The Childhood Asthma Epidemic
Observations from Galway, and a Hypothesis

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Childhood Asthma

- Asthma: Reversible Airways Obstruction
- 10-20% Children
- Common reason for Hospital Admission

- Western “Epidemic” 1960→
- Halving of admissions from Mid 1990
- A therapeutic success story.
- Or maybe an environmental one?
Content

- Prevalence studies
- Admission trend study
- Comparative Admission studies - 3 separate years
- Environmental study

- 45 minutes  (45 Slides!)
## Acknowledgements

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## Parents & Children

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- Ailise Loftus
- Gloria Avalos
- Iggy O Muircheartaigh
- John Newell
- Gerry Jennings
- Carl Scarrot
Main causes of bronchial narrowing in asthma

1. Smooth muscle spasm
2. Oedema, hyperaemia and infiltration
3. Luminal plugging
## Prevalence Studies in Galway City 9-10 year olds

<table>
<thead>
<tr>
<th>Category</th>
<th>1992</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Questionnaires</td>
<td>24.5%</td>
<td>27.6%</td>
</tr>
<tr>
<td>Wheeze ever</td>
<td>16.1</td>
<td>16.5</td>
</tr>
<tr>
<td>Current wheeze</td>
<td>16.1</td>
<td>18.5</td>
</tr>
<tr>
<td>Current Asthma</td>
<td>10.8</td>
<td>15.3</td>
</tr>
<tr>
<td>Exercise induced asthma</td>
<td>10.6</td>
<td>22*</td>
</tr>
<tr>
<td>Nocturnal cough</td>
<td>8</td>
<td>10.2</td>
</tr>
<tr>
<td>Allergen induced asthma</td>
<td>11.8</td>
<td>18.2*</td>
</tr>
<tr>
<td>Asthma medication</td>
<td>10.6</td>
<td>20.4*</td>
</tr>
</tbody>
</table>
### Diagnostic and treatment patterns

<table>
<thead>
<tr>
<th></th>
<th>1992</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number with Asthma</td>
<td>134</td>
<td>121</td>
</tr>
<tr>
<td>Doctor diagnosed</td>
<td>67%</td>
<td>84%</td>
</tr>
<tr>
<td>Bronchodilator</td>
<td>74%</td>
<td>76%</td>
</tr>
<tr>
<td>Prophylaxis</td>
<td>28%</td>
<td>48%*</td>
</tr>
<tr>
<td>&gt;10 episodes per annum</td>
<td>12%</td>
<td>6%*</td>
</tr>
<tr>
<td>4-10 episodes per annum</td>
<td>30%</td>
<td>14%*</td>
</tr>
<tr>
<td>&lt;4 episodes per annum</td>
<td>58%</td>
<td>80%*</td>
</tr>
</tbody>
</table>
Conclusions 1

• Prevalence of “current wheeze” unchanged
• Small increase in “clinical” Asthma
• Increase in diagnosis.
• Increase in use of prophylaxis.
• Decline in severity, measured by attack frequency
Admission studies

- H.I.P.E./ Ward register
- Acute Asthma age 1-4, 5-14 1990-2004
- Admissions with asthma, prospective study 2003/4 over 12 months.
- Compared with similar studies 1990, 1997
Table 1: Admission rates per thousand in preschool, and school age children at 5 year intervals

<table>
<thead>
<tr>
<th></th>
<th>1-4 years</th>
<th>5-14 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>3.2</td>
<td>1.4</td>
</tr>
<tr>
<td>1990</td>
<td>5.5</td>
<td>3.1</td>
</tr>
<tr>
<td>1995</td>
<td>10.8</td>
<td>4.1</td>
</tr>
<tr>
<td>2000</td>
<td>5.9</td>
<td>1.9</td>
</tr>
<tr>
<td>2004</td>
<td>5.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>
Conclusions 2

