Advanced Aerosol Delivery Devices for Potential Cure of Acute and Chronic Diseases: New Challenges

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In recent years, the inhalation route has gained importance for the treatment of both pulmonary and extra pulmonary diseases. This is because delivery of drugs or bioactive molecules through this route has great potential for achieving maximum therapeutic effect. Also, many effective inhalation devices have been developed. A wide range of aerosol delivery devices are available for the treatment and management of pulmonary diseases, such as asthma, chronic obstructive pulmonary disease (COPD). Research shows that many other devices are currently under development.

Various advancements and innovations have improved the performance and efficiency of existing aerosol delivery devices. These inhalation devices (i.e., nebulizers, metered-dose inhalers, and dry powder inhalers) and the recent advances in inhalation technology have significantly impacted the treatment and potential cure of many acute as well as chronic diseases [1].

During the evolution of the above advanced applications, new devices have been developed to provide an increased dosing efficiency and less loss during delivery. Thus, this is early promise of aerosolized systemic drug delivery and its outlook for future success. In addition, there are challenges to aerosolized gene therapy and the need for appropriate gene vectors as well as a progress in the development of aerosolized vaccination.

The future challenges for the expansion of the role of aerosols will depend on:

1. Improving the bioavailability of systemically delivered drugs.
2. Developing gene therapy vectors that can efficiently penetrate the mucus barrier and cell membrane navigate the cell cytoplasm and efficiently transfer DNA material to the cell nucleus.
3. Improving delivery of gene vectors and vaccines to infants.
4. Developing formulations that are safe for acute and chronic administrations.

Therefore, to insure satisfactory outcomes and patient acceptability of systemic drug delivery by aerosolization in the future, it is clear that the bioavailability of expensive drugs...
like insulin with relatively low bioavailability needs to be improved. One can ask: how to improve bioavailability? We can improve bioavailability by including: a) better targeting of the alveolar region with nano particle (<0.1 µm in diameter) formulations, or b) formulations containing porous particles that have aerodynamic characteristics similar to extra fine particles (~1.0 µm in diameter) and c) enhancing absorption by adding absorption enhancers that do not damage lung tissue. Several additives that have been tested in rats appear to enhance absorption and permeation and maybe appropriate to improve absorption in future pulmonary protein formulations. These include endogenous surfactants such as DPPC, citric acid, and hydroxypropylcellulose.

It is clear to us and we must make sure that: (1) formulations are needed that do not produce cough, or changes in lung function, and are safe for acute and chronic administrations; (2) the device should be small, portable and easy to use; (3) the total cost of the device and formulation should be similar in cost to the injection product. (4) patients and physicians should be well-educated in terms of the advantages of this route of administration compared to injection therapy to ensure compliance.

Successful correction of lung diseases with inhaled gene therapy remains elusive. A number of challenges must be overcome before pulmonary gene therapy becomes a reality. These include:

(1) Developing gene vectors that can more efficiently penetrate the mucus barrier and cell membrane, navigate the cell cytoplasm and transfer DNA material to the cell nucleus.

(2) Improving delivery of gene vectors to infants.

(3) Developing formulations that are safe and effective for acute and chronic administrations.

To conclude, the role of aerosol therapy has changed over the years to now include systemic drug delivery by inhalation, inhaled gene therapy and vaccination by inhalation. Each of these new applications has led to the development of new delivery devices and achieved varying degrees of success in treating their disease targets. The continued expansion of the role of aerosol therapy in the future will depend on:

(1) Improving the bioavailability of systemically delivered drugs.

(2) Developing gene therapy vectors that can efficiently penetrate the airway mucus barrier and cell membrane navigate the cell cytoplasm and efficiently transfer DNA material to the cell nucleus.

References
