Air Pollution in Uganda

Why does a physician talk about that?

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Ischemic Heart disease

An (un)usual presentation of IHD
<table>
<thead>
<tr>
<th>Disease</th>
<th>Total</th>
<th>% of Cardiac Disease Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertensive H.D.</td>
<td>140</td>
<td>23</td>
</tr>
<tr>
<td>R.H.D.</td>
<td>104</td>
<td>17</td>
</tr>
<tr>
<td>E.M.F.</td>
<td>61</td>
<td>10</td>
</tr>
<tr>
<td>E.M.F. + R.H.D. Combined Features</td>
<td>16</td>
<td>3</td>
</tr>
<tr>
<td>Infective Endocarditis/Acute</td>
<td>74/31</td>
<td>12/5</td>
</tr>
<tr>
<td>Pericarditis (Non-Rheumatic)</td>
<td>64</td>
<td>10</td>
</tr>
<tr>
<td>Cor Pulmonale</td>
<td>57</td>
<td>9</td>
</tr>
<tr>
<td>&quot;Syphilitic&quot; H.D. with A.I.</td>
<td>40</td>
<td>7</td>
</tr>
<tr>
<td>Congenital H.D.</td>
<td>32</td>
<td>5</td>
</tr>
<tr>
<td>Idiopathic Cardiomegaly</td>
<td>32</td>
<td>5</td>
</tr>
<tr>
<td>Ischaemic H.D.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myocardial Infarction etc.</td>
<td>16</td>
<td>3</td>
</tr>
<tr>
<td>Other Cardiac Disease</td>
<td>49</td>
<td>8</td>
</tr>
</tbody>
</table>

**Number of Autopsies with Cardiac Disease**: 615

**Total Autopsies**: 3589

Cardiac Disease = 17%
How big is the problem of EMF

- Normal Heart
- Cor Pulm.
- Constrict.Peric
- Peric. Effus.
- MVP
- SBE
- Hypert.HD*
- Cardiomyop.
- Rheum.HD
- Congen. HD
- EMF

Freers J, Ziegler J, Majanja-Kizza H, Rutakingirwa M.
Echocardiographic Diagnosis of Heart Disease in Uganda. Tropical Doctor, July 1996, 26, 216/95. 1-4
## COPD / UHI Adult (2002)

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>COPD</th>
<th>UHI</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>755</td>
<td>764</td>
<td>1519</td>
<td>49.9</td>
</tr>
<tr>
<td>Dilated Cardiomyopathy</td>
<td>124</td>
<td>385</td>
<td>509</td>
<td>16.7</td>
</tr>
<tr>
<td>Ischaemic Heart Disease</td>
<td>8</td>
<td>46</td>
<td>54</td>
<td>1.8</td>
</tr>
<tr>
<td>Endomyocardial Fibrosis</td>
<td>106</td>
<td>62</td>
<td>168</td>
<td>5.5</td>
</tr>
<tr>
<td>Rheumatic Heart Disease</td>
<td>355</td>
<td>381</td>
<td>736</td>
<td>24.2</td>
</tr>
<tr>
<td>Others</td>
<td>16</td>
<td>43</td>
<td>59</td>
<td>1.9</td>
</tr>
<tr>
<td>Total</td>
<td>1364</td>
<td>1681</td>
<td>3045</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Adult cases only (Paediatric cases not included)
Statistics of the Cardiology Unit 4c, 2009
1230 in-patients, M:F = 35% : 65%
86 pt’s with IHD
Is this an emerging Epidemic? Where does it come from?

• Common quick answer is adaption of Ugandans to Western life style
  – Over eating
    • Salty food
    • Fatty food
      – Chips
      – Mayonaise etc.
  – Lack of exercise
  – Sedentary life style
Is that generally the case? A typical case study might illustrate.

