EFFECT OF AMMONIA, UREA AND DIAMMONIUM PHOSPHATE (DAP) ON LUNG FUNCTIONS IN FERTILIZER PLANT WORKERS

M. RAMESH BHAT* AND C. RAMASWAMY

Department of Physiology,
Kasturba Medical College,
Mangalore - 575 001 (D.K)

(Received on September 26, 1992)

Abstract: A spirometric study (FVC, FEV₁, & PEF/Min) was carried out in workers exposed to fertilizer chemicals (91) as a whole, out of which 31 were Ammonia, 30 Urea and 30 DAP plant workers, and 68 were controls belonging to the same age, sex, body surface area and socio-economic status.

This study showed a significant reduction in both PEF/Min and FEV₁, the reduction being more in PEF/Min., seems to indicate obstructive type of lung changes affecting the larger air-ways first, followed by bronchospasm. But FVC showed a significant reduction only after more than 10 years of exposure, probably causing restrictive changes only after prolonged exposure.

Out of the 3 chemicals, DAP affected all the 3 parameters most, followed by Ammonia and Urea affected the least.

Key words: lung function tests ammonia urea FVC FEV₁ PEF/Min DAP fertilizer workers

INTRODUCTION

Pneumoconiosis is virtually always related to the occupation of the afflicted person. They are preventable if detected early. The major challenge that faces today’s Physician is the detection of dust-induced physiological impairment early in the course of the disease (1).

Lung function study is considered as one of the earliest tools in the detection of Pneumoconiosis-induced diseases. Reduction in ventilatory functions is reported in cotton mill workers (2,3), coal miners (4) and grain elevators. (5). A significant drop in FVC and FEV₁ was exhibited in workers exposed to grain and flour dust (6). Even the inhalation of volatile gases like SO₂ can cause pathological changes, including laryngotracheal and pulmonary oedema, eventually death (7,8) in excessive concentrations. Whereas long-term effects (4 years) show obstructive type of changes in spirometric findings (9). Various agents such as Ozone, SO₂ and Tobacco smoke seem to cause hyper-reactivity (10), increase in permeability of pulmonary mucosa (11) and damage to the pulmonary epithelium after exposure (12), which affect lung functions.

The present study has been carried out in workers exposed to irritants like Ammonia, Urea and Diammonium Phosphate (DAP) in Fertilizer plants to find out whether there is any change in lung function tests prior to the onset of diseases.

METHODS

This study was carried out at the Mangalore Fertilizer Chemical Plant, Mangalore. The Selected Fertilizer workers were exposed to various chemical irritants, who apparently were in good health. Accordingly, 91 workers underwent lung function tests, out of which 31 were working in the Ammonia plant,
30 in the urea plant and 30 in the Diammonium phosphate plant. In each of these subjects their age, sex, height, weight and duration of exposure to chemical irritants were recorded. A group of 68 people having comparable body surface area chosen from the same socio-economic status and sex served as controls. The smokers were excluded to avoid the effect of smoking on lung function.

The lung function study was carried out using Morgans Spirocheck portable spirometer. The parameters studied were FVC, FEV₁ and PEFR/Min. All the tests were performed in the standing posture. Each subject was asked to exhale into the spirometer as forcibly as possible after maximum inspiration. Each test was repeated 3 times and the highest reading was taken for calculation. Statistical significance was calculated by using paired ‘t’ test.

RESULTS

The parameters studied FVC, FEV₁ and PEFR/Min were compared between controls and fertilizer chemical workers as a whole and also between controls and urea, ammonia and DAP plant workers individually. The subjects were regrouped according to their duration of exposure into 2 groups: (1) upto 10 years of exposure (51) and (2) more than 10 years of exposure (40) and compared with controls.

<table>
<thead>
<tr>
<th>Parameters used in litres</th>
<th>Controls (n=68)</th>
<th>Fertilizer chemicals (n=91)</th>
<th>DAP plant (n=30)</th>
<th>Urea plant (n=30)</th>
<th>Ammonia plant (n=31)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FVC</td>
<td>3.43±0.21</td>
<td>3.00±0.06*</td>
<td>2.51±0.06**</td>
<td>3.28±0.11</td>
<td>3.19±0.07</td>
</tr>
<tr>
<td>FEV₁</td>
<td>2.84±0.10</td>
<td>2.43±0.06***</td>
<td>2.08±0.08***</td>
<td>2.68±0.10</td>
<td>2.52±0.1*</td>
</tr>
<tr>
<td>PEFR/Min</td>
<td>383.3±7.6</td>
<td>282±11.6***</td>
<td>227.6±18.2***</td>
<td>306.9±18.8***</td>
<td>314±19.9***</td>
</tr>
</tbody>
</table>

*P<0.05; **P<0.01; ***P<0.001

Fig. 1 shows comparison of FVC, FEV₁ and PEFR/Min between controls and workers of fertilizer plant as a whole, urea ammonia and DAP plant workers individually.

