Diabetes Mellitus: Our Role in Preventing Long-term Complications

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University Hospital Birmingham NHS Trust, Birmingham, UK
Diabetes is estimated to have cost the UK £9.8 billion in direct costs in 2010/2011 - approximately 10% of the total health resource expenditure. 80% of these costs are incurred in treating potentially avoidable complications.

The scale of the problem: 32 million people in England were estimated to have diabetes in 2010.

This is expected to increase by 23% to 38 million in 2030.

Cost of Diabetes vs Other Medical Conditions in the US

Yearly Cost of Type 1 Diabetes (in iPhone 7s***)


***(Apple 2017)
FIGURE 2  Box plot of annual total secondary care costs incurred for patients with diabetes by number of vascular complications.
Hyperglycaemia is important.

It is a marker of poor outcome.
Relationship between HbA$_{1c}$ and risk of all-cause hospital admissions among people with Type 2 diabetes

D. Yu and D. Simmons
Does Improving Glycaemic Control Reduce Long-term Diabetes Complications?

### Impact of Intensive Therapy in Diabetes in Major Clinical Trials

<table>
<thead>
<tr>
<th>Study</th>
<th>HbA$_{1c}$</th>
<th>Microvascular</th>
<th>CVD</th>
<th>Mortality</th>
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<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>Study End</td>
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<td></td>
<td>Std</td>
<td>Intensive</td>
<td></td>
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<tr>
<td>DCCT/EDIC</td>
<td>9</td>
<td>9</td>
<td>7</td>
<td>↓</td>
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<tr>
<td>UKPDS</td>
<td>9</td>
<td>7.9</td>
<td>7</td>
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<tr>
<td>ACCORD</td>
<td>8.3</td>
<td>7.5</td>
<td>6.4</td>
<td>↓</td>
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<tr>
<td>ADVANCE</td>
<td>7.5</td>
<td>7.0</td>
<td>6.4</td>
<td>←</td>
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<tr>
<td>VADT</td>
<td>9.4</td>
<td>8.5</td>
<td>6.9</td>
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</tbody>
</table>

Microvascular disease – Yes

Macrovascular disease - No

Why did we not see the benefit with Macrovascular disease in the VADT/ACCORD?ADVANCE Studies?
## BUT Microvascular Disease Begets Macrovascular Disease!

Comparative Effects of Microvascular and Macrovascular Disease on The Risk of Major Outcomes in Patients with Type 2 Diabetes Mohammedi Et Al. Cardiovasc Diabetol (2017) 16:95

<table>
<thead>
<tr>
<th>History of microvascular or macrovascular disease</th>
<th>Number of events (event rate)</th>
<th>Microvascular disease alone vs. dual absence</th>
<th>Macrovascular disease alone vs. dual absence</th>
<th>Both micro- and macrovascular disease vs. dual absence</th>
</tr>
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<tbody>
<tr>
<td>Dual absence (n = 6789)</td>
<td></td>
<td>HR (95% CI)</td>
<td>P</td>
<td>HR (95% CI)</td>
</tr>
<tr>
<td>All-cause mortality</td>
<td>1136 (1.9)</td>
<td>1.43 (1.20 to 1.71)</td>
<td>&lt;0.0001</td>
<td>1.43 (1.30 to 1.57)</td>
</tr>
<tr>
<td>Major macrovascular events</td>
<td>970 (1.7)</td>
<td>1.64 (1.37 to 1.97)</td>
<td>&lt;0.0001</td>
<td>1.04 (1.86 to 2.25)</td>
</tr>
<tr>
<td>Cardiovascular death</td>
<td>396 (0.7)</td>
<td>1.96 (1.52 to 2.52)</td>
<td>&lt;0.0001</td>
<td>1.13 (1.84 to 2.46)</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>310 (0.5)</td>
<td>1.68 (1.22 to 2.30)</td>
<td>&lt;0.0001</td>
<td>0.94 (1.65 to 2.29)</td>
</tr>
<tr>
<td>Stroke</td>
<td>446 (0.8)</td>
<td>1.32 (0.99 to 1.76)</td>
<td>0.06</td>
<td>0.15 (1.87 to 2.47)</td>
</tr>
<tr>
<td>Major clinical microvascular events</td>
<td>342 (0.6)</td>
<td>4.74 (3.86 to 5.82)</td>
<td>&lt;0.0001</td>
<td>2.26 (1.06 to 1.51)</td>
</tr>
<tr>
<td>Retinal photocoagulation or blindness</td>
<td>284 (0.5)</td>
<td>5.28 (4.25 to 6.56)</td>
<td>&lt;0.0001</td>
<td>3.34 (1.10 to 1.63)</td>
</tr>
<tr>
<td>ESRD or renal death</td>
<td>70 (0.1)</td>
<td>1.95 (1.12 to 3.37)</td>
<td>0.02</td>
<td>0.91 (0.60 to 1.38)</td>
</tr>
</tbody>
</table>

