare technologies for information on EP.

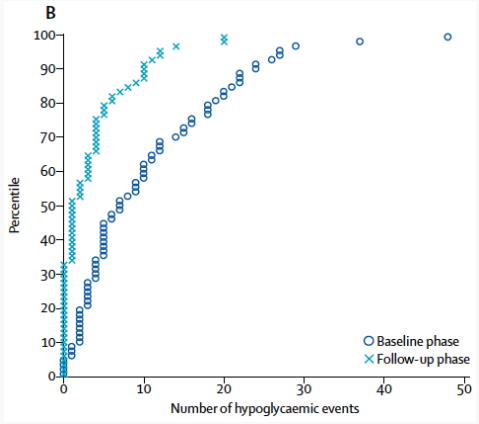
Benefits of POC testing in diabetes

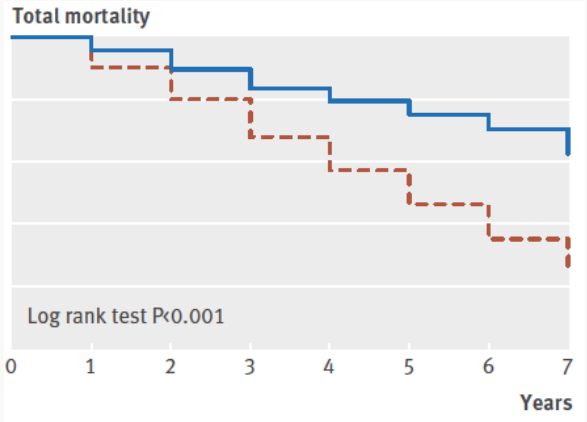


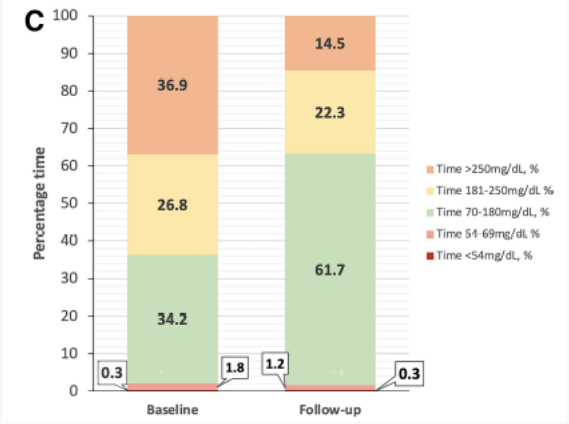
https://doi.org/10.1177/19322968221137360

Wearable diabetes technologies

- Benefits of wearable diabetes technologies are clear in the community
  - Improved glycaemia
  - Reduced HbA1c
  - Association with reduced mortality
- Can these benefits be transferred into the inpatient environment?







https://doi.org/10.1016/s0140-6736(18)30297-6
https://doi.org/10.1136/bmj.h3234
https://doi.org/10.2337/dc23-0635