- Admission Rates increased to 1995, now falling.
- School age > Pre-School
- Similar pattern Europe, N America
<table>
<thead>
<tr>
<th></th>
<th>1990</th>
<th>1997</th>
<th>2003/04</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of admissions</strong></td>
<td>110</td>
<td>218</td>
<td>128</td>
</tr>
<tr>
<td>Admissions under 5 Yrs. Old</td>
<td>51%</td>
<td>45%</td>
<td>69%</td>
</tr>
<tr>
<td>Male patients</td>
<td>62%</td>
<td>61%</td>
<td>63%</td>
</tr>
<tr>
<td>Repeat admissions</td>
<td>10%</td>
<td>8%</td>
<td>14%</td>
</tr>
<tr>
<td><strong>Regular Asthma Medications</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Treatment</td>
<td>33%</td>
<td>29%</td>
<td>42%</td>
</tr>
<tr>
<td>Bronchodilators Alone</td>
<td>37%</td>
<td>35%</td>
<td>11%</td>
</tr>
<tr>
<td>Cromoglycate</td>
<td>8%</td>
<td>9%</td>
<td>0%</td>
</tr>
<tr>
<td>Inhaled Steroids</td>
<td>22%</td>
<td>29%</td>
<td>45%</td>
</tr>
<tr>
<td><strong>GP Referrals</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>29%</td>
<td>23%</td>
<td>22%</td>
</tr>
<tr>
<td>Nebulised Bronchodilator</td>
<td>30%</td>
<td>38%</td>
<td>73%</td>
</tr>
<tr>
<td>Steroids</td>
<td>26%</td>
<td>23%</td>
<td>35%</td>
</tr>
<tr>
<td>Antibiotics</td>
<td>31%</td>
<td>14%</td>
<td>23%</td>
</tr>
<tr>
<td>Length of Stay</td>
<td>1990</td>
<td>1997</td>
<td>2003/4</td>
</tr>
<tr>
<td>---------------</td>
<td>------</td>
<td>------</td>
<td>--------</td>
</tr>
<tr>
<td>&lt;24 Hrs.</td>
<td>38%</td>
<td>65%</td>
<td>74% *</td>
</tr>
<tr>
<td>24-48 Hrs.</td>
<td>46%</td>
<td>23%</td>
<td>15%</td>
</tr>
<tr>
<td>&gt;48 Hrs.</td>
<td>15%</td>
<td>11%</td>
<td>11%</td>
</tr>
</tbody>
</table>

**In Patient Management**

<table>
<thead>
<tr>
<th></th>
<th>1990</th>
<th>1997</th>
<th>2003/4</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Treatment</td>
<td>0%</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>Bronchodilators</td>
<td>84%</td>
<td>96%</td>
<td>99% *</td>
</tr>
<tr>
<td>Steroids</td>
<td>91%</td>
<td>94%</td>
<td>95%</td>
</tr>
<tr>
<td>Intravenous Medication</td>
<td>10%</td>
<td>13%</td>
<td>10%</td>
</tr>
<tr>
<td>(aminophylline, steroids)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous Oxygen (&gt;3 hrs.)</td>
<td>17%</td>
<td>12%</td>
<td>36% *</td>
</tr>
<tr>
<td>Intensive Care</td>
<td>2%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>SEVERITY on admission</td>
<td>1990</td>
<td>2003/4</td>
<td></td>
</tr>
<tr>
<td>-----------------------</td>
<td>------</td>
<td>--------</td>
<td></td>
</tr>
<tr>
<td>Mild</td>
<td>73%</td>
<td>27%</td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>18%</td>
<td>59%</td>
<td></td>
</tr>
<tr>
<td>Severe</td>
<td>9%</td>
<td>14%</td>
<td></td>
</tr>
<tr>
<td>Heart rate &gt;100</td>
<td>69%</td>
<td>89%</td>
<td></td>
</tr>
<tr>
<td>Resp rate &gt;30</td>
<td>77%</td>
<td>77%</td>
<td></td>
</tr>
<tr>
<td>SaO2 &lt;92%</td>
<td>-</td>
<td>33%</td>
<td></td>
</tr>
</tbody>
</table>

Mixed message: Subjective assessment, HR (pre-hospital b agon), Length of stay (vigorous treatment)
Conclusions 3

• Severity unchanged?
• Management more aggressive in acute phase, and more on prophylaxis in primary care
• Cromoglycate …… no longer used.
• Hospital treatment more intensive
Are we making a difference?

- More preventive therapy
- Diminished severity
- Less admissions
- A causal relationship???
Was it good?
Fantastic! The earth moved!
Was it good?
Amazing! The earth moved!
Was it good?
Wonderful! The earth moved.
Was it good?
Terrific! The earth moved!

我是？
美國人！
Was it good?

Fantastic! The earth moved!

Was it good?

Amazing! The earth moved!

Was it good?

Wonderful! The earth moved.

Was it good?

Terrific! The earth moved!

SAN FRANCISCO, 1906
What is going on?