On admission

- 45 year old house wife with 7 kids
  - Increasing PND over the last 2 weeks
  - Fatigue
  - Gen. Weakness
  - Nycturia 3x
  - No pain
  - Reduced appetite
  - Early satiety

All typical for CCF
On Examination

• Ausk. heart gallop rhythm
• BP 95/78    P=92
• Chest bilat. Basal crackles
• Mild ped. Edema
• Liver 3 fb enlarged painful on palpation

Also typical for CCF
Paraclinical investigations

- **CXR** = cardiac enlargement, congested lungs
- **Echo** = big akinetic area and dilated left ventrikel and atrium = *ischemic area*
- **ECG** = Q in V 1-3, slight ST elevation in 1, diffuse repolarisation disturbances
  - *Typical for a past myocardial infarction*
- **Lab**’s normal
Back to the history

• Any history of chest pain
  – a little bit of discomfort some 3 weeks ago

• Risk faktors
  – No Smoking
  – No Fatty diet
  – No sedentary life style
  – No positive family history for IHD
  – No diabetes, no hypertension
Häufige auslösende Ursachen der Angina pectoris:

Charakteristische Schmerz-
BUT …..

- Patient lives in house with an outside kitchen
- On a dirt road with heavy traffic due to building sites nearby
- Next to the house is a noisy welding and a car mechanical workshop
So risk factors seem to be various types of pollution

- Open fire smoke (kitchen)
- Road-traffic pollution
- Dust pollution
- Building pollution
- Industrial dust pollution
- Noise pollution
- Possibly there is waste burning
That's Kampala today
But we are not only talking of the dirt we see …..

• We are looking at Fine Particulate Air Pollution or *fine dusts or particulate matter (PM10)*

• These fine dusts are by-passing the filters of nose and the ciliary barriers of the bronchial mucosa. They **reach the aveoli**

• The very fine particles may pass through the aveoli direct into the vascular system

• Not fully researched are the nano-particles
About the particle sizes

• Dust particles of more than 15 mikro-meter diameter are filtered usually by nose and bronchial ciliary system

• Particles of less than 10 micro-meter are reaching the aveoli and take if not in excess month to be cleared

• Particles of less than 2.5 mikro-meter can reach the blood stream and cause through a complicated immunological process atheromatotic plaques
The background

• Already in 1995 the hypothesis was launched that inhalation of very fine dust from air pollution induces inflammatory reactions in the lungs with release of mediators which may influence blood coagulation.¹

IL-6 $\rightarrow$ Fibrinogen

- Two years later the pathogenic pathway was found:
  
- release of interleukin-6 (IL-6) from cells in the bronchial mucosa stimulate production of fibrinogen from hepatocytes.\(^2\)

Assoc. between Fibrinogen concentration and IHD is causal

• In 1998 it was concluded in a meta-analysis of more than 18 studies that an association between fibrinogen concentration and the occurrence of coronary heart diseases is causal.³

Increased Fibrinogen concentr. = increased blood viscosity

- As an increased blood concentration of fibrinogen increases the blood viscosity, this feature may be part of the pathogenic explanation as to why workers in several occupations with exposure to fine dust and other lung irritants have an increased risk of ischaemic heart diseases (IHDs).²,⁴

- Many papers for mine workers, indoor diesel machine operators welding factories etc.

- **Hilt B, Qvenild T, Rømyhr O. Morbidity from ischemic heart disease in workers at a stainless steel welding factory. Norsk Epidemiologi1999;9(suppl 1):21–6**
Air pollution in Europe

- Air pollution shortens average life expectancy in Europe by more than eight months and leads to the premature death of 370,000 Europeans annually.
- EU introduced binding directives on air quality in 1999.
- The requirements on air quality were stepwise increased (last increase on 1.1.10).
EU Regulations to protect human health

• Throughout the EU the concentration of PM$_{10}$ is not allowed to exceed 50 µg/m$^3$ in 24-hours on more than seven days in a year

• Cars have to have an annually renewable air controll certificate.