Reducing ward hypoglycaemia

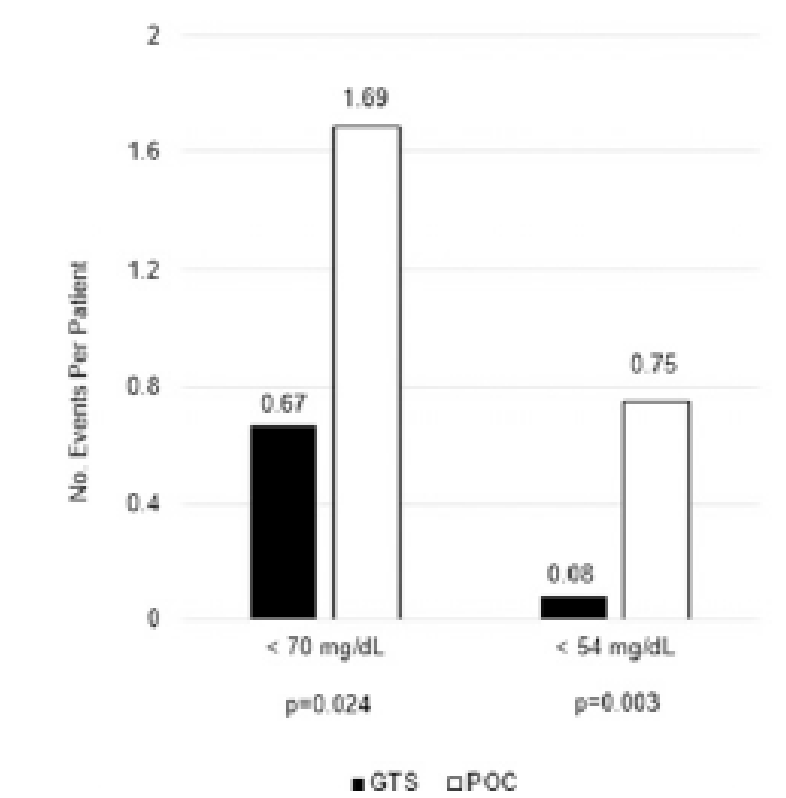


Figure 1—Hypoglycemic events per patient.

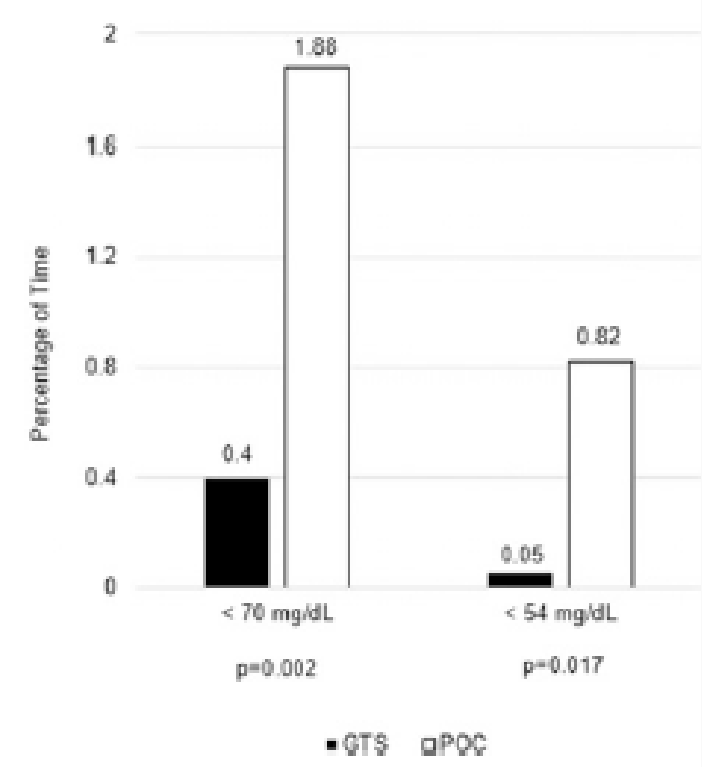


Figure 2—Percentage of TBR.

https://doi.org/10.2337/dc20-0840

Insulin pump use in hospital

- Limited randomized study data

- Observational data
  - No difference in mean glucose
  - Fewer episodes of severe hyperglycaemia (glucose over 16.7 mmol/l)
  - Fewer episodes of severe hypoglycaemia (glucose below 2.2 mmol/l)
  - High satisfaction when allowed to continue pump therapy in hospital
  - Supports self-management and autonomy

HCL use in hospital

- Some randomized study data
- Often in people with type 2 diabetes
  - General wards
  - Enteral or parenteral nutrition
  - Haemodialyis
- Also people with type 1 diabetes through labour, delivery and post-partum
- Increased time in target, no reduction in TBR