- Reduction in acute asthma a world-wide trend
- Prevalence falling
- Drugs may be contributing

- BUT … acute respiratory illness reduced at all ages.
- Fall in asthma maximal in pre-school group.(DDW!)
- Why did it increase 1960-1995?
GALWAY
Observations/ Hypothesis

- Mace Head observations
- Atlanta-Olympics, Utah –Steel Mill natural experiments
- Declining asthma and respiratory illness generally
- Alveolar macrophage carbon deposition, air pollution, lung function relationship USA, UK, EU.
- Changes to Diesel emission & sulphur standards 1993, 98

- Could it be cleaner vehicular emissions?
Measurement of Pollution is Crude

- Particle size, Weight
- PM 2.5, 5,10 : weight of particles below diameter of 2.5,5,10 microns expressed as mcgr/M3.
- Content, Reactivity, pH, particle numbers, surface area.
- Sea salt, soil & sand particles, coal, diesel……

- Paracetamol = Ciprofloxacin or…
- Connemara Pony = Siberian Tiger
Black Smoke

- 24 hour measurement
- Filter, holding chamber, paper deposition.
- Particles mainly <2 Microns diameter.

- Largely Abandoned after 1990s, but now recognised as good indicator of Diesel particles - very small, very black.
- Galway City recordings 1985-2005
Black Smoke- Carbon

- Incomplete combustion of Biomass, Fossil fuels
- Diesel >> Petrol > Coal.
- Spheres, aggregates—many particles < 2 microns
- Polyaromatic hydrocarbons, Free radicals++
- Acute airway narrowing effects – may be sub-acute.
- Chronic effects on lung function growth in children
Galways Opportunity!

- No heavy industry
- Dominant source of Air pollution is vehicle emission + domestic fuel.
- City population → exclusive paediatric service provision
- Age specific Asthma Admission data
- Daily Black smoke Measurements for >25 years
Setting & Aim

• Single Paediatric unit serving a well defined child population in the West of Ireland.
• Clean Air
• Black Smoke and Climatic Data for the City Area 1985-2005.
• Explore the possible influence of black smoke air pollution, and climatic variables on acute asthma over the 21 years 1985-2005.
Methods

- Monthly Admission Rates of children resident in City with acute asthma aged 1-4, 5-14, 1-14 yrs calculated 1985-2005.
- Population Census data
- Monthly climatic data- temp, rainfall, wind-speed, sunshine, humidity.
- Monthly black smoke levels.
- Correlations, SLR
- Generalised Additive Models (GAM) ***
Results

• There was convincing evidence of a positive association between asthma admissions and black smoke levels for the 1-4 year olds (p<0.0004) and the 5 to 14 year olds separately (p<0.0004).

• The residual smooth time trend (after allowing for effects of climate and air pollution,) in the admission rates was significant for both pre-schoolers (p=0.04) and school age children (p<0.001) indicating factor(s) other than Air pollution.
Change from 1985 Baseline; Climate and Smoke

Annual city data - smoke & climatic variables

Year

Level of variable (1985=1, subsequent years as a fraction of this)


- smoke
- temp
- rainfall
- windspeed
- sunshine
- humidity
Annual Admission rates 1-14 and Smoke levels

[Graph showing annual admission rates and smoke levels from 1985 to 2005.]
Annual Admission Rates 1-4 year olds and Smoke levels
Annual admission rates 5-14 and smoke levels

[Graph showing the correlation between annual admission rates for 5-14 years and smoke levels over the years 1985 to 2005.]
Correlations

• **Group**
  
  • 1-4
  • 5-14
  • 1-14
  
  • $R=0.43$
  • $R=0.73$
  • $R=0.55$
Admissions 1-14 when effects attributable to pollution excluded: Overall little change, small peak 1995
Admissions 1-4 when effects of pollution excluded: Residual rise 2005 V 1985 not attributable to pollution.
Admission rates 5-14 when effects of pollution excluded: Fall from peak greater than that attributable to smoke
Conclusions 1

• Black smoke levels increased to 1995.
  – Vehicle numbers 44,000 → 60,000
  – Percentage Diesel increased 18→28%
  – No change in coal sales

• Black smoke levels fell from 1995.
  – Vehicles increased to 108,000; 35% Diesel    BUT
  – Improved coal quality, “early” switch to non bituminous.
  – Bituminous coal ban in 2000

• Asthma admission rates mirror trend.
Conclusions 2: Age specific Confounding Factors

- Increase in referral to hospital of pre school children post 1998 (Westdoc et al)


- Most of the changes in acute childhood asthma may be attributable to air quality
How does it work?

- Reactive factors in Vehicle exhaust enter paediatric airway
- Transport in cars increases exposure!
- Acute effect (back to school?)
- Chronic effect (Lag- Macrophage mediated?)
- Pre-schoolers more vulnerable (Smaller airway calibre)
- Tighter emission standards $\rightarrow$ clean up
Evolution of Fact.

- “Absolute nonsense, statistical garbage”

- “Well, in certain well circumscribed instances, may have some merit.”

- “We’ve all been saying this for years!”
Conclusions 3

- Asthma prevalence and severity reduced
- Improved diagnosis, and treatment
- Plausible environmental contribution

- We may have halted the Childhood asthma epidemic unknowingly!