Dual absence means absence of both macrovascular and microvascular disease at baseline. HRs estimated using Cox proportional hazards regression model adjusting for sex, age, region of origin (established market economies, Eastern Europe and Asia), BMI, duration of diabetes, HbA1c, systolic blood pressure, antihypertensive treatment, use of CGB and its regimens, urine albumin-creatinine ratio (normoalbuminuria, microalbuminuria and macroalbuminuria), LDL- and HDL-cholesterol, history of ever smoking, and randomized study allocations.
The Newer Antidiabetic Agents have been shown to Reduce Macrovascular Disease

GLP-1 RA CVOTs
Comparison of Results

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Primary composite endpoint</td>
<td>CV death, MI, stroke, or UA HR: 1.02 (0.89, 1.17) P = .81</td>
<td>CV death, MI, or stroke HR: 0.87 (0.78, 0.97) P = .01</td>
<td>CV death, MI, or stroke HR: 0.74 (0.58, 0.95) P &lt; .001 for noninferiority P = .02 for superiority</td>
</tr>
<tr>
<td>CV death</td>
<td>0.98 (0.78, 1.22) P = .85</td>
<td>0.78 (0.66, 0.93) P = .007</td>
<td>0.98 (0.65, 1.48) P = .92</td>
</tr>
<tr>
<td>Nonfatal MI</td>
<td>1.03 (0.87, 1.22) P = .71</td>
<td>0.86 (0.73, 1.00) P = .046</td>
<td>0.74 (0.51, 1.08) P = .12</td>
</tr>
<tr>
<td>Nonfatal stroke</td>
<td>1.12 (0.79, 1.58) P = .54</td>
<td>0.86 (0.71, 1.06) P = .15</td>
<td>0.61 (0.38, 0.99) P = .04</td>
</tr>
<tr>
<td>Hospitalization for UA</td>
<td>1.11 (0.47, 2.62)^* P = .81</td>
<td>0.98 (0.76, 1.26) P = .87</td>
<td>0.82 (0.47, 1.44) P = .49</td>
</tr>
<tr>
<td>Hospitalization for HF</td>
<td>0.96 (0.75, 1.23) P = .75</td>
<td>0.87 (0.73, 1.05) P = .14</td>
<td>1.11 (0.77, 1.61) P = .57</td>
</tr>
</tbody>
</table>

[^1] Primary composite endpoint.

SGLT2 Inhibitor CVOT
Results From EMPA-REG OUTCOME

### Glycemic Control, Complications, and Death in Older Diabetic Patients

The Diabetes and Aging Study

*Diabetes Care* 34:1329–1336, 2011

<table>
<thead>
<tr>
<th>Table 3—Age-stratified results: adjusted analyses*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcome</strong></td>
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<td></td>
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<tr>
<td><strong>Mortality</strong></td>
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<tr>
<td>Age-group</td>
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<tr>
<td>60–69</td>
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<tr>
<td>70–79</td>
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<tr>
<td>≥80</td>
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<tr>
<td><strong>Any complication</strong></td>
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<tr>
<td>Age-group</td>
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<tr>
<td>60–69</td>
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<td>70–79</td>
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<td>70–79</td>
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<td>≥80</td>
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*Models adjusted for sex; race/ethnicity; duration of diabetes; systolic blood pressure; use of insulin, sulfonylurea, or thiazolidinedione; smoking status; glucose-monitoring adherence; GFR (chronic kidney disease stages 1–5); microalbuminuria; and proteinuria.
## Glycaemic Targets in a Hospital Setting

<table>
<thead>
<tr>
<th>Endocrine Society</th>
<th>ICU</th>
<th>Non-ICU</th>
</tr>
</thead>
</table>
| **ADA/AACE**      | Initiate insulin therapy for persistent hyperglycaemia glucose >10.0 mmol/L  
Treatment goal: 7.8-10.0 mmol/L. | No specific guidelines  
If treated with insulin, pre-meal glucose targets <7.8 mm with random glucose levels <10.0 mmol/L |

### 6.0 - 10.0 mmol/L

<table>
<thead>
<tr>
<th>Endocrine Society</th>
<th>ICU</th>
<th>Non-ICU</th>
</tr>
</thead>
</table>
| **Society of Thoracic Surgeons**  
(Guidelines specific to adult cardiac surgery) | Continuous insulin infusion preferred over SC or intermittent intravenous boluses  
Treatment goal: <10.0 mmol/L during surgery ≤6.1 mmol/L in fasting and pre-meal states | Pre-meal glucose target <7.8 mmol/L and random blood glucose <10.0 mmol/L  
Glucose <10.0-11.1 mmol/L is appropriate in patients terminal illness and/or with limited life expectancy or at high for hypoglycaemia |