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Survey of Current Inpatient Technology Use

Original Article

Variation in the Current Use of Technology to Support Diabetes Management in UK Hospitals: Results of a Survey of Health Care Professionals

Alistair Lumb, MBBS, BA, FRCP, PhD[1],
Shivani Misra, BMedSci, MBBD, MSc, FRCPath, PhD[2,3],
Gerry Rayman, MD, FRCP[4],
Parizad Avari, MBBS, PhD[3], Daniel Flanagan, MD, FRCP[5],
Pratik Choudhary, MBBS, PhD, FRCP[6],
and Ketan Dhatariya, MBBS, MSc, MD, MS, FRCP, PhD[7,8]

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Current position - staffing

Table 3. Availability of a Member of the Diabetes Specialist Team to Support People With Diabetes Using Wearable Technology in Hospital.

	Always	Sometimes	No
Weekdays Normal working hours	35/42 (83.3%)	7/42 (16.7%)	0/42 (0%)
Weekdays Outside normal working hours	7/42 (16.7%)	8/42 (19.0%)	27/42 (64.3%)
Weekends	6/41 (14.6%)	13/41 (31.7%)	22/41 (53.7%)

Table 4. Which Team Members Are Available to Support People With Diabetes Using Wearable Technology in Hospital.

	Diabetes specialist nurse	Diabetes specialist doctor	Other
Weekdays Normal working hours	33/36 (91.7%)	17/36 (47.2%)	6/36 (16.7%)
Weekdays Outside normal working hours	4/14 (28.6%)	11/14 (78.6%)	1/14 (7.1%)
Weekends	11/18 (61.1%)	14/18 (31.7%)	1/18 (5.6%)

Current position - POCT

- 86% of organisations reported having networked glucose meters
- In 75% of these, results can be viewed using the normal results viewer
- Data are used for audit, quality improvement or clinical care in 58% of organisations
- **So we are not making best use of the available data**

Current position - guidelines

- 64.3% respondents reported having a policy for the use of insulin pumps/HCL systems in hospital
  - 93.3% of the remainder will allow pump use in hospital

- In contrast, only 16.7% of organisations have a specific policy for the use of CGM in hospital
  - 91.4% will allow people to continue using CGM in hospital

Current position – benefits of CGM

- Those using CGM in hospital in the UK report benefits – similar to those seen in outpatient settings
- Note it is a GIRFT recommendation to have **and promote** a self-management policy for PWD in hospital (currently achieved in 72% of acute Trusts)

Table 8. Reported Benefits of Using Continuous Glucose Monitoring in Hospital.

Empowerment of people with diabetes	25/26 (96.2%)
More information to guide treatment decisions	19/26 (73.1%)
The ability to review results remotely	17/26 (65.4%)
Prevention of hypoglycaemia	17/26 (65.4%)
Reduced need for fingerstick monitoring	13/26 (50.0%)
Other	1/26 (3.8%)

Barriers to CGM use in hospital

- Lack of familiarity of ward staff with the technology
- Concerns about accuracy in some situations, for example diabetic ketoacidosis (this is an absence of evidence rather than evidence of a problem)
- An inability of the diabetes specialist team to monitor CGM remotely in hospital
- CGM not integrating with current EHRs
- A reliance on the PWD having capacity to self-monitor and provide appropriate readings, whilst being unwell

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Available resources

RCEM Safety Flash

https://rcem.ac.uk/wp-content/uploads/2022/03/Wearable_Diabetes_Technology.pdf

On admission

- For any person with diabetes admitted to hospital, particularly T1D and insulin treated T2D, check whether they use any wearable technology
- Determine whether the device is a continuous glucose monitoring system (real-time or intermittently scanned CGM) or an insulin delivery system (i.e. insulin pump)
- If admitted unconscious, check for wearable diabetes technology (usually worn on the arm or abdomen, but may sometimes be on thighs/ buttocks)
- Ensure the device (CGM/ insulin pump) is not inserted into area of generalized oedema or cellulitis

