Chronic Cor Pulmonale in Delhi
A Study of 127 Cases


The incidence of chronic cor pulmonale in Indian states, including Delhi, is the highest reported in nonindustrial populations. The patients presented as acute severe congestive heart failure and at younger ages than those reported. In many cases there was only a short history of respiratory symptoms. Following the first attack of failure, repeated attacks were the rule and death ensued within 2 years. A study is presented of 127 patients of this type in Delhi with clinical and laboratory data and autopsy data of 4 cases. The probable causes of these peculiar features are discussed.

The high incidence of chronic cor pulmonale in Delhi prompted this study with a view to elucidating its etiology. Although statistics regarding heart disease from the various states of India are meager, the few available indicate that the incidence of this condition in Delhi is one of the highest. In statistics of routine hospital admissions Jaipur is the only state from which a high incidence of pneumoconiosis has been reported. A comparison for different parts of India of the incidence of cor pulmonale shown as percentage of all cardiac cases suggests that it is much more prevalent in the northern part of India than in the west (table 1).

By contrast, figures from most western countries are low except when they are from industrial areas (table 2). While the incidence as reported from hospital statistics is nowhere near the figures from India, those from industrial areas show an incidence as high as or higher than those for Indian states. Thus Gooding, in reporting on 227 postmortem examinations on miners certified as having pneumoconiosis, found no less than 37 per cent dying of cardiac failure. Flint in a recent study of 300 cases of congestive heart failure at Sheffield in iron and steel workers, reported an incidence of cor pulmonale of 40 per cent among men and 8.5 per cent among women with a total incidence of 25 per cent among all types of heart disease. Other workers reported a high incidence among coal miners. There is perhaps an underestimate of the true incidence of cor pulmonale, owing probably to the masking of the cardiac signs by the physical signs of the underlying lung disease. Thus White and Brenner, and Parkinson and Hoyle found a low incidence of cardiac failure from emphysema, bronchial asthma, and pulmonary tuberculosis. Michael, however, was of the opinion that chronic cor pulmonale was much more common than statistical evidence would indicate. This study from Delhi is of interest because of the high incidence in a nonindustrial population.

In Delhi, out of 132,794 cases admitted to the 2 large hospitals (Lady Hardinge and Irwin Hospitals), cor pulmonale accounted for 392 cases between 1950 and 1955 (0.3 per cent). Out of 2,360 cardiac cases admitted to these hospitals in the same period cor pulmonale accounted for 392 cases, giving an incidence of 16.6 per cent. The proportion of males to females was 211:181 (1.2:1.0).

The present detailed study relates only to patients from the Lady Hardinge Hospital, about whom it was possible to get definite data and adequate records. There were 123 women and 4 men in this series. In the Medical Unit of the Lady Hardinge Hospital, of 7,113 patients admitted during the 5-year period (1953 to 1957), there were 122 cases.
of cor pulmonale, accounting for 1.7 per cent of all medical admissions. Out of 706 cardiac cases admitted during the same period, cor pulmonale accounted for 17.3 per cent of cases. By contrast, in a 5-year survey (1951 to 1955), rheumatic heart disease accounted for 39.1 per cent and degenerative heart disease for 11.3 per cent.²

A large number of these cases of cor pulmonale was not seen in the out-patient department, as on their very first attendance the patients were ill enough to be admitted directly into the wards, without going through the cardiac clinic. Of 1,069 cases registered from 1952 to 1957 there were only 51 cases of cor pulmonale (4.8 per cent), according to the out-patient cardiac clinic records—an erroneously low figure.

In an industrial survey of 500 workers in a local cloth mill, there was not a single case of cor pulmonale, although one would expect it in an industrial concern where dusty occupations were involved. By contrast, in a rural survey carried out in the village of Najafgarh, near Delhi, out of 729 cases examined there were 10 cases of cor pulmonale (1.3 per cent).

Etiologic Factors

Age. The maximum incidence of the disease was between 30 and 59 years (table 3), the highest incidence being in the fifth decade. The youngest patient was 6 years old, a case of primary pulmonary hypertension and the second youngest one of pectus excavatum.

Pulmonary Conditions. Chronic bronchitis was the underlying cause in the largest number of patients. Pulmonary tuberculosis formed a low figure despite its high incidence in Delhi (table 4).

Residence. Of 119 patients whose addresses and permanent place of residence could be definitely verified, 68 belonged to rural and semirural areas, and 51 to the city of Delhi. By semirural areas are meant workmen’s colonies and huts situated on the outskirts of Delhi city, which might be considered slums. Rural and semirural cases therefore accounted for 57 and urban for 43 per cent of cases. In the rural and semirural areas, the houses were mostly 1- or 2-roomed mud huts in which several members of the family lived together. There was no outlet for smoke with the result that the house was filled with smoke when the family meal was cooked. The city dwellers lived in small 1- or 2-roomed tenements, ill ventilated and overcrowded.

The fuel used almost universally is cow dung which is dried into flat cakes for this purpose. Probably from inadequate combus-

TABLE 1.—Incidence of Cor Pulmonale in Indian States

<table>
<thead>
<tr>
<th>Disease</th>
<th>Delhi³</th>
<th>Bombay⁴</th>
<th>Amritsar⁵</th>
<th>Jaipur⁶</th>
<th>Lucknow⁷</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cor pulmonale</td>
<td>22</td>
<td>186</td>
<td>50</td>
<td>342</td>
<td>1000</td>
</tr>
<tr>
<td>Percentage</td>
<td>16.6</td>
<td>10.0</td>
<td>10.8</td>
<td>31.6</td>
<td>18.5</td>
</tr>
</tbody>
</table>

TABLE 2.—Cor Pulmonale in Countries Outside India

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<thead>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cor pulmonale</td>
<td>10,000</td>
<td>4304</td>
<td>300</td>
<td>3000</td>
<td>1000</td>
</tr>
<tr>
<td>Percentage</td>
<td>0.45</td>
<td>4.2</td>
<td>25.0</td>
<td>1.1</td>
<td>0.6</td>
</tr>
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</table>

TABLE 3.—Age Incidence of Cor Pulmonale

<table>
<thead>
<tr>
<th>Age in years</th>
<th>Below 10</th>
<th>10-19</th>
<th>20-29</th>
<th>30-39</th>
<th>40-49</th>
<th>50-59</th>
<th>60-69</th>
<th>70 and above</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>1</td>
<td>2</td>
<td>9</td>
<td>29</td>
<td>43</td>
<td>29</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Percentage</td>
<td>0.8</td>
<td>1.6</td>
<td>7.1</td>
<td>22.8</td>
<td>33.8</td>
<td>22.8</td>
<td>11.1</td>
<td></td>
</tr>
</tbody>
</table>

TABLE 4.—Underlying Pulmonary Disease

<table>
<thead>
<tr>
<th>Disease</th>
<th>No. of patients</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic bronchitis</td>
<td>76</td>
<td>59.8</td>
</tr>
<tr>
<td>Bronchial asthma</td>
<td>17</td>
<td>13.4</td>
</tr>
<tr>
<td>Bronchiectasis</td>
<td>22</td>
<td>17.3</td>
</tr>
<tr>
<td>Pulmonary tuberculosis</td>
<td>7</td>
<td>5.5</td>
</tr>
<tr>
<td>Chest deformity</td>
<td>3</td>
<td>2.4</td>
</tr>
<tr>
<td>Primary pulmonary hypertension</td>
<td>2</td>
<td>1.6</td>
</tr>
</tbody>
</table>
tion, it emits a lot of smoke. A recent survey estimated that cow dung provides as much as 90 per cent of power in India.

Economic Status. The 127 cases studied were distributed as follows: Low-socioeconomic class, income below 50 rupees per month, 100 cases—79 per cent. Middle class, income between 50 rupees and 250 rupees per month, 20 cases—16 per cent. High socioeconomic class, income 250 rupees and over per month, 7 cases—6 per cent.

Occupation. Of the adults, there were only 4 office workers. The female patients were all housewives. Those coming from the rural areas were part-time farm workers. One of the urban group worked in a canning factory. All the patients from the villages and some from the city gave a history of having spun cotton in their homes for varying periods. It was part of their daily life. Many of them had given it up only on becoming ill. A few of the semirural group had also done part-time stone breaking and grinding, but this work did not appear to be long enough to be a significant etiologic factor.

Climate. All the patients in this group were from Delhi and the neighboring districts. Delhi has a dry climate except for about 2 months in the monsoon season (rainfall 20 to 25 inches). In summer the temperature rises to 110 F. and in winter falls as low as 40 F. Dust storms are a daily feature for about 4 months of the year.

Clinical Features

Duration of Underlying Respiratory Disease. Before the onset of failure, patients gave a history of symptoms referable to the underlying lung condition for a variable period of time (table 5). The total duration of symptoms was below 10 years in 68 per cent of cases. The shortest in this series was 8 months and the longest, 40 to 45 years (since childhood). The fact that a fairly large number (14 per cent) of patients gave a short history of less than 1 year might be partly attributed to their not paying much attention to minor respiratory complaints and not seeking medical aid. All these patients showed signs of marked pulmonary emphysema. In contrast, in the small number of patients from the higher socioeconomic group, symp-

<table>
<thead>
<tr>
<th>Duration</th>
<th>No. of Patients</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>5—12 yr.</td>
<td>37</td>
<td>29.1</td>
</tr>
<tr>
<td>12—20 yr.</td>
<td>42</td>
<td>33.1</td>
</tr>
<tr>
<td>More than 20 yr.</td>
<td>44</td>
<td>34.7</td>
</tr>
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</table>

There was evidence of gross pulmonary disease in all but 2 patients (cases of primary pulmonary hypertension) (table 4). Emphysema and coarse bubbling rales were present on admission in all these cases in
failure, indicating that pulmonary edema was a prominent feature of the heart failure. Bronchospasm was present, persistently in some cases and intermittently in others.

Cardiac Findings. There were no special cardiac signs. In fact the absence of signs of heart disease to account for the congestive heart failure associated with findings of gross pulmonary disease indicated the diagnosis of cor pulmonale. The heart size was enlarged in 90 per cent of cases but this enlargement could not be clinically ascertained in the majority, owing to emphysema. Correct assessment was made on fluoroscopy in 118 cases. The only notable findings pertaining to the heart were a loud pulmonic second sound in 65 per cent of cases and systolic murmur of grade I and II in 20 per cent and grade III in 4 per cent of cases.

Associated Heart Disease of Other Types. Benign hypertension was present in 5 cases. Left bundle-branch block was present in 2 cases, perhaps indicative of atherosclerotic heart disease. The physical signs and symptoms of these cases were those of cor pulmonale and not those of degenerative heart disease. These might have acted as contributory causes, however.

Superadded Acute Respiratory Infection. Fever was present on admission together with congestive heart failure in 33 per cent of the patients. It was not possible, except for fever, to make a definite diagnosis of superadded respiratory infection, which might have precipitated the congestive failure. Polymorphonuclear leukocytosis was present in 14 per cent of cases on admission, which might have been due to superadded respiratory infection.

Mortality. Twenty-eight patients (22 per cent) of this series died, 50 per cent of them during the first attack of failure. The rest lived for periods ranging from 6 months to 3 years after the first attack. The average duration of life after the first attack was 1 year and 7 months. The number of attacks of cardiac failure before death occurred is shown in table 7.

Follow-up. It was possible to follow up only 52 cases (41 per cent) out of this group of 127. The rest failed to report to the cardiac clinic after their discharge from hospital. Of these 28 died. Of the remaining 24, 6 cases (25 per cent) were alive at the end of 2 years and 3 cases (12.5 per cent) at the end of 3 years.

Laboratory Findings

Radiologic Features. There were characteristic findings of emphysema in all cases, such as wide intercostal spaces, poor chest movements, depressed and flat diaphragms, increased bronchovascular markings, and evidence of the underlying lung disease.

The heart was enlarged in 90 per cent of cases in which x-rays and fluoroscopy were done. Table 8 gives the cardiothoracic ratios in this series. In many cases the enlarged heart shadow diminished as the heart failure resolved. The pulmonary cone was full in the posteroanterior view in 75 per cent of cases and in another 4 per cent it was prominent only in the right anterior oblique view. Right ventricular enlargement as judged by the oblique views was noted in 67 per cent and left ventricular enlargement in the left anterior oblique view was present in 22 per cent. The position of the heart was usually vertical. The markings of the pulmonary arteries at both hila were pronounced in all the cases.

Electrocardiographic Findings. The electrocardiograms of 101 patients were available for study. The conventional 12 leads were taken in all, V3R and V5R in 46 and V3R in 7 cases. The major abnormalities consisted of right deviation of the electric axis in 74 per cent, right ventricular hypertrophy in 73 per cent, and T-wave changes in 27 per cent.

Cardiac Catheterization Data. Fifteen patients were submitted to right heart catheterization. All of them had recovered from congestive failure at the time of the procedure. Right ventricular and pulmonary artery resting pressures were considerably elevated in 11 patients (over 60 mm. Hg) and moderately in 4 (30-60 mm.).

Definite peripheral arterial unsaturation was present in 4 cases out of 6 in which arterial oxygen saturations were done. The cardiac output could not be accurately determined in these cases owing to inadequate facilities.

Although pulmonary artery pressures were elevated in all the cases, the electrocardiogram was normal in 5 and showed a pattern of left bundle-
CHRONIC COR PULMONALE IN DELHI

branch block in 1. In 2 cases the pattern of the electrocardiogram changed from normal to pattern III later in the course of the disease.

Hematologic Findings. Twenty-five per cent of patients were anemic. As the majority of patients were from a low-socioeconomic group, poor diet could have been a contributory cause of anemia (table 9).

Venous Pressure. The jugular venous pressure was estimated in 92 cases (table 10). In 83 per cent of cases venous pressures above the normal values were recorded. Of the 16 patients with normal values 1 had never been in failure, 10 were in mild congestive failure and the other 6 in gross congestive failure.

Autopsy Findings. Permission for autopsy could be obtained in only 4 cases owing to the religious prejudice against autopsy (table 11). Representative pathologic changes are shown in figures 1 to 10.

Discussion

The outstanding feature of this series was the high incidence of cor pulmonale in an entirely nonindustrial population. Previous studies except from some parts of India and from predominantly industrial populations had shown a low incidence of this condition. Pneumoconiosis has been repeatedly stressed as the most important predisposing cause of all.22

Men and women were almost equally affected in the present study (1.2:1.0) unlike previous ones which recorded a high preponderance of males over females.5, 6, 8, 22 The comparatively young age of these patients was another important feature. Fifty-six per cent of the patients were between the ages of 30 and 50 years and nearly a third (32 per cent) below 40 years. In White and Jones'22 series all but 4 were more than 50 years old, and 13 were over 60. In Scott and Garvin's14 series of 50 autopsy cases, 35 were over 50 years and 16 over 60.

The short duration of pulmonary symptoms was another striking feature. The majority of patients in this series had a history of pulmonary disease of less than 10 years. As many as 15 per cent had a history of less than 1 year's illness. In many cases a history of cough was elicited with difficulty on direct questioning. It is very probable that minor respiratory infections went unnoticed, owing to the general apathy of the patients who were extremely poor and in no position to pay attention to anything except a severe illness. This indifference has been noticed with regard to most ailments by those of us who have worked in the health center at Najafgarh, outside Delhi.

The very squalid living conditions and the smoke-filled atmosphere in which these patients lived were undoubtedly contributory factors to the rapid progress of the disease.

Rural patients predominated over urban in the ratio of 1.33:1.0. Although both groups came from extremely poor classes, this slight predominance is probably explained by the existence of even fewer medical facilities in the villages as compared to the city. In the rural and industrial surveys mentioned earlier cor pulmonale was also more prevalent in the former group. In the 1951 census it was estimated that in 72 villages around Delhi there was 1 doctor per 31,000 of population. In Delhi city on the other hand there is 1 doctor per 1,400 people. During history taking it was noticed that most of the rural patients admitted to having consulted a doctor for the first time while seeking admission to hospital for congestive heart failure. In the case of the

<table>
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<tr>
<th>Table 9.—Hematocrit Values in 120 Cases</th>
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<tbody>
<tr>
<td>Hematocrit in cm. per cent</td>
</tr>
<tr>
<td>No. of patients</td>
</tr>
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<td>Percentage</td>
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<table>
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<tr>
<th>Table 10.—Venous Pressure Readings in 92 Cases</th>
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<tr>
<td>Jugal venous pressure in cm. of water</td>
</tr>
<tr>
<td>No. of patients</td>
</tr>
<tr>
<td>Percentage</td>
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</table>
Fig. 1-9. 1. Case 2. Photomicrograph of lung showing thickening of alveolar walls. X 10. 2. Case 1. Photomicrograph showing marked emphysema, thinning and avascularity of alveolar walls, and thick-walled medium-sized blood vessels. X 43. 3. Case 1. Photomicrograph showing bronchiectasis and markedly thickened blood vessels with endarteritis and narrowing of lumina. X 48. 4. Case 2. Photomicrograph showing atherosclerosis of pulmonary artery. X 10. 5. Case 3. Photomicrograph showing marked emphysema with thickening of alveolar

(Continued on bottom of next page)
city dwellers, many more had been to a doctor for treatment of respiratory infection at some time of their lives prior to the onset of congestive heart failure. It must however be admitted that even city dwellers had been seen by a physician on not more than a few occasions prior to the onset of congestive heart failure. The term "doctor" was confusing to these patients as there are 100 hakims and vaids (physicians practicing ancient Indian systems of medicine) and 65 homeopaths registered in Delhi (as against 900 doctors qualified in modern medicine).

In this series all the patients were in an advanced stage of cardiac involvement on their admission to hospital. As many as 125 out of 127 patients were admitted with gross signs of congestive heart failure. Cardiac enlargement was present in 90 per cent of cases. Electrocardiographic evidence of right ventricular hypertrophy was present in 75 per cent of cases, pointing to advanced disease. It is well known that the pattern of right ventricular hypertrophy is late in appearance in cases of cor pulmonale. The high pressures in the right ventricle and pulmonary artery on catheterization in all the cases were also indicative of advanced disease.

The mortality figures in this study were probably low, as those patients who never came back for follow-up (59 per cent), probably died at home. This is surmised from the fact that in those who were followed up (41 per cent), frequent relapses of congestive heart failure were the rule. The average duration of life, after onset of congestive failure in this series was 1 year and 7 months, which resembles the figures given by Fulton. The slightest change from strict bed rest or a minor respiratory infection precipitated another bout of failure.

Necropsy findings pointed to considerable pulmonary insufficiency due to severe emphysema, bronchitis, bronchiolitis, and bronchiectasis. The pulmonary findings in fact dominated the picture. There was involvement of the smaller blood vessels (atheroma) in 2 cases. Atheroma of the pulmonary artery was present in 3 cases out of 4 suggesting high pressure in the pulmonary circulation. It is all the more remarkable, for atheroma of the aorta was not present in these patients except minimal lesions in 1 (no. 4). The heart was enlarged in all, the lowest heart weight being 300 Gm. Although the thickness and weight of each ventricle separately was determined in
only 1 case, the heart weight was increased in all cases, and the right ventricular wall thickened and the cavity dilated in all the cases. Right ventricular hypertrophy resulted, presumably, from the greatly diminished vascular bed secondary to the emphysema, which was a striking feature in all the cases. Pulmonary fibrosis was not a prominent feature.

It seems reasonable to conclude that the high incidence of cor pulmonale in Delhi is the result of emphysema secondary to widespread chronic respiratory infections that go untreated owing to lack of medical facilities and to the poverty of the people.

No other factors could be held responsible in this study. Whether the high incidence as reported from other parts of India is due to the same cause, it is not possible to say.
**Summary**

A high incidence of cor pulmonale was noted in Delhi in an entirely nonindustrial population. Men were only slightly more affected than women and there was a preponderance of rural over urban cases.

The patients were comparatively young, gave a short history of the underlying pulmonary disease, and presented with very florid signs of congestive heart failure on their first visit to hospital.

The cardiac involvement was considerably advanced in all cases as judged by electrocardiographic and cardiac catheterization data.

Four cases came to autopsy and the findings showed advanced pulmonary disease with right ventricular hypertrophy.

It is postulated that this high incidence of cor pulmonale was the result purely of chronic respiratory infections that had remained untreated owing to lack of medical facilities and the extreme poverty of the people.

**Acknowledgment**

We gratefully acknowledge the assistance of the Pathology Department of Lady Hardinge Hospital.

**Unserochno pulmonale in Delhi**

Un alte incidentia de cor pulmonale eseva notate in Delhi in un population completamente non-industrial. Le masculos eseva afficiate a grados solmente pauso plus alte que le femininas, e le casos ab areas rural proponderava in comparation con illos ab areas urban.

Le patientes eseva comparativemente juvène. Le historia del subjacente morbo pulmonar non eseva prolongate. Le patientes se presentava con floridissime signos de congestive disfallimento cardiae al tempore de lor prime vista al hospital.

Le affection cardiae eseva multo avantiate in omne le casos, a judecar per datos electrocardiographic e catheterisatori.

Quatro cases eseva studiate necropticamente. Illos exhibiva signos de avantiate morbo pulmonar con hypertrophia dextero-ventricular.

Es postulate que iste alte incidentia de cor pulmonale eseva le resultato exclusive de chronic infecciones respiratorii que habeva remanite sin tratamentio a causa del absentia de facilitates medical e a causa del extreme pauperitate del gente.

**References**


From which observations with good reason we may gather that the heart at that time whilst it is in motion, suffers constriction, and is thickened in its outside, and so streightned in its ventriciles, thrusting forth the blood contained within it: which from the fourth observation is evident, because that in the tention it becomes white, having thrust out the blood contained within it, and presently after in its relaxation and rest a purple and crimson colour returns to the heart. But of this no man needs to make any further scruple, since upon the inflictting of a wound into the cavity of the ventricle, upon every motion and pulsation of the heart, in the very tention, you shall see the blood within contained to leap out.—William Harvey. De Motu Cordis, 1628.
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