<table>
<thead>
<tr>
<th>Endocrine Society</th>
<th>ICU</th>
<th>Non-ICU</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Joint British Diabetes Society</strong></td>
<td>Target blood glucose levels 6.0-10.0 mmol/L with an acceptable range of between 4.0-12.0 mmol/L</td>
<td></td>
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</tbody>
</table>
Encourage Them To Take Their Medication

GLP-1RA

Figure 2: Variation in impact of glucagon-like peptide 1 receptor agonist therapy on glycated haemoglobin levels observed between real-world and randomised-controlled trial populations is mainly explained by adherence to therapy.

HbA1c: glycated haemoglobin; RCT: randomised controlled trial.

Carls GS et al. Copyright and all rights reserved. Material from this publication has been used with the permission of American Diabetes Association.
See it or hear it through the eye or ears of the patient!

Healthcare Professional 1
‘I understand you have just seen someone with DKA.’
Healthcare Professional 2
‘Yes, Mr Smith is in cubicle 2.’
Healthcare Professional 1
‘Oh, I know Mr Smith. He’s been here quite a few times this year. How awful for him.’
Healthcare Professional 2
‘Yes, exactly.’
Healthcare Professional 1
‘He is really struggling with his diabetes.’
Healthcare Professional 2
‘Didn’t he take part in one of those insulin trials?’
Healthcare Professional 1
‘Yeah, I can’t imagine how he managed all those hypos while he was using human insulin. So, he volunteered to try an analogue but it seems he is still having problems.’
Healthcare Professional 2
‘So, that regimen isn’t working out well for him either?’
Healthcare Professional 1
‘Type 1 diabetes is such a difficult condition to manage. I wonder what we can do today to support him.’
Is there a link between poor choice of language in diabetes care and diabetes stigma?

- There are 8760 hours in a year.
- The average patient will see a diabetes healthcare professional for probably 4 hours per year.
- This equates to 0.05% of the total time.

- Good communication can lower anxiety, build confidence, educate, motivate and help people to develop the skills need for self-care.
"Partnerships do not work well if one partner dominates... and forcefully directs decisions or if they have an inadvertently condescending manner which may be underlined by the unhelpful use of language."

Negative and Positive Language Commonly used by HCPs
Inpatient Hyperglycaemia and Diabetes Management
Self Medication

Assessment for the Self Administration of Insulin

- The patient wants to undertake self-administration of insulin
  - Patients have the mental capacity to undertake self-administration. (Complete reverse)

- Patient has no identified risk factors
  - Acute/Chronic Delirium
  - Self-Harm
  - Head Injury
  - Self-Neglect
  - Acute Mental Health Episode
  - Suspected/confirmed non-adherence to treatment
  - Admission due to glycaemic problems e.g., DKA
  - This list is not exhaustive.

- Patient has the necessary knowledge and skills for self-administration
  - Patient can:
    - State the dose and timing of their insulin
    - Explain what to do if a dose is missed
    - Understands changes to food can affect glucose levels
    - Knows own target blood glucose range
    - Inpatient range 6-10mmol/L
    - Describe & explain rationale for self-dose adjustments
    - Recognise and treat hypoglycaemia
    - Understands safe disposal of sharps and blood products

Patient Signature
I understand the principles of self-administration as explained by the Healthcare Practitioner, have read the self-administration patient information leaflet and agree to undertake self-administration of my insulin. I will accept responsibility for safe custody of the medication locker key and contents of the medicine locker. I also understand that any changes in my medical condition will require a review of my ability to self-administer and this may be suspended in my best interest.

Signature
Print Name
Date

Healthcare Practitioner

I am satisfied that the patient above meets the criteria for self-administration of insulin

Signature
Print Name
Date

The above patient does not meet the criteria for self-administration of insulin

Signature
Designation
Print Name
Date

1st Review within 24hrs
Date/Signature

2nd Review 72hrs
Date/Signature

3rd Review weekly
Date/Signature

Store in Patients Bedside notes when in use
Self Administration pro-forma v0.3 MMNJ 05/2012

THINKGLUCOSE™
Inpatient care for people with diabetes
**Monitoring Charts**

**BLOOD GLUCOSE (BG) MONITORING CHART**

**Name:**
**Ward:**
**PID:**
**Date of Birth:**

Monitor BG QID for first 24h in all patients or newly diagnosed hyperglycaemia.

