Diabetes Mellitus – Safety critical workers

Registrars’ Conference
Oxford March 2015

Dr R V Johnston, FRCP, FFOM, FFTM, DAvMed, MBA
Registrar Faculty of Occupational Medicine (Retd)
“The foundation of knowledge must be laid by reading. General principles must be had from books; which, however, must be brought to the test of real life.”

Samuel Johnson
Aims

- Key issues in diabetes mellitus
- Application to safety critical workers
- Principles of evidence based individual assessment
  NOT long lists of criteria
- The aviation model
Safety Critical Worker

- is one whose job function is directly related in some way to the safety of others, or who could seriously impact the safety of others by not performing the job correctly.

- is one where *sudden* or *subtle* incapacitation of that individual may compromise their ability to undertake a task defined as essential to safety, thereby posing a significant risk to the health and safety of *themselves* and *others*

Evidence based medicine: does it make a difference?
Diabetes Risk Assessment

Hazard:

- The potential to produce harm or an adverse effect.

Risk:

- The probability that an event will occur i.e. quantification and time.
Risk Assessment

Analysis

Risk

Perception  Management
Diabetes
Prevalence: Increasing!
Projected prevalence of diabetes in 2007 and 2025 in adults aged 20-79 years, by region

DIABETES: Health Crisis of the 21st Century

£4bn
10%
Within six years, one pound in every 10 spent on the NHS will go on treating diabetes.

100,000
people in the UK are diagnosed with Type II diabetes – which is linked to obesity - each year.

1.8m
people in the UK have diabetes – a 450% rise on 1960.

3m
will be confirmed sufferers within six years – an increase of 67% on today’s figure.

50%
More than 50% of British children could be obese by 2020, according to the Royal College of Physicians.

1m
more are estimated to have diabetes – but don’t even know it.

37"
A waist this size puts men at high risk of developing diabetes.

31.5"
A waist this size puts women at high risk of developing diabetes.

30
A Body Mass Index above 30 means a 10 times greater chance of developing diabetes.

41,000
people in the UK will die from diabetes in 2015. This marks a 25% increase on today’s annual death rate.

1/2
or more of all diabetes cases would be eliminated if weight gain in adults could be prevented.

The UK has the fastest growing rate of diabetes in the developed world. Britain also has the fastest growing rate of obesity.

The World
Globally, cases of diabetes have risen from 50 million in 1985 to 150 million in 2004, projected to grow to 300 million by 2025.
Diabetes
Polymorphic Risk
Consequences of hyperglycaemia

Figure 1. Pathophysiological consequences of hyperglycaemia

- Excessive hyperglycaemia

  - Blood coagulation↑
  - Fibrinolysis↓
  - Subclinical inflammation↑
  - Endothelial dysfunction (NO release↓)

  - HDL-C catabolism
  - TG-rich lipoproteins
    - LDL removal↑
    - FFA↑
    - Oxidative stress↑
    - Insulin resistance↑
    - B-cell function↓

  - Plaque stability↓

FFA, free fatty acids; HDL-C, high-density lipoprotein; LDL, low-density lipoprotein; TG, triglyceride.
Diabetes Mellitus - Aims

- Good Control: Glucose, BP, Lipids, BMI
- Prevent Complications:
- Drivers:
  - Type 1 (DCCT, 1993)
  (DCCT FU 27ys JAMA 2015)
  - Type 2 (UKPDS, 1998)
Assessing Control

HbA1c, an integrated measure of glycaemic variation

Plasma glucose

(mmol/L) (mg/dL)

0 5.0 10.0 15.0

0 100 200 300

0600 1200 1800 2400 0600

Time of day

Postprandial hyperglycaemia

Fasting hyperglycaemia

Normal

Hypoglycaemia

Riddle MC (1990)
Significant Studies

San Luigi Gonzaga Study: Cavalot F (EASD) Sep 2011

- 505 patients
- 14 years follow up
- Post prandial blood glucose *not* fasting level predicts cardiovascular events and all cause mortality in people with type 2 diabetes
- HbA$_{1c}$ also a predictor of both outcomes
Target for good control

