"Diabetes mellitus: an Aviation Medicine point of view"

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CLASSIFICATION

- **TYPE 1**

- **TYPE 2**
  Related to obesity and familial tendency. Endogenous insulin always present and often hyperinsulinaemic with insulin resistance. Rarely if ever ketotik. Onset 40+. There is a non obese sub-group displaying different aethiology and family aggregation.

- **GESTATIONAL DIABETES MELLITUS**
These conditions often represent a pre-diabetic state that may convert to the full disease at a rate of around 4% per year. Cases may need dietary treatment and will require prolonged and detailed follow up in order to continue aeromedical.

A remark: Glycosuria with normal glucose tolerance (low renal threshold) is acceptable for any certification.
The continuum of glucose intolerance

Normal $\leftrightarrow$ IGT $\leftrightarrow$ Type 2 Diabetes $\rightarrow$ Complications $\rightarrow$ Disability

Preclinical state $\rightarrow$ Primary prevention $\rightarrow$ Clinical disease $\rightarrow$ Secondary intervention $\rightarrow$ Complications $\rightarrow$ Tertiary intervention $\rightarrow$ Death
The worldwide pandemic of type 2 diabetes
All-cause mortality has a linear relationship with 2-hr plasma glucose

\[ Y = 0.49594 + 0.13196 \times X \]
Hyperglycemia and complications in type 2 diabetes
EVERY 1% reduction in HbA1c

- Deaths from diabetes: -21%
- Heart attacks: -14%
- Microvascular complications: -37%
- Peripheral vascular disorders: -43%

Intervention to effect better control means fewer complications.
A HOLISTIC ATTITUDE AGAINST GLOBAL CV RISK: treating both type 2 diabetes hyperglycemia and metabolic syndrome

Good glycemic control

Microvascular and Macrovascular

Dysmetabolic syndrome
Insulin resistance, obesity, hyperinsulinaemia (initially), hypertension, atherosclerosis,
DIABETES MELLITUS

This carbohydrate metabolic disorder is associated with many complication which may produce sudden incapacitation or grossly reduced performance and thus cause a serious risk to air safety. Micro-angiopathic vascular damage is the common background for the coronary, brain and peripheral arterial disease which may contribute to a major aeromedical risk and may be related to the hyperlipidaemic effects of diabetes. Betes-related cardiovascular risk varies depending on different estimates but is clinically significant and increases with the duration of the disease. Roangiopathy is associated with progressive retinal and renal damage. Neuropathy is also related to the long
WHO 2009 International Expert Committee Report recommendations for the diagnosis of DM and disglycemia

**BETES**

- Fasting plasma glucose >7.0 mmol/l – 126 mg/dl
- Fasting plasma glucose* > 11.1 mmol/l – 200 mg/dl

**AIRED GLUCOSE TOLERANCE**

- Fasting plasma glucose >7.0 mmol/l – 126 mg/dl
- Fasting plasma glucose* >7.8 mmol/l and <11.1 mmol/l
- 140 mg/dl and 200 mg/dl

In plasma glucose is not measured, status is uncertain as diabetes GT cannot be excluded

**AIRED FASTING GLUCOSE**

- Fasting plasma glucose 5.6 mmol/l to 6.9 mmol/l
- 100 mg/dl to 125 mg/dl
- Fasting plasma glucose* <7.0 mmol/l < 140 mg/dl

**DIAGNOSTIC CRITERIA**
It should be noted that an apparent remission of insulin invariably ends in relapse and the applicant should not be neither certificated during such a remission or “honeymoon” period.

Type 1 diabetics are unfit to fly. The intrinsic risks of the disease itself are further increased by that of hypoglycaemia. No present injection regime or insulin infusion pumps are sufficiently efficient to act as an artificial pancreas. Nevertheless, progress in such developments as islet transplantation or stem cells may require re-consideration in the future.

JAR-FCL 3.175 Class 1 - 3.295 Class 2 Amendment 5
(d) Applicants with diabetes requiring insulin shall be assessed as unfit.
THIS IS THE “EUROPEAN” WAY TO DIABETES CERTIFICATION...

BUT

THERE IS AN “AMERICAN” WAY TO DIABETES CERTIFICATION!
Medical Certification Guidelines for Pilots with Insulin-treated Diabetes

FAA – USA

(very similar in Canada and Australia)

Terms and conditions have been adapted to European Organization on medical certification

Individuals may exercise only the privileges of a student, leisure, or private pilot certificate.

Individuals are prohibited from operating an aircraft as a required crewmember on any flight outside the airspace of the United States of America.