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CGM - Guidance

Symposium/Special Issue

Continuous Glucose Monitoring Within Hospital: A Scoping Review and Summary of Guidelines From the Joint British Diabetes Societies for Inpatient Care

Parizad Avari, MBBS, PhD[1,2], Alistair Lumb, MBBS, MA, PhD[3], Daniel Flanagan, MD, FRCP[4], Gerry Rayman, MD, FRCP[5], Shivani Misra, BMedSci, MBBS, MSc, MRCP, FRCPath, PhD[2], Ketan Dhatariya, MBBS, MSc, MD, MS, FRCP, PhD[6], and Pratik Choudhary, MBBS, PhD, FRCP[7]; on behalf of the Joint British Diabetes Societies for Inpatient Care

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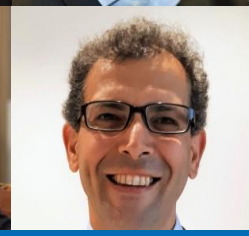

CGM

- If the person with diabetes can self-manage and is capable of using their technology device, they should be encouraged to do so as they do out of hospital
- At the current time CGM can be used to augment capillary glucose testing in hospital but cannot replace it. If a sensor is being used in hospital, at least two CBG tests should be performed. Otherwise, POC CBG testing should be done at the previously recommended frequency (i.e. before meals and at bedtime for those on a basal-bolus insulin regimen)
- In-hospital glycaemia, aim should be for no episodes of hypoglycaemia and to minimise hyperglycaemia
- Glucose between 4.0-6.0mmol/L is indicative of looming hypoglycaemia so consider intervening, particularly if there is a downward CGM arrow

Glucose targets

JBDS-IP

Inpatient glycaemic target 6-10 mmol/L

(in elderly frail, aim for 6 – 12mmol/L)

Diabetes tech targets in hospital:

Aim for no hypoglycaemia episodes and minimise hyperglycaemia

If well in hospital, then can use outpatient time in range target 3.9-10 mmol/L

LOW ALERT:
set at 4 or 5 mmol/L
- consider treating to prevent hypoglycaemia (especially if downward arrow on CGM)

HIGH ALERT:
set at 15 – 18 mmol/L

– consider extra insulin

Checking fingerstick CBG

Table 2. Situations to Always Check Fingerstick CBG.

Situations to ALWAYS check fingerstick CBG:

- To confirm hypoglycemia AND monitor recovery from hypoglycemia
- If symptoms do not match sensor glucose (eg, if symptoms of hypoglycemia are present but the sensor glucose reading is normal)
- If the sensor reading seems unlikely in the circumstances
- If the sensor reading is unreliable or obviously erroneous (eg, no reading, or no arrow)
- If required for calibration
- During and after exercise (eg, after extensive physiotherapy)
- To confirm accuracy before continuation of CGM use (eg, severe hypotension, after surgery, cardiac arrest, etc)

Abbreviations: CBG, capillary blood glucose; CGM, continuous glucose monitoring.

CGM

- Alarms should be used to trigger a capillary glucose reading and consideration of intervention by ward nursing staff
- If the person is due for a procedure or operation where it is agreed or planned to continue using their device, ensure it is on a different area of the body (contralateral side) so that it is not affected
- Avoid placing CGM sensors on the abdomen in the prone individual, as increased pressure may reduce sensor accuracy
- Any CGM devices removed, should be labelled, stored in a safe place and documented
- Diabetes inpatient teams are encouraged to maintain a supply of sensors available to support people in hospital who rely on these for self-management (although individuals are recommended to bring their own CGM supplies)

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Pumps and HCL - Guidance

Symposium/Special Issue

Insulin Pumps and Hybrid Close Loop Systems Within Hospital: A Scoping Review and Practical Guidance From the Joint British Diabetes Societies for Inpatient Care