Study of Type 2 diabetics looking at median HbA$_{1c}$ and outcomes

- Decile with lowest hazard ratio for events median HbA$_{1c}$ 7.5% (59)

- Those with lowest median HbA$_{1c}$ (6.4%) and highest median HbA$_{1c}$ (10.5%) were associated with increased all-cause mortality and cardiac events

Currie C et al Lancet 2010
# HbA$_{1c}$ Standardisation

**Jan 2011**

<table>
<thead>
<tr>
<th>Current HbA1c (%)</th>
<th>New HbA1c (mmol/mol)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.0</td>
<td>42</td>
</tr>
<tr>
<td>6.5</td>
<td>48</td>
</tr>
<tr>
<td>7.0</td>
<td>53</td>
</tr>
<tr>
<td>7.5</td>
<td>59</td>
</tr>
<tr>
<td>8.0</td>
<td>64</td>
</tr>
<tr>
<td>9.0</td>
<td>75</td>
</tr>
</tbody>
</table>
“Man may be the captain of his fate, but he is the victim of his blood sugar.”

Diabetes
Rate determining step
HYPOGLYCAEMIA
In risk analysis
Rate of severe Hypoglycaemia in Patients receiving Intensive Therapy, and Mean Monthly Glycosylated Haemoglobin value during the DCCT Trial.
Prevalence of Hypoglycaemia – Type 1

- **Mild:** Difficult to obtain accurate data.
- **Severe:** 9 - 31%

**DCCT:**
- 0.17 episodes/patient/year (C)
- 0.54 episodes/patient/year (I)
Hypoglycaemia risk among insulin users

Low Risk

- Stimulated C-Peptide levels > 25% of normal
- No previous hypoglycaemic reactions requiring the intervention of another person.
- Stable blood glucose control as measured by:
  (a) Glycosylated Hb: ~ 7.5%
  (b) 90% of blood glucose measurements > 5.0 mmol/l
- Adequate self monitoring with a memory chip glucose meter.
- Good diabetes education and understanding.
- No evidence of hypoglycaemia unawareness
- Positive attitude to monitoring and self care.

C-peptide is an indicator of beta cell activity
Most Type 1 diabetics are C-peptide negative
**β-Cell Function in Type 2 Diabetes**

Pancreatic function = 50% of normal

HOMA = homeostasis model assessment

Risk of Severe Hypoglycaemia

Figure 1. Proportion of each group experiencing at least one severe self-reported hypoglycaemic episode during 9–12 months of follow-up. Vertical bars, 95% CI


Heller SR (2007)
Meta-analysis of a number of trials with a total follow up of 163,000 person years showed good control reduced non-fatal MI by 17% and CHD by 15% (Ray et al 2009)
<table>
<thead>
<tr>
<th>End Point</th>
<th>OR (95% CI)</th>
<th>Studies: n</th>
<th>Total Participants: n</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV morbidity</td>
<td>0.85 (0.69 – 1.05)</td>
<td>7</td>
<td>11,986</td>
</tr>
<tr>
<td>CV mortality</td>
<td>0.74 (0.62 – 0.89)</td>
<td>6</td>
<td>11,385</td>
</tr>
<tr>
<td>All-cause mortality</td>
<td>0.81 (0.60 – 1.08)</td>
<td>9</td>
<td>13,046</td>
</tr>
</tbody>
</table>

* Fatal and nonfatal myocardial infarction (MI) or stroke

Selvin E et al  Arch Intern Med 2008
Modern advances in treatment, monitoring and glycaemic control have led to a substantial reduction in microvascular complications in type 1 ITDM.

Many more people with type 2 diabetes are treated with insulin.

Macrovascular risks can be mitigated by regular follow up e.g. Exercise ECG.
Safety Critical Work – Diabetes Mellitus

- It is *unlawful* (Equality Act 2010) for an employer to operate a blanket ban on recruitment of people with diabetes. Some jobs involving safety-critical work will have *legitimate health requirements* that may exclude some people with certain medical conditions, including diabetes.

