ASSESSMENT OF HEALTH EFFECTS OF LONG-TERM EXPOSURE TO LOW LEVELS OF CHLORINE

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Introduction
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• TiO2 industry involves production of Cl2, TiCl4, and pyrolysis products

• Workers may suffer from upper airway diseases and acute or chronic bronchitis

• Workers rapidly lose their ability to detect Cl2 odor in low concentrations
INTRODUCTION

• Some studies have indicated no significant connection between adverse health effects and chronic exposure to low Cl2 concentrations.

• Others have shown affection of the respiratory system.
Aim of the Study
Evaluation of the health effects of long-term exposure to low levels of chlorine
Subjects and Methods
SUBJECTS AND METHODS

DESIGN
A cross-sectional research design

SETTING
CRI STAL and Arabian Chlorine Company (ACC) firms, producing titanium dioxide and chlorine
SUBJECTS AND METHODS

SUBJECTS

- Workers at the two companies at the time of the study
- Minimum of 1 year in current job
SAMPLE

- Estimated sample size: 144
- After adjustment for a dropout rate of 10%, sample size increased to 168
DATA COLLECTION TOOLS

• Interview questionnaire:
  - Socio-demographic data sheet
  - Occupational history/work exposures
  - Assessment of various health hazards

• Investigations:
  - Pulmonary function tests: ATS
  - Urine analysis
DATA COLLECTION TOOLS

• **Assessment of exposure:**
  - Job title
  - Industrial hygiene records
  - Duration of work
  - Exposure index
Sample characteristics (n=168)

<table>
<thead>
<tr>
<th>Age (years): Mean±SD</th>
<th>41.0±9.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education:</td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>8.3</td>
</tr>
<tr>
<td>Intermediate</td>
<td>48.2</td>
</tr>
<tr>
<td>High</td>
<td>43.5</td>
</tr>
<tr>
<td>Job category:</td>
<td></td>
</tr>
<tr>
<td>Clerical</td>
<td>14.9</td>
</tr>
<tr>
<td>Manager/supervisor</td>
<td>11.3</td>
</tr>
<tr>
<td>Foreman</td>
<td>7.7</td>
</tr>
<tr>
<td>Operator/technician</td>
<td>66.1</td>
</tr>
<tr>
<td>Duration of work (years): Mean±SD</td>
<td>7.2±3.8</td>
</tr>
</tbody>
</table>
Smoking (n=168)

- Current: 33.3%
- Ex-smoker: 15.5%
- Non-smoker: 51.2%
Sample exposures (n=168)

<table>
<thead>
<tr>
<th>Substance</th>
<th>% exposed</th>
<th>Exposure Index*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cl2</td>
<td>74.4</td>
<td>8.1±6.6</td>
</tr>
<tr>
<td>Ti dioxide</td>
<td>26.2</td>
<td>13.7±12.2</td>
</tr>
<tr>
<td>Ti tetrachloride</td>
<td>29.2</td>
<td>9.2±5.8</td>
</tr>
</tbody>
</table>

(*) intensity x duration
## Symptoms possibly related to exposures (n=168)

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Recurrent</th>
<th>Increased At work</th>
<th>Decreased On leave</th>
<th>Needed Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irritant cough</td>
<td>10.7</td>
<td>3.0</td>
<td>3.0</td>
<td>8.3</td>
</tr>
<tr>
<td>Dyspnea</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Expectoration</td>
<td>2.4</td>
<td>0.0</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Wheezing</td>
<td>1.8</td>
<td>0.0</td>
<td>0.0</td>
<td>1.8</td>
</tr>
<tr>
<td>Mouth irritation</td>
<td>6.0</td>
<td>1.2</td>
<td>1.8</td>
<td>1.8</td>
</tr>
<tr>
<td>Eye irritation</td>
<td>3.6</td>
<td>1.8</td>
<td>2.4</td>
<td>2.4</td>
</tr>
<tr>
<td>Skin allergies</td>
<td>6.0</td>
<td>1.8</td>
<td>3.0</td>
<td>3.6</td>
</tr>
</tbody>
</table>
Total having symptoms (n=168)

- Free: 65.5%
- Symptoms: 34.5%
Dental problems among workers (n=168)

- Caries: 48.8%
- Mottled: 45.8%
- Broken: 19.6%
- Discoloration: 7.1%
- Denture: 14.9%
## Comparison of exposed and unexposed workers

<table>
<thead>
<tr>
<th></th>
<th>Exposed (n=149)</th>
<th>Unexposed (n=19)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Having any illness</td>
<td>10.7</td>
<td>21.1</td>
</tr>
<tr>
<td>Having any symptoms</td>
<td>35.6</td>
<td>26.3</td>
</tr>
<tr>
<td>Having teeth problems</td>
<td>75.8</td>
<td>84.2</td>
</tr>
<tr>
<td>Having urine abnormality</td>
<td>59.8</td>
<td>89.5*</td>
</tr>
<tr>
<td>Normal FEV1/ FVC (%)</td>
<td>97.2</td>
<td>94.7</td>
</tr>
</tbody>
</table>

(* p<0.05)
Best fitting multiple stepwise regression model for FEV1/ FVC ratio

<table>
<thead>
<tr>
<th></th>
<th>Beta coefficient</th>
<th>Standard error</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>92.79</td>
<td>1.02</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Cl(_2) exposure index</td>
<td>-0.80</td>
<td>0.28</td>
<td>0.037</td>
</tr>
<tr>
<td>TiO(_2) exposure index</td>
<td>0.79</td>
<td>0.29</td>
<td>0.041</td>
</tr>
</tbody>
</table>

Exposure index: intensity x duration

r-square=0.62
Follow-up of PFTs among exposed workers

- FVC (% pred.)
- FEV1 (% pred.)
- FEV1/FVC (%)
CONCLUSION
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- Chronic exposure to low dose chlorine is associated with slight lowering of FEV1/ FVC ratio

- Exposure to titanium dioxide is not associated with negative changes in PFTs

- The high prevalence of dental problems needs further investigation
RECOMMENDATIONS
RECOMMENDATIONS

Exposure to chlorine should be closely monitored to ensure compliance with permissible levels.

Regular periodic assessment of pulmonary functions.

Further study for the possible association of exposure to chlorine and dental problems.
LIMITATIONS

Cross-sectional design

Assessment of exposure

Healthy Worker Effect
Thank You
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