Parizad Avari, MBBS, PhD[1,2], Alistair Lumb, MBBS, MA, PhD[3], Daniel Flanagan, MD, FRCP[4], Gerry Rayman, MD, FRCP[5], Shivani Misra, BMedSci, MBBS, MSc, MRCP, FRCPath, PhD[2], Pratik Choudhary, MBBS, PhD, FRCP[6], and Ketan Dhatariya, MBBS, MSc, MD, MS, FRCP, PhD[7]; on behalf of the Joint British Diabetes Societies for Inpatient Care

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Insulin Pumps

- An insulin pump should be discontinued if there is any impairment to consciousness, or if the person with diabetes is acutely unwell and/or confused
- If there is disruption of insulin delivery via subcutaneous insulin pump (for example, removal of pump or blocked cannula), ensure an alternative source of insulin is started immediately (intravenous or subcutaneous injections)
- Any removed insulin pump devices, should be labelled, stored in a safe place and documented
- All pump users should be discussed with a member of diabetes specialist team

Safe peri-operative insulin pump use

Table 2. Requisites for Safe Perioperative Use of CSII (All Conditions Must Be Met).

- The person with diabetes should be seen preoperatively by a registered health care practitioner who is knowledgeable about the perioperative use of CSII
- Documentation of discussions and decisions made with the person with diabetes
- Multidisciplinary agreement that continued use of CSII is appropriate
- Provision to issue patient information leaflet
- Ability to communicate with medical teams
- Short fasting period (eg, no more than one missed meal)
- Elective or expedited surgery
- Optimal preoperative HbA1c $<$ 69 mmol/mol
- Ability to site pump away from the site of proposed surgery
- Ability to avoid positioning the insulin pump between the earthing plate and the diathermy
- Use of a Teflon cannula (and not a steel cannula)
- Sufficient Teflon consumables
- Ability to monitor CBG regularly (ie, every 60 minutes) and to monitor capillary blood ketones
- Ability to replace CSII with variable rate intravenous insulin infusion (VRIII) if necessary

Abbreviation: CBG, capillary blood glucose; CSII, continuous subcutaneous insulin infusion.

Contraindications to pump use

Table 1. Contraindications to Insulin Pump Therapy in Hospital.

- Impaired level of consciousness or confusion
- Critical illness requiring intensive care/high-dependency care
- Diabetic ketoacidosis or hyperosmolar hyperglycemic state
- Psychiatric illness or suicidal ideation
- Person unable to use hands and/or physically manipulate pump due to medical condition
- Person unwilling to participate in diabetes self-management, or share pump management decisions with hospital clinical staff
- Lack of pump supplies or mechanical pump malfunction
- Lack of trained health care providers or available diabetes specialists to supervise pump therapy
- Medical team decision for health and safety of the person

Source: Adapted from Umpierrez et al[14] and Yeh et al.[15]
Abbreviation: CSII, continuous subcutaneous insulin infusion.

HCL

- Closed loop algorithms should be “disengaged” and switched to “manual” control in hospital
- After discontinuation of auto-mode within the hybrid closed loop, the system may be used individually (as CGM only or insulin pump only) if criteria are met
- For inpatients meeting the criteria to continue insulin pump and CGM therapy, continuing in closed loop mode may be considered but only under specific guidance from the diabetes team