- *Blanket bans* have been *lifted* in the emergency services for people with Type 1 diabetes and people with Type 2 diabetes who use insulin. Decisions made on someone’s suitability for employment in these services should be made by a process of *individual assessment*. Ideally treating physician and OH physician working together.

- The UK *armed forces are exempt* from the Equality Act.
Safety Critical Work – Diabetes Mellitus

• In some NHS Ambulance Trusts, there are still restrictions in place on people with diabetes who wish to be ambulance crew. These restrictions are being challenged.

• Shift work: People with diabetes used to be discouraged from doing shift work, but improvements in blood glucose testing and more flexible insulin regimes mean that diabetes is less likely to be a barrier to shift work.
Professional Driving – Diabetes Mellitus

• Taxi Driving: Local councils issue licences for taxis and minicabs. Their policies may vary throughout the UK and it is best to check with individual councils for further information.

• HGVs and PCVs: Diet & oral agents – may be ok

  If managed on insulin automatically lose the entitlement to drive vehicles within:

• C1/C1+E class (including categories C1, C1E, D1, D1E, C, CE, D or DE - vehicles between 3.5 and 7.5 tonnes with a trailer, up to a combined weight of 8.25 tonnes. BUT can apply for individual assessment subject to:
Professional Driving – Diabetes Mellitus

• No episode of hypoglycemia at the wheel within the last 12 months

• An assessment once a year by a diabetes consultant

• Regularly testing blood glucose levels, particularly before and around times of driving

• Having been stable on insulin for at least a month

• Have no other conditions that would invalidate an application for the license

• Signing a declaration to follow doctor’s decisions and report any significant change in their condition to the DVLA
Have you checked your blood sugar?
“In safety-critical roles, the question is NOT whether insulin is used, but whether there is good control of the disease, lack of significant complications of the disease and good knowledge of the disease.”

Sussex Police Force
Safety Critical Work – Diabetes Mellitus
Police

• All officers with diabetes should be offered a case evaluation (CE) based on open discussion and should be informed about the merits of having regular individual medical assessment (IMA).

• A policy procedure should be put in place detailing the steps that need to be taken to make reasonable adjustments.

• No officer should be prevented from carrying out a duty/getting a job because they have diabetes without an IMA and a CE.

• Forces might also offer psychological support to enable the officer to come to terms with the condition, but this all depends on individual circumstances.
Safety Critical Work – Diabetes Mellitus Police

• CE, whether or not it includes an IMA, must not inhibit or delay promotion or specialisations. Time must be allowed for these to take place before job application deadlines pass.

• Specialisms and hazardous aspects of the job should be considered at CE and at IMA if appropriate.

• There should be an appeals process for officers to use if they feel that an unfair decision has been made.

Diabetes and the Police Officer- A Survey Report Led by Diabetes UK In collaboration with the Disability Rights Commission, the National Police Diabetic Association and the National Disabled Police Association 2006
Developments in Managing Diabetes
Diabetic Control

….. “intensive strategies have been demonstrated to reduce complications”.. “… therapies directed at other coincident features” are important..

Incretin Actions

- **Heart**: Cardioprotection, Cardiac output
- **Liver**: Glucose production
- **Muscle**: Glucose uptake & storage, Insulin sensitivity
- **Fat**: 
- **Stomach**: Gastric emptying
- **Brain**: Neuroprotection, Appetite
- **Intestine**: GLP-1
- **Pancreas**: Insulin, Glucagon secretion, Insulin biosynthesis, β-cell proliferation & neogenesis, β-cell apoptosis
Two therapeutic avenues

- **Incretin Mimetics** (Exanitide)
  - mimic the enhancement of glucose-dependent insulin secretion and other glucose lowering actions of incretins.
  - injectable (bd)

- **DPP-IV Inhibitors** (Sitagliptin)
  - work on endogenous metabolism of GLP-1 as well as GIP
  - potentiate incretin action by inhibiting the enzyme which breaks down incretin
  - oral (od)
Clinical effects

- **Incretin mimetics**
  - Exanatide associated with 1% ↓ in HbA$_{1c}$
  - modest weight loss (year 1)
  - weight loss and glycaemic control durable (3 yr FU)

- **DPP-IV inhibitors**
  - sitagliptin average ↓ in HbA$_{1c}$ 0.6 – 0.8%
  - weight neutral
Safety

- Incretin Rx well tolerated..nausea main side effect
- DPP-IV well tolerated wrt GI side effects
- Lack of hypoglycaemia since incretin Rx enhance glucose-dependent insulin secretion
- Concerns re pacreatitis...? pancreatic neoplasm
Banting, Best, Collip, Campbell and Fletcher (1922)
What has changed since 1922?