Exceptionally low risk ITDM who already holds a Class 1 medical certificated licence, be considered for fitness for flight restricted to “as or with co-pilot”, also as Airline

Evaluation of Individuals With Insulin-Treated Diabetes Mellitus

Individuals with ITDM who have no otherwise disqualifying conditions, especially significant diabetes-related complications such as arteriosclerotic coronary or cerebral disease, retinal disease, or chronic renal failure, will be assessed as fit if they:

- had no recurrent (two or more) hypoglycemic reactions resulting in a loss of consciousness or seizure within the past 5 years. A period of 1 year of demonstrated stability is required following the first episode of hypoglycemia;

- had no recurrent hypoglycemic reactions requiring intervention by another individual within the past 5 years. A period of 1 year of demonstrated stability is required following the first episode of hypoglycemia;
In order to provide an adequate basis for an individual medical determination, the person with ITDM requesting special issuance of a medical certificate must submit the following to CAA - AMS:

1. Copies of all medical records concerning the individual's diabetes diagnosis and disease history and of all hospital records, if admitted for any diabetes-related cause, including accidents and injuries.

2. Copies of complete reports of any incidents or accidents, particularly involving moving vehicles, whether the event resulted in injury or property damage, if due in part or totally to diabetes;

3. Copies of a complete medical evaluation by an endocrinologist or other diabetes specialist physician available to the AMS. This report should detail the individual's complete medical history and current condition. The report must include a general physical examination and, at a minimum, the following information:
   - Two measurements of glycated hemoglobin (total A1 or A1C concentration and the laboratory normal range), the first at least 90 days prior to the current measurement;
   - A detailed report of the individual's insulin dosages (including types) and diet utilized for glucose control;
   - Appropriate examinations and tests to detect any peripheral neuropathy or circulatory insufficiency in extremities;
   - Confirmation by an ophthalmologist of the absence of clinically significant eye disease. The eye examination should assess, at a minimum, visual acuity, ocular tension, and presence of lenticular opacities, if any, and include a careful examination of the retina for evidence of any diabetic retinopathy or cataract edema. The presence of microaneurysms, exudates, or other findings of background or macular edema, by themselves, are not sufficient grounds for disqualification unless it prevents the subject from meeting visual standards. However, individuals with active proliferative retinopathy or vitreous hemorrhages will not be considered for special issuance of a medical certificate until the condition has stabilized and this has been confirmed by an ophthalmologist; and

4. Certification by a specialist that the individual has been educated in diabetes and its control and has been highly informed of and understands the monitoring and management procedures for the condition and the actions that should be followed if complications of diabetes, including hypoglycemia, should occur.
ITDM individual applying for special issuance of a medical certificate should have been receiving appropriate insulin treatment for at least 6 months prior to submitting a request for special issuance of a medical certificate.

If the AMS determines that there is need for an ITDM applicant to demonstrate his or her ability to comply with the medical protocol, it may require a special medical examination and/or medical flight test prior to a determination of the applicant's eligibility for special issuance of a medical certificate.
Criteria for individuals with ITDM who have been granted special issuance of medical Certificates

Individuals with ITDM who are granted special issuance must:

- Submit to a medical evaluation by an AMC every 3 months. This evaluation must include a physical examination and a report of glycated hemoglobin (total A1 or A1C) concentration. This evaluation shall also contain an assessment of the individual's continued and willingness to monitor and manage properly his or her diabetes and of whether individual's diabetes or its complications could reasonably be expected to adversely his or her ability to safely control an aircraft.

- Use a digital whole blood glucose measuring device with memory that is suitable to the CAA. Provide records of all daily blood glucose measurements for review to the CAA at each 3-month evaluation required above and, if required, to the CAA at each evaluation.

- Provide to the CAA, on an annual basis, written confirmation by a specialist that the individual's diabetes remains under control and without significant complications and that she has demonstrated reasonable accuracy and recordation of his or her blood glucose measurements with the above described device.

- Provide to the CAA, on an annual basis, confirmation by an ophthalmologist of the absence of any disease that would prevent the individual from meeting current visual standards.

- Provide to the CAA, immediately, a written report of any episode of hypoglycemia associated with cognitive impairment, whether or not it resulted in an accident or adverse events.

- Provide a written report to the CAA, immediately, of involvement in any accidents, including those involving aircraft and motor vehicles, or other significant adverse events, whether or not they are believed related to an episode of hypoglycemia.

- Provide to the CAA, immediately upon determination by a specialist or other physician, any
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duals with ITDM shall maintain appropriate medical supplies for glucose management at all times while preparing

OGHT and while acting as pilot-in-command (or other flightcrew member). At a minimum, such supplies shall

OGHT:

FAA-acceptable whole blood digital glucose monitor with memory;

OGHT supplies needed to obtain adequate blood samples and to measure whole blood glucose; and

OGHT amount of rapidly absorbable glucose, in 10 gram (gm) portions, appropriate to the potential duration of the flight.

OGHT disposable supplies listed above must be within their expiration dates.

OGHT individual with ITDM, acting as pilot-in-command or other flightcrew member, shall establish and document a

OGHT blood glucose concentration equal to or greater than 100 milligrams/deciliter (mg/dl) but not greater than 300 mg/dl

OGHT within 1/2 hour prior to takeoff. During flight, the individual with ITDM shall monitor his or her blood glucose

OGHT concentration at hourly intervals and within 1/2 hour prior to landing. If a blood glucose concentration range of 100-300

OGHT mg/dl is not maintained, the following action shall be taken:

OGHT

OGHT individual with ITDM shall test and record his or her blood glucose concentration within 1/2 hour prior to takeoff. If

OGHT blood glucose measures less than 100 mg/dl, the individual shall ingest an appropriate 10 gm glucose snack (minimum 10

OGHT and recheck and document blood glucose concentration after 1/2 hour. This process shall be repeated until blood

OGHT glucose concentration is in the 100-300 mg/dl range. If blood glucose concentration measures greater than 300 mg/dl, the

OGHT individual shall follow his or her regimen of blood glucose control, as provided to the CAA by his or her attending

OGHT physician, until the measurement of blood glucose concentration permits adherence to this protocol.

OGHT

OGHT one hour into the flight, at each successive hour of flight, and within 1/2 hour prior to landing, the individual shall

OGHT ensure and document his or her blood glucose concentration. Listed below are blood glucose concentration ranges and

OGHT actions to be taken when they occur during flight:

OGHT 1) Less than 100 mg/dl: The individual shall ingest a 20 gm glucose snack and recheck and document his or her blood

OGHT glucose concentration after 1 hour.

OGHT 2) 100-300 mg/dl: The individual may continue his or her flight as planned.

OGHT 3) Greater than 300 mg/dl: The individual shall land as soon as practicable at the nearest suitable airport.

OGHT The individual, as pilot, is responsible for the safety of the flight and must remain cognizant of those factors that are

OGHT important in its successful completion. Accordingly, in recognition of such elements as adverse weather, turbulence, air

OGHT traffic changes, and other variables, the individual may decide that a scheduled measurement of blood

OGHT glucose concentration during the flight is of lower priority than the need for full, undivided attention to piloting. In such

OGHT cases, the individual shall ingest a 10 gm glucose snack. One hour after ingesting this glucose snack, the individual

OGHT shall measure and document his or her blood glucose concentration. If the individual is unable to perform the

OGHT measurement of his or her blood glucose concentration for the second consecutive time, the individual shall ingest a 20
GUIDANCE MATERIAL TO SUPPORT THE PROPOSED CHANGE TO THE MEDICAL PROVISIONS CONTAINED IN ANNEX 1 – Personnel Licensing

ICAO State letter AN 5/22-08/33, dated 5 May 2008

Risk of severe hypoglycaemia among ID diabetics:
0.05 – 0.27 cases per patient per year; Bott & C. 1997

Incapacitation risk:
using the extrapolation for the pilot group one may estimate the rate to be between 1 and 2 per cent per annum; O’Neill – Silberman 2008

Risk of subtle impairment of performance:
0.85 episodes/patient/week; Pramming 1991 – McLeod 1992

From the literature revue, the ID risk assessment is outside that which would be acceptable in terms of the “1 per cent rule”. But taking into account the flight groups are highly selected, well motivated and meticulous in managing their diabetes, some Contracting State certificate Class 1 ID professional pilots limited to multicrew operation, following selection criteria and monitoring procedures...
TWO COMPLETELY DIFFERENT APPROACHES

INDIVIDUAL RIGHT vs COMMON GOOD

PATIENT vs DISEASE
Periodic medical examination of type 2 diabetics involves:

- regular weight measurements;
- (excellent Body Mass Index less than 25);
- control of diet and hypoglycaemic drugs use \textbf{(insulin in occasional resistant cases is disqualifying)};
- control of blood glucose, lipids, urine test, blood pressure and any other risk factor (e.g. smoking);
- careful examination to exclude common complications of diabetes.
TYPE 2 Assessment

crew should undergo careful review of the following in addition to the periodic medical examination:

- regular ophthalmoscopy after pupillary dilation to check for retinopathy and lens or vitreous opacities;
- CNS examination for evidence of neuropathy;
- cardiological review with consideration of exercise electrocardiography;
- periodic blood tests including glycosylated haemoglobin (HbA1c <6.5%) or serum fructosamine, renal function, liver function and plasma proteins, fasting blood lipids;
- periodic urinary test for early renal damage detection.
TREATMENT AND CERTIFICATION

DIRECTLY OR INDIRECTLY INCREASE INSULIN SENSITIVITY

- Biguanides (Metformin)
  - Class 1 OML
  - Class 2 unrestricted

- Thiazolidinediones (Glitazones)
  - Pioglitazone – at present suspended by UE
  - Class 1 OML
  - Class 2 unrestricted

- Some proliferator-activated receptor: gamma/alfa agonists
  - Will probably have an important role in managing Type 2 diabetes within a few years like glitazones

- Alpha-glucosidase inhibitors

- Lipid lowering agents
TREATMENT AND CERTIFICATION

INCREASE CIRCULATING INSULIN

- **Phonylureas**
  - Not acceptable
  - Class 1
- Acceptable
  - Class 2 OSL

- **Nides (nate- or repaglinide)**
  - Not acceptable
  - Class 1
- Acceptable
  - Class 2 OSL

- **Octagon-like peptide-1 (GLP1) analogues/mimetics**
  - Not easily not acceptable due to parenteral administration
  - May require re-consideration in the future

- **Peptidase IV inhibitors (DPP4-I)**
  - Oral administration.
  - May require re-consideration in the future
Thank you for your attention!