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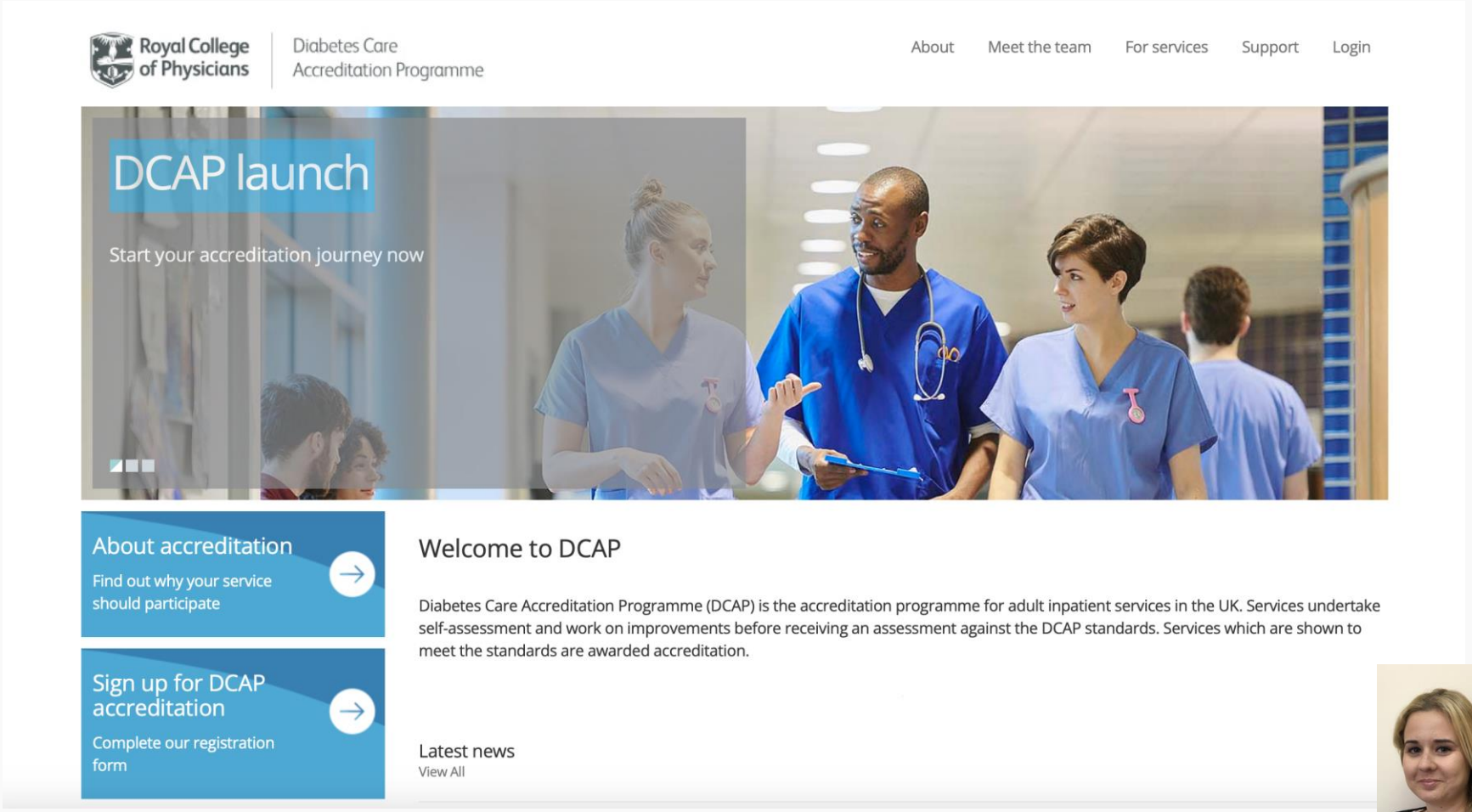
Future directions

Future directions

- Imminent UK guidance for the use of diabetes technology to support inpatient diabetes care – joint venture between JBDC-IP group and DTN-UK
- Development of the evidence base for safety and efficacy of wearable diabetes technologies in the inpatient setting
- Integration of CGM into EPR systems and safety mechanisms
- Use of machine learning to identify people at high risk of inpatient hypoglycaemia
- Wider use of automated insulin delivery in inpatient settings

Accreditation



https://www.dcap.org.uk
Accessed 29 September 2023

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Summary

- Background
- Current guidance
- Future directions

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