Insulin Treatment 2015
Insulin Formulations

• **Short acting** (Actrapid/Humulin; Aspart/Lispro analogues): 4 - 6hrs

• **Intermediate acting** (Insulatard and Humulin I): 8 - 12hrs

• **Biphasic** (Humulin M1): a mixture of short and intermediate acting (30/70): 8 - 12 hrs

• **Long acting** (analogues glargine and detemir): ~ 24hrs
Insulin Regimes

- Basal insulin with prandial boluses
- Flexibility in transmeridian travel: basal insulin at “home” time zone
Insulin Pump Therapy

- 46 patients changed from MDI to CSII, 4 yrs follow up
- HbA$_{1c}$ fell 0.65% yrs 2 – 4 (p< 0.001)
- DTSQ scores (0= unsatisfied, 36 very satisfied) before CSII median 22, after 3yrs median 33 (p<0.001)

Garmo et al Practical Diabetes 2011;28(7):295-9
Insulin Pump Therapy

• Concerns re: hypoglycaemia in flight due to bubbles increasing insulin delivered

King BR et al Diabetes Care 2011
Insulin on the Flight Deck 2015
Diabetes Mellitus

Basic question in air crew:

- Will the disease or its treatment affect performance?
- 70 - 80% of accidents are due to human factors.
Diabetic pilot on insulin
OML only
Disclosure to other pilot
Robust protocol
Good understanding, hypoglycaemic awareness
Continuous glucose monitoring ....... ?
Counter regulation

- Release of counter regulatory hormones
- Symptoms
- Cognitive impairment
- Cerebral blood flow
- Coma

BG mmol/l

Time
Aviation & Glucose Monitoring

- Aim is to reduce risk of hypoglycaemia

  - Finger stick?
  - Continuous Glucose Monitoring?

- What is the rational approach to developing one or both of these technologies?

- Do the technologies work reliably in the flight deck?
“The test of real life” - Johnson

Aviation Medical Certification
Diabetes Mellitus
Aeromedical Policy CAA Update Summary 2015

**Insulin:**
- Class 1: OML SSL ILA MON
- Class 2: OSL* SSL ILA MON
- Class 3: SSL APC MON

**Sulphonylureas/Glinides:**
- Class 1: OML SSL MON
- Class 2: OSL* SSL MON
- Class 3: SSL MON
Glitazones ] Class 1: OML (unless monoRx)
Gliptins ]
Incretin mimetics: ] Class 2/3: Unrestricted
( GLP-1 analogues) ]
Biguanides ]
Alphaglucosidase inhibitor ]

http://www.caa.co.uk/docs/2499/P027-Diabetic%20Certification%20Guidance.pdf
CAA Diabetes - Acronyms

OML  Operational Multi Pilot Limitation
OSL  Operational Safety Pilot Limitation
OPL  Operational Passenger Limitation
APC  ATCO Proximity Endorsement

---

SSL  Special Restrictions as specified
ILA  Issued by the Licensing Authority in accordance with MED.B.001 (for EU medical certification)
MON  Monitoring of blood sugar required whilst exercising licence privilege
It’s time to take your insulin, Nigel... time to take your insulin.
Reflection on innovation

“Each work has to pass through these stages – ridicule, opposition and then acceptance. Those who think ahead of their time are sure to be misunderstood”.

Vivekananda
A thought for you – the future of our specialty

“Exert your talents and distinguish yourself, and don’t think of retiring from the world until the world will be sorry that you retire.”
Questions?