<table>
<thead>
<tr>
<th>Date</th>
<th>Frequency</th>
<th>GD</th>
<th>SD</th>
<th>QDS</th>
<th>GD</th>
<th>SD</th>
<th>QDS</th>
<th>GD</th>
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Enter Exact Time

Check blood glucose BEFORE MEALS at the set times. For more frequent readings cross out the set times.

**Type of Diabetes**
- T2DM on diet
- T2DM on tablets
- T2DM on insulin
- T1DM
- Other

**For Further Guidance see overview**
Weekly Reviews - Foot Assessment and Glycaemic Pattern

To be assessed on admission if patient is known diabetic and repeated weekly.

Please Answer YES or No for signs of infection or ulceration to either foot.

Guidance not on the back of Blood Glucose chart.

If you are concerned that your patient has an infection or ulceration escalate to doctor/patient’s medical team for review.

Weekly review of your patient if answering ‘YES’ to any of the following please escalate to the patient’s medical team.

If CBG below 4.0mmol/l repeat CBG reading 15 minutes after initialisation action if reading still below <4.0mmol/repeat action.
Inpatient treatment of hypoglycaemia

Hypoglycaemia is a blood glucose of 4 mmol/L or less.
Wherever possible, check blood glucose level prior to treatment. If patient asymptomatic, repeat test.

<table>
<thead>
<tr>
<th>4mmol/L</th>
<th>3mmol/L</th>
<th>2mmol/L</th>
<th>1mmol/L</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MILD</strong></td>
<td><strong>MODERATE</strong></td>
<td><strong>SEVERE</strong></td>
<td></td>
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<tr>
<td>Patient conscious and able to swallow</td>
<td>Patient conscious and able to swallow, but in need of assistance to treat hypog</td>
<td>Patient unable to swallow. Unconscious/fitting SEEK URGENT MEDICAL HELP</td>
<td></td>
</tr>
</tbody>
</table>

**STEP 1**

- **USE HYPO BOX**
  - Administer 10g – 20g fast acting glucose
  - 3-5 x GlucoTabs (4g glucose per tablet) or
  - 1 x 59ml bottle of GlucoJuice

- **USE HYPO BOX**
  - Ensure gag reflex is present.
  - Administer 1-2 tubes of GlucoGel (10g glucose per tube)
  - If no gag reflex use iv/im routes

- Check airway and place patient in recovery position
  - If CBG is 1.5mmol/l or less give 250mls IV 10% glucose
  - If CBG is 1.6 - <4mmol/l give 150mls IV 10% glucose
  - Re-check CBG every 15mins and repeat treatment until CBG above 4mmol/l
  - Consider 10% glucose infusion at 50 -100mls/hr
  - If no IV access administer glucagon 1mg IM
  - When CBG is above 4mmol/l monitor BG hrly until within target range

**STEP 2**

- Wait 15 minutes and recheck glucose levels, and record.
  - If reading is still below 4 mmol/L, or if no physical improvement, repeat STEP 1
  - **ONCE PATIENT IS CONSCIOUS, GIVE SIPs OF** GlucoJuice or Lucozade. Recheck glucose level every 15 minutes to ensure increase to at least 4 mmol/L

**ALWAYS FOLLOW UP WITH A SLOWLY DIGESTED/STARCHY CARBOHYDRATE**

Check glucose level. Once it is at 4 mmol/L or over and patient is recovered, eat a minimum of 15g slowly digested/starchy carbohydrate. Eg: 1 x slice/sandwich of low GI bread (ideally multigrain or granary); two digestive biscuits, glass of milk, banana, small carton of fruit juice. Recheck glucose levels after 15 minutes.

**NOTE:** Insulin should NEVER be omitted following an episode of hypoglycaemia.
Refer patients to the Diabetes Inpatient Team from iCare:
Words can inspire. And words can destroy. Choose yours well.

Robin Sharma
Welsh teenager, 17, sent home from A&E after complaining about constipation is found dead 24 hours later

- A “fit and healthy” teenager who was told by doctors that his severe stomach pains was constipation was found dead in his bed 24 hours later.
- Jack Dunn, 17, was sent home from A&E at the Royal Glamorgan Hospital in Wales after a ‘constipation scan’.
- The teen was told to get a good night’s sleep but the next day his father Keiron found him dead in bed at his home in Rhondda.
- A post-mortem found that Jack died from diabetic ketoacidosis.
- Mr Dunn said his son could “barely walk” because of how much pain he was in.
- He told The Mirror: “With Jack we found it difficult to breathe the doctor thought it was probably anxiety because Jack was always afraid of being in hospital.”
- “Finding my son dead in his bed was the worst moment of my life. I believe Jack would be alive today if a few more simple tests had been carried out.”

https://www.mirror.co.uk/news/uk-news/teen-17-found-dead-bed-11975293