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Topical Review

