Inhaled medication other than antibiotics

Chronic use of dornase alfa (pulmozyme) in patients > 6 years old

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Background

In Cystic Fibrosis (CF) lung disease, there is a large influx of neutrophils into the airways. As the neutrophils die, they release large quantities of DNA causing the sputum to be thick and tenacious and decreasing ciliary transport. The thick secretions lead to mucus plugging of the airways and further cycles of infection and inflammation.

Dornase alfa (Pulmozyme®) is a highly purified solution of recombinant human deoxyribonuclease (rhDNase); when inhaled (2.5 mg/die), it reduces viscosity in the lungs, promoting improved clearance of secretions. rhDNase cleaves extracellular DNA in the airway to facilitate mucus clearance in the lung. By decreasing the size and viscosity of DNA in sputum, rhDNase has the direct effect of relieving obstruction, which was the original rationale for its development, this translating into a significant improvement in lung function. In addition to its effect on obstruction, dornase alfa also significantly reduces the risk of exacerbations or infections requiring intravenous antibiotics, probably as a result of improved mucociliary clearance and/or broader effects on host defenses against infection.

Observational studies originating from registries confirmed that patients using dornase alpha benefit slightly from the use of the drug and that the tolerability and safety profile of the drug in all age groups are good. Moreover initiating dornase alfa therapy leaded to an acute improvement in FEV1 and a consistent use of that drug was associated with an improvement in the annual rate of decline in FEV1 over a 2-years period.

A large body of evidence on the efficacy of dornase alfa and its potential mechanisms was reviewed (Konstan MW, 2012). Recent publications and expanding indications of dornase alfa were further reviewed (Wagener JS, 2012).

Based on the available evidence dornase alfa has been recommended in Cystic Fibrosis Foundation Guidelines (Flume PA, 2007) as a standard of treatment for children 6 years and above with mild to severe lung disease and in the standards of care of the European CF Society (Smyth AR, 2014).

Issues

1. To determine whether there is evidence of benefit in using dornase alfa in people with CF in terms of a reduction in morbidity or mortality.
2. To identify any adverse events associated with the use of dornase alfa.
3. To compare the efficacy of dornase alfa with other mucolytics (such as hypertonic saline, acetylcysteine and mesna).
4. To determine the effect of timing of dornase alfa inhalation on measures of clinical efficacy in people with cystic fibrosis (in relation to airway clearance techniques or time of the day).
5. To determine the effect of dornase alfa on sinonasal problems in CF.

What is known

Regarding issues 1 - 3

A recent CDSR is available on this topics (Yang C, 2018).

There is evidence to show that, compared with placebo, therapy with dornase alfa improves lung function in people with cystic fibrosis in trials lasting one month to two years. There was a decrease in pulmonary exacerbations in trials of six months or longer.

There is not enough evidence to firmly conclude if dornase alfa is superior to other hyperosmolar agents in improving lung function. A recent review (Southern KW, 2019) explores the evidence supporting the use of dornase alfa, hypertonic saline, and mannitol in improving mucus clearance in patients with CF from different age groups with differing disease severity and the unanswered questions regarding the optimal use of these agents.

The effect of dornase alfa on mortality is inconclusive, because many of the trials are short-term.

Dornase alfa is well-tolerated. Voice alteration and rash appear to be the only adverse events reported with increased frequency in randomised controlled trials.

Limiting the treatment to selected groups of patients may be a more reasonable approach in practice, given the high drug cost and varied treatment response.

Recently, an observational study, based on registry data from UK (Newsome SJ, 2019), showed that DNase improved lung function in individuals with reduced lung function (ppFEV1 < 70%), bringing a step-change in lung function, but no change in the slope of decline. On the other side, there was no evidence for a benefit in lung function in those initiating treatment with ppFEV$_1$?>?70%.

Regarding issue 4

A recent CDSR is available on this topic (Dentice R, 2018)

The current evidence is insufficient to recommend inhaling dornase alfa before or after the airway clearance techniques.

Inhalation of dornase alfa before airway clearance techniques may be more beneficial for small airway function, but does not affect other outcomes.

However, the timing of dornase alfa inhalation can be largely based on pragmatic reasons or individual preference.

Regarding issue 5

Nasally inhaled dornase alfa can be effective in patients with cystic fibrosis and sinonasal disease who do not respond to conventional therapy after surgical treatment. A RCT (Mainz JG, 2014) with a novel device gave promising results for the new therapeutic concept of sinonasal inhalation with vibrating aerosols. In fact, primary nasal symptoms improved significantly with dornase alfa compared with no treatment, while small improvements with isotonic saline did not reach significance. SNOT-20 overall scores improved significantly after dornase alfa compared with isotonic saline (p=0.017).

Recently, a systematic review (Shah GB, 2018) concluded that topical intranasal dornase appears to improve sinonasal symptoms in CF patients to a greater degree than saline alone. The impact on other outcomes is less clear. Larger studies are needed to fully elucidate the true efficacy of dornase alfa in the treatment of CRS in CF patients.

Miscellanea of further clinical trials

- rhDNase was tested vs inhaled mannitol: mannitol was showed to be at least as effective as rhDNase after 3 months of treatment. The combination of mannitol and rhDNase was not useful (Minasian C, 2010).
- rhDNase significantly improved Lung Clearance Index in CF patients with mild lung disease (Amin R, 2011).
- Administration of dornase alfa via an electronic nebulizer with vibrating membrane technology (eRapid nebulizer) resulted in comparable efficacy and safety, shorter nebulization times, and higher patient preference (Sawicki GS, 2015).

Unresolved questions

There is a need to investigate on the effect of rhDNase on longitudinal outcomes such as rate of decline for FEV_1 in CF. It is likely that further trials comparing daily dornase alfa with other regimens (e.g. alternate day dornase alfa) or with other mucolytics will be important in the future.

FEV_1 was not affected by the timing of dornase alfa inhalation with respect to airway clearance or time of the day. To investigate the effect on small airway function, a more sensitive measure, such as nitrogen washout and/or lung clearance index, might be used.

Long term research is needed to evaluate the long term cost effectiveness of rhDNase and to identify which patients would benefit most from this expensive treatment.

Keywords

Airway clearance drugs -expectorants- mucolytic- mucociliary-;