Overview of evidence of a link between air pollution and diabetes

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Diabetes mellitus or „Honey-sweet urine“

- Honey-tasting urine, attracts ants when spilled on floor (India, 600 BCE)
- Unquenchable thirst, excessive drinking, incessant flow of urine (Aretaeus of Cappadocia, 1st century CE)
- Ultimate proof of glucose in urine: Francis Home (Scot, 18th century)
## Major types of Diabetes mellitus

<table>
<thead>
<tr>
<th>Type 1 (T1DM)</th>
<th>Type 2 (T2DM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Autoimmune reaction</td>
<td>• Insulin resistance of cells</td>
</tr>
<tr>
<td>• Destruction of beta-cells in pancreas</td>
<td>• <strong>Relative</strong> insulin deficiency, inadequate production of insulin</td>
</tr>
<tr>
<td>• <strong>Absolute</strong> insulin deficiency</td>
<td>• RF: high BMI and poor diet, inactivity, ethnicity, genetic susceptibility</td>
</tr>
<tr>
<td>• Without insulin quick death</td>
<td>• Therapy: lifestyle modification and mostly oral medication</td>
</tr>
<tr>
<td>• Therapy requires daily insulin</td>
<td>• Slow onset mostly in older adults, long predetection period</td>
</tr>
<tr>
<td>• RF: Genetic susceptibility plus environmental triggers (viral, toxic, ?)</td>
<td>• Frequent (90%) and rising (children and adolescents)</td>
</tr>
<tr>
<td>• Acute disease onset in childhood</td>
<td></td>
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<tr>
<td>• Infrequent, but rising</td>
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*RF: Risk Factors*
Major types of Diabetes mellitus

Gestational D.m. (GDM)

- Pathogenesis similar to T2DM
- Insulin resistance aggravated by hormones during pregnancy
- Risk factors similar to T2DM
- Often transient
- Risk for T2DM elevated in mothers and babies -> children/adolescents
Diabetes mellitus

Prevalence in adults

Rates of diabetes worldwide in 2000 (per 1,000 inhabitants) — world average was 2.8%.

WHO 2009, IDF Atlas 2017

415 million in 2015
>600 million in 2040
Appr. 30% -80% undiagnosed

WHO 2009, IDF Atlas 2017
6% to 15% of total health expenditures
Diabetes mellitus - prevention

- High prevalence
- Complications
- Financial burden

Paradigm shift from therapy to prevention

Focus on modifiable risk factors

Understanding of behavioural and environmental causes
DM

Modified after: Rajagopalan and Brook, Diabetes 2012
What can be done?

Randomized lifestyle intervention, 15 months in primary care setting

9-year follow-up of lifestyle intervention in low SES community

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Sedentary lifestyle

Obesity

Role of air pollution???

Modified after: Rajagopalan and Brook, Diabetes 2012
Role of air pollution in diabetic disease

**Etiologic factor**
- Incidence of T2DM or prediabetes
- Effects on glucose regulation in healthy individuals
- Effects in vulnerable populations (i.e. pregnant women and their babies, other subgroups)
- Incidence of T1DM

**Susceptibility factor**
- Stronger adverse effects of air pollution on diverse outcomes in diabetics

**Possible intermediate**
- Possible mediator of air pollution action on cardiovascular disease
## Early measures – prediabetes and IR

<table>
<thead>
<tr>
<th>Impaired glucose tolerance (IGT)</th>
<th>Impaired fasting glucose (IFG)</th>
<th>Insulin resistance (IR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Fasting glucose &lt;126 mg/dL and</td>
<td>• Fasting glucose elevated, but not diabetic (110-125 mg/dL) and</td>
<td>• (Glucose x insulin) elevated</td>
</tr>
<tr>
<td>• Glucose elevated (140-199 mg/dL at 2h oral glucose tolerance test (OGTT))</td>
<td>• OGTT normal</td>
<td></td>
</tr>
</tbody>
</table>

- High risk for T2DM,
- IGT and IFG already increased insulin resistance
- Risk factors same as for T2DM
Proposed biological effects– air pollution

Black box: to be lifted by Sanjay Rajagopalan

Epidemiological evidence for etiological role

• Incidence of diabetes:
  – Relatively few prospective studies with diverse exposures and findings
    -> presented by Robin Puett

• What other clues do we have?
  – Metabolism in potentially vulnerable groups, i.e. children exposed to air pollution at young age
    -> presented by Abby Fleisch