The urea plant workers when compared with controls showed significant reduction (P<0.001) only in PEFR/Min. Their FVC and FEV₁ did not show any significant change.
The ammonia plant workers when compared with controls did not show any significant fall in FVC, but their FEV1 (P<0.05) and PEFR/min (P<0.001) showed a significant fall.

On the other hand, the DAP workers showed significant reduction in their FVC (P<0.01), FEV1, and PEFR/min (P<0.001) when compared to controls.

**TABLE II :** Comparison of lung functions in fertilizer chemical workers with controls according to the duration of exposure

(Data are mean±SE)

<table>
<thead>
<tr>
<th>Parameters used</th>
<th>Controls (in litres) (n=68)</th>
<th>Duration of exposure to chemicals (n=51)</th>
<th>(P&lt;0.05)</th>
<th>(P&lt;0.01)</th>
<th>(P&lt;0.001)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Upto 10 Years</td>
<td>More than 10 years</td>
<td>FVC</td>
<td>FEV1</td>
</tr>
<tr>
<td>FVC</td>
<td>3.43±0.21</td>
<td>2.98±0.07</td>
<td>2.76±0.09*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FEV1</td>
<td>2.84±0.10</td>
<td>2.55±0.08*</td>
<td>2.29±0.07***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PEFR/Min</td>
<td>383.3±7.6</td>
<td>298±17.4***</td>
<td>265±14.3***</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*P<0.05, **P<0.01, ***P<0.001.

PEFR/min was very much decreased (P<0.001) in upto 10 years of exposure group, which reduced further in more than 10 years of exposure group.

**DISCUSSION**

Among the lung function tests, the exposure to fertilizer chemicals affect firstly and mostly PEFR/min. The PEFR/min was highly reduced even in upto 10 years of exposure group. Further the PEFR/min was significantly reduced in workers exposed to all the types of chemicals, urea, ammonia and DAP. This shows that all the fertilizer chemicals affect larger airways immediately. It has been shown that exposure to cotton dust effects larger airways which was evident from their reduced PEFR/min (3). It was further proved by the pathological study of Byssinosis in which they had detected abnormalities in larger airways with low PEFR/min (13). So the reduction in PEFR/min in this study may indicate that fertilizer chemicals may primarily cause abnormalities in larger airways first.

The FEV1 though reduced by the fertilizer chemicals upto 10 years of exposure (P<0.05), the
decrease in FEV₁ when compared to PEFR/min (P<0.001) was less. Among the chemicals the DAP decreased FEV₁ (P<0.001) much more than Ammonia (P<0.05) whereas the urea did not affect the FEV₁. Fertilizer chemicals further decreased FEV₁ (P<0.001) only after more than 10 years of exposure. This shows that Ammonia and DAP being more volatile can enter the smaller bronchioles and cause hypersensitive reaction (10,11,12) leading to bronchospasm. Further it was shown that these changes occur slowly and continuously and that is why FEV₁ was affected slowly and then further deteriorated after more than 10 years of exposure.

Whereas FVC was not affected significantly in the fertilizer worker until exposed for more than 10 years (P<0.05), only DAP reduced FVC significantly (P<0.01), showing that restrictive changes are caused by DAP.

In conclusion, it is evident that fertilizer chemicals affect the pulmonary larger airway function first, followed by bronchospasm thus predominantly causing obstructive type of lung disorders. They also affect the pulmonary alveoli only after longer exposure to cause restrictive type of lung disorders.

Among the three fertilizer chemicals, DAP affects all the 3 parameters of lung functions causing both obstructive and restrictive changes in the lungs, followed by ammonia and urea affects them the least.

ACKNOWLEDGEMENTS

The authors thank Miss Geetha Pai for the nice secretarial assistance given.

REFERENCES