• With this they are allowed / not allowed into the cities

• Lorries are not at all allowed into the city (except for deliveries) older cars are not allowed in cities

• Governments / cities which do not enforce these regulations are fined. (EU legislation)
Simple Measurements of Pollutants

$O_3$ - Ozone

CO - Carbon Monoxide

$SO_2$ - Sulfur Dioxide // $H_2S$ - Hydrogen Sulfide

NO/NO$_2$/NO$_x$ - Nitrogen Oxides

PM10/PM2.5 - Particulate Matter
We must advocate for emission control not only of vehicles but also of the industry
WHO Recommendations are even more stringent for fine dusts

1. Average per year PM$_{10}$ 20 µg/m³
2. Average per year PM$_{2.5}$ 10 µg/m³
3. Average per day PM$_{10}$ 50 µg/m³ without allowing any day with more fine dust.
4. Average per day PM$_{2.5}$ 25 µg/m³ Average per year

This is even less than the EU allowance for fine dusts
In Uganda

• MoH is not having any regulations
• According to inquiries as of last week NEMA is not checking the air quality

• IT IS HIGH TIME THAT WE DOCTORS PROTECT OUR PATIENTS AND OURSELVES AND EDUCATE THE PUBLIC INCLUDING THE LEGISLATORS
Back to the topic IHD

• From the 60s to the mid 90s there was no to negligible IHD in Uganda
• The occurrence of IHD in the last decade has been attributed to the adoption of western life-styles
• Common experience on the cardiol. ward shows that this is actually the exception
• The lady presented did not have any of the known typical risk factors of the west
• Are we breeding a new epidemic of IHD ????
The second observation

- The lady in our case did not present with the pain that is described in our standard textbooks
  - Excruciating retrosternal chest pain
  - Feeling of impending doom
  - Radiating to the shoulder
  - Diaphoresis and many a times vomiting
- Often by chance old MI’s are found where the patient could not remember any of the typical symptoms except some vague chest discomfort
- A publication as of 5.10 mentioned isolated scattered cell death in the myocardium due to PM
Häufige auslösende Ursachen der Angina pectoris:

Charakteristische Schmerz-
Long Time Exposure to Fine-Dust

• There is evidence that long-term exposure to particulate air pollution contributes to
  – pulmonary and systemic oxidative stress
  – Pulmonary inflammation
  – progression of atherosclerosis
  – risk of ischemic heart disease and death.
Short-Time Exposure to Fine-Dust

- Short-term particulate exposures contributes to acute coronary events, especially among patients with established underlying coronary artery disease or patients with other risk factors.
- Individuals with stable presentation and those with angiographically demonstrated clean coronaries are not as susceptible to short-term particulate exposure.

Arden Pope, III, PhD; Joseph B. Muhlestein, MD; Heidi T. May, MSPH; Dale G. Renlund, MD; Jeffrey L. Anderson, MD; Benjamin D. Horne, PhD, MPH

From the Cardiovascular Department, LDS Hospital and Intermountain Medical Center (J.B.M., H.T.M., D.G.R., J.L.A., B.D.H.) and University of Utah (J.B.M., D.G.R., J.L.A.), Salt Lake City, and Brigham Young University (C.A.P.), Provo, Utah. 2006
SHORT TIME EXPOSURE TO PM10 FOR THE ELDERLY

- Data from a four-year study of 11.5 million Medicare enrollees
- Short-term exposure to fine particle air pollution from such sources as motor vehicle exhaust and power plant emissions significantly increases the risk for cardiovascular, cerebrovascular and respiratory disease among people over 65 years of age.

ScienceDaily (Mar. 9, 2006)
What Does This Mean for Physicians and Their Patients

• Additional risk factors for IHD and Stroke other than air pollution must be addressed vigorously:
  – BP control
  – Blood sugar control
  – Weight control
  – Control of blood lipids
  – Enough physical exercise ***

• Patient must be advised to avoid indoor and outdoor pollution
Air pollution and diabetes mellitus

- Prevalence of DM increases with high levels of PM 2.5
- Air quality data from EPA were compared with CDC data for DM
- Data were cleared of other risk factors
- Every increment of 10 microgram/m3 of PM 2.5 increases the risk of DM by 1%

- Pearson J, Brownstein J et al. 10.2010. Diabetes Care (Study funded by NIH)
Air Pollution and its effects on Children

• Children living in air polluted areas have lower IQ

• 1980 to 1995 asthma in Kids doubled, from 3.6% in 1980 to 7.5% and almost tripled to 9.4% in 2008

