Clinical studies

7.1. Clinical studies
Clinical studies were performed in a mixed population of asthma and COPD patients (n=6). Due to this reason the predicted forced vital capacity (FVC) of mixed population has huge differences. To normalize these values and fit the data of all patients in one graph, all four tested parameters (FVC, FEV₁, SpO₂ and Pulse) were converted in to percentage with respect to their baseline values for each patient. The resulting data has been averaged and their standard deviation calculated to prepare different plots.

7.2. Forced vital capacity (FVC)
FVC is the total volume of air expired after a full inspiration. Patients with obstructive lung disease usually have a normal or only slightly decreased vital capacity. Patients with restrictive lung disease have a decreased vital capacity. Thus FVC is an important parameter to differentiate between patients of asthma, bronchiectasis (both are obstructive diseases) and COPD, Interstitial lung disease (both are restrictive lung diseases). In this study mixed population of patients has been studied, so the data has been converted in to percentage with respect to baseline values of each patient. The results of FVC post treatment of standard and test are presented in Fig. 7.1. It is clearly visible that there is no significant (P>0.05) difference in the FVC values at different time points after treatment.

![Figure 7.1: FVC of patients after treatment with standard and test medication](image)

p>0.05 for standard Vs test at same time points. n=6
7.3. Forced Expiratory Volume in 1 Second (FEV₁)
FEV₁ is the volume of air expired in the first second during maximal expiratory effort. The FEV₁ is reduced in both obstructive and restrictive lung disease. The FEV₁ is reduced in obstructive lung disease because of increased airway resistance. It is reduced in restrictive lung disease because of the low vital capacity. The results of FEV₁ are shown in Fig. 7.2. It is clearly visible that there is no significant (P>0.05) difference in the FEV₁ values at different time points after treatment.

Figure 7.2: FEV₁ of patients after treatment with standard and test medication
p>0.05 for standard Vs test at same time points, n=6

7.4. Oxygen saturation (SpO₂)

Figure 7.3: SpO₂ of patients after treatment with standard and test medication
p>0.05 for standard Vs test at same time points, n=6
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SpO$_2$ is a term referring to the concentration of oxygen in the blood. The human body requires and regulates a very precise and specific balance of oxygen in the blood. Normal blood oxygen levels in humans are considered 95-100 percent. If the level is below 90 percent, it is considered low resulting in hypoxemia. The results of SpO$_2$ after standard and test medication are mentioned in Fig. 7.3. There is no significant differences in the SpO$_2$ values of standard in comparison to test at same time points. However test medication was capable of maintaining the oxygen saturation more as compared to standard. Although the differences are not significant but it can help in improvement of quality of life.

7.5. Heart rate

The results of change in heart rate after 6 min walk test with standard and test medication are mentioned in Fig. 7.4. It is clearly visible from the figure that the test medication is quiet efficient in maintaining the reduced heart rate as compared to standard. There is significant (p<0.01) difference in heart rate at 3Hrs and 4Hrs time point, indicating that the test medication can improve quality of life.

![Heart rate of patients after treatment with standard and test medication](image)

**Figure 7.4:** Heart rate of patients after treatment with standard and test medication

p>0.05 for standard Vs test at same time points 0Hr, 0.5Hr, 1Hr, and 2Hr, n=6

p<0.01 for standard Vs test at 3Hr and 4 Hr, n=6
7.6. Discussion

The present study was carried out after obtaining approval from Drug Controller General of India (DCGI Approval: F. No. 12-183/10-DC dated 31/08/2012). The study was randomized and comprised of six volunteers for 4 days. Every day baseline readings of different parameters such as spirometry (FVC, FEV₁), pulse oximetry (SpO₂) and heart rate were taken. After that patient were subjected to 6 min. walk test. Post 6 min walk test the volunteers received single daily dose of FP (100µg) either in the form of standard (Flohale Rotacaps, 100µg, Cipla India Ltd.) or test (nano FP) as oral inhalation. Out of six volunteers 3 received standard medication for the first two days while the other 3 volunteers received test medication for first two days. During the next two days, dosing was reversed for both the group. After dosing all parameters such as FVC, FEV₁, SpO₂ and heart rate were recorded at time interval of 0.5, 1, 2, 3 and 4 Hrs. The data of standard was compared with the test to check the differences in clinical manifestations of the two medications. Randomization was done to rule out the possibility of additive effects of any medication on the other’s clinical manifestation. From the data it is clearly visible that FVC and FEV₁ with both medication have not changed significantly (p>0.05). Pulse oximetry is a non-invasive and accurate method of measuring arterial oxygen saturation (Levene and McKenzie, 1988). It is a useful predictor of hypoxaemia (Reuland et al., 1991). The nano FP formulation was comparatively more helpful in achieving good oxygen saturation as compared to standard. Normal blood oxygen levels in humans are considered 95-100 percent. If the level is below 90 percent, it is considered low resulting in hypoxemia. Blood oxygen levels below 80 percent may compromise organ function, such as the brain and heart, and should be promptly addressed. While in case of heart rate, nano FP showed better therapeutics in keeping the heart rate low as compared to standard.

Due to exercise the oxygen demand increases and to fulfil this heart rate also increases. In this case also nano FP showed better therapeutics in maintaining the heart rate low and oxygen saturation high. All this data indicates that better lung deposition resulted in better therapeutic performance. The lung functions generally describes the upper respiratory tract (Thien, 2013) while oxygen saturation (Fowler and Comroe, 1948) and pulse rate are associated with lower respiratory tract. This fact has been confirmed by the data obtained in this study. The test medication did not show any significant differences in FVC and FEV₁ because both standard and test are available to upper and central respiratory tract. On the other hand changes in SpO₂ and especially heart rate confirms that deposition of inhaled
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corticosteroids in lower respiratory tract may or may not change the disease progression but it has sufficient potential to improve the quality of life. The study was conducted for short duration so it is not the sole conclusion. In future if the study will be conducted for a longer duration with more volunteers there are chances to get more information to prove the efficacy of developed medication.