6. Results and Conclusion

Overview

This Chapter provides the data collected with this instrument and analysis carried out on the data and the results. The study is conducted on different normal subjects and patients groups. Finally, waveforms of normal subjects, tuberculosis patients and bronchial asthma patients are displayed in the power spectrum panel; the low, medium and high frequencies with their powers and the ratio of power from low to high frequency are also displayed. The different peaks in the power spectrum of respiration amplitude and respiration rate helps to decide the subject/patient results such as normal, tuberculosis or bronchial asthma etc.
6.1 Results

![Power spectrum of resp amp variability and rate variability](image.png)

**Figure 6.1: Power spectrum of Normal Subject**

Figure 6.1 shows that the frequency peaks in power spectrum of respiration amplitude are in decreasing order up to 0.2Hz and afterwards there are no peaks. Similarly the frequency peaks in the power spectrum of respiration rate are also seen. The low frequency powers (area) in both the cases are higher as compared to the high frequency power. The important factor in the normal subject is that the ratio of the low to high frequency ratio of respiration amplitude is higher than the respiration rate (40.43: 6.75) i.e. 6 to 7 times higher.
Figure 6.2: *Power spectrum of Normal Subject*

Figure 6.2 shows that the frequency peaks in power spectrum of respiration amplitude are in decreasing order up to 0.2Hz and afterwards there are no peaks. Similarly the frequency peaks in the power spectrum of respiration rate are also seen. The low frequency powers (area) in both the cases are higher as compared to the high frequency power. The important factor in the normal subject is that the ratio of the low to high frequency ratio of respiration amplitude is higher than the respiration rate (98.74:9.98) i.e. 10 to 11 times higher.
Figure 6.3: Power spectrum of Tuberculosis Patient

Figure 6.3 shows that the frequency peaks in power spectrum of respiration amplitude are not in decreasing order in the normal subject and afterwards there are no peaks. Similarly the frequency peaks in the power spectrum of respiration rate are also seen. The low frequency powers (area) in both the cases are higher as compared to the high frequency power. But the important factor in tuberculosis patient is that the ratio of the low to high frequency ratio of respiration amplitude is lower than the respiration rate (8.71:23.50) 3 to 4 times lower.
Figure 6.4: Power spectrum of Tuberculosis Patient

Figure 6.4 shows that the frequency peaks in power spectrum of respiration amplitude are not in decreasing order as in the normal subject and afterwards there are no peaks. Similarly the frequency peaks in the power spectrum of respiration rate are also seen. The low frequency powers (area) in both the cases are higher as compared to the high frequency power. But the important factor in tuberculosis patient is that the ratio of the low to high frequency ratio of respiration amplitude is lower than the respiration rate (8.52:14.06) 1.5 to 2 times lower.
Figure 6.5: Power spectrum of Bronchial Asthma Patient

Figure 6.5 shows that the frequency peaks in power spectrum of respiration amplitude are not in decreasing order as in the normal subject and afterwards there are no peaks. Also there are peaks which are coming up and down which shows that the inspiration end expiration is not smooth. The number of peaks is more as compared to the normal subject and tuberculosis patients. Similarly the frequency peaks in the power spectrum of respiration rate are also seen. The low frequency powers (area) in both the cases are higher as compared to the high frequency power. But the important factor in Bronchial Asthma patient is that the ratio of the low to high frequency ratio of respiration amplitude is lower than the respiration rate (20.32:36.60) 1.5 to 2 times lower.
Figure 6.6: Resp. Signal with Power Spectrum and Poincare plot of Normal Subject.
Figure 6.7: Resp. Signal with Power Spectrum and Poincare plot of Normal Subject.
Figure 6.8: Resp. Signal with Power Spectrum and Poincare plot of Normal Subject.
Figure 6.9: Resp. Signal with Power Spectrum and Poincare plot of Normal Subject.
Figure 6.10: Resp. Signal with Power Spectrum and Poincare plot of Normal Subject.
Figure 6.11: Resp. Signal with Power Spectrum and Poincare plot of Normal Subject.
Figure 6.12: Resp. Signal with Power Spectrum and Poincare plot of Normal Subject.
Figure 6.13: Resp. Signal with Power Spectrum and Poincare plot of Normal Subject.
Figure 6.14: Resp. Signal with Power Spectrum and Poincare plot of Normal Subject.
Figure 6.15: Resp. Signal with Power Spectrum and Poincare plot of Normal Subject.
Figure 6.16: Resp. Signal with Power Spectrum and Poincare plot of Normal Subject.
Figure 6.17: Resp. Signal with Power Spectrum and Poincare plot of Normal Subject.

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Figure 6.18: Resp. Signal with Power Spectrum and Poincare plot of Normal Subject.
Figure 6.19: Resp Signal with Power Spectrum and Poincare plot of Normal Subject.
Figure 6.20: Resp. Signal with PSD and Poincare plot of Bronchial Subject.
Figure 6.21: Resp. Signal with PSD and Poincare plot of Bronchial Subject.
Table 6.1: Detail information of patients with different parameters

<table>
<thead>
<tr>
<th>General Information of the Subject/Patient</th>
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<tbody>
<tr>
<td>1. ID No.</td>
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<tr>
<td>2. Name</td>
</tr>
<tr>
<td>3. Age</td>
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<tr>
<td>4. Weight</td>
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<tr>
<td>5. Height</td>
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<tr>
<td>6. Gender</td>
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</table>

<table>
<thead>
<tr>
<th>Respiration Signal</th>
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<tbody>
<tr>
<td>7. LF</td>
</tr>
<tr>
<td>8. MF</td>
</tr>
<tr>
<td>9. HF</td>
</tr>
<tr>
<td>10. L/H</td>
</tr>
<tr>
<td>11. LF Area</td>
</tr>
<tr>
<td>12. HF Area</td>
</tr>
<tr>
<td>13. L/F Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Respiration Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>14. LF</td>
</tr>
<tr>
<td>15. MF</td>
</tr>
<tr>
<td>16. HF</td>
</tr>
<tr>
<td>17. L/H</td>
</tr>
<tr>
<td>18. LF Area</td>
</tr>
<tr>
<td>19. HF Area</td>
</tr>
<tr>
<td>20. L/F Area</td>
</tr>
<tr>
<td>21. Total Breath</td>
</tr>
<tr>
<td>23. General</td>
</tr>
</tbody>
</table>
6.2 Discussions

The result shows that, the normal subject respiration signal is like sinusoidal in nature (not exact). Generally for the normal subject there is a smooth curve (absence of any up downs). While the patients having tuberculosis or bronchial asthma the respiration signal is much disturbed during inhalation or / and exhalation of the patients. One more thing is that the normal subject’s breathing rate is in between 12 and 18 (normally); but for the restrictive or obstructive type it exceeds this. There may be a possibility of some lung disease even though we are considering it normal. In the tuberculosis and bronchial asthma there is always restrictive or obstructive breath rate.

When we see the power spectrum of the normal subject then it is observed that the frequency peaks of both the spectrums are in decreasing orders. Which shows that the signal is nearly sinusoidal type (but not exact) without (or less) obstruction in breathe. The power spectrum also shows that the ratio of the respiration amplitude to respiration rate of spectrum is higher. There are no peaks above 0.25 Hz frequencies.

In the tuberculosis patient’s inhalation and / or exhalation time varies exponentially with fluctuations in the respiration signal (disturbances-not smooth curve). So the power spectrum also shows that there are no regular decreases in frequency peaks as in normal subjects. The frequency ratios of low to high in power spectrum of respiration amplitude and respiration rate is reverse as that of the normal subjects. The power spectrum is some what noisy in nature.
In the bronchial asthma the respiration signal is like tuberculosis but with more disturbances. In the power spectrum the ratio is like the tuberculosis patients but the frequency peaks are large in numbers and the peaks are also high in amplitude (powers). The power spectrum is noisier.

6.3 Conclusions

It is concluded that the results coming for the normal subjects, tuberculosis patients and the bronchial asthma patients are having different patterns. For getting the precise clinical results a large number of patient data has to be collected for better analysis.

The assessment of pulmonary function by respiratory variability, will be helpful for the PHC'S (Primary Health Centers), where the lung diseases are observed with varying severity i.e. the subject in Mumbai will be healthy but the respiration rate and its parameters will not be as good as the healthy persons of the village or hill station. So the region wise standard parameters will be decided with this instrument and application of this principle will give good results for individual regions of our country. It will help the use of DOT programs efficiently to the area/region where the tuberculosis patients are increasing in numbers. It will also indicate the improvising or deteriorating condition of the patient during the treatment.