• 1975 to 2005 cancer in kids up from 129 to 172 cases per million (mostly leukemias)

• Mental retardation and the attention deficit hyperactivity disorder syndrome (ADHD) increased

• Birth defects on the increase

http://www.epa.gov/envirohealth/children/
Burning of Rubbish / Plastic
Emission of PM10 + Toxic Pollutants

• Among many other substances this releases
  – Lead
  – Cadmium
  – Benzene
  – Dioxin (PBT’s)
  – Furans
  – Polyaromatic hydrocarbons
  – Hydrochloric acid
  – Bisphenyl A
  – VOC’s
What do these compounds do
This Actually Needs Toxicologists / Epidemiologists

- Lead – kidney damage, brain retardation (esp. kids)
- Cadmium – Carcinogen, kidney damage
- Benzene – Carcinogen esp. leukemia
- Dioxin – enters the food chain and causes
  - reproductive impairment, developmental injuries, disturbance of the hormonal and immunological system
- Furans - Carcinogen (esp. liver and lungs)
- Aromatic hydrocarbons – Carcinogen
- Hydrochloric acid – Acid Rain
- Bisphenyl A – Endocrine Disruptor (estrogenic) **
- VOC’s – H/aches, rhinitis, bronchits, conjunctivitis
Burning of Tyres

• Synthetic rubber contains among others
  – Styrene, a benzene derivative
  – Butadiene
  – Extender oils (benzene based compounds)
  – heavy metals, including, but not limited to,
    • lead,
    • chromium,
    • cadmium,
    • mercury.
  – Tyre chlorine
  – Dioxins,
  – Furans,
  – Polyaromatic hydrocarbons
  – Polychlorinated bisphenyls
What to Do in Case of Severe Air Pollution -> run away

• Leave the area of pollution
• Limit exposure to smoke in- and outdoor
• Stay inside, close all windows, use air-con
• Avoid physical activities

• Dust mask or wet clothes do not help for long - mostly not at all
• Exposure to air pollutants is largely beyond the control of individuals and requires action by public authorities at the national, regional and even international levels.
What can we do on an individual basis to keep the air clean

- Regular car engine tuning / servicing
- Regular replacement of oil/fuel filters
- Switch off the engine in case of traffic jam
- Get exhaust filters
- Plan / restrict your errands
- Organize transportation to work (car pool)
- Use inverter instead of a generator
What can we do on an individual basis to keep the air clean

• Reduce / avoid wood stove use
• Don’t burn garden waste (leaves etc)
• **By no means burn rubbish / plastic**

For KCC

• Tarmac all roads
• Fill all potholes
• Create an efficient and acceptable public transport
What must be done as a matter of Policy

- Measurement of air quality (NEMA)
- Information about air quality (NEMA)
- Observation of weather conditions (Inversion w.)
- Restriction of traffic in case of air pollution
- Car exhaust emission controls (road worthiness)
- For cars no licence without an exhaust filter
- Industry exhaust controls (removal of licence)
- Strict ban on all burning (fines for contravention)
  - Police, fire-brigade
Some ideas to improve air quality

• Public transport
  – Buses
  – City railway (Mukono – Mpigi, Port Bell – Mpigi via K’la central)

• Plastic recycling industry
  – with tax holiday Attracting investors for the first years

• Companies to take back plastic bottles and other packaging
  – Deposit to be refunded upon return of e.g. plastic bottles

• Rubber recycling (building, road construction)

• Small scale industry for diesel-filters
  – with tax holiday Attracting investors for the first years
First Step

• My own impression is if **WASTE BURNING** is made a **PUNISHABLE OFFENCE** PM10 and various toxics would be reduced by some 30%
In Summary

• Air Pollution is a serious attack on public health
• Air polluters are criminals (so far unknowingly)
• Education on the importance of clean air is urgently needed
  – For decision makers and for the general public
  – Through the media
  – In Schools, Universities
• Legislation on air quality is needed

• CLEAN AIR IS A HUMAN RIGHT
• AIR QUALITY MUST BE PROTECTED
Thank you for your attention

I hope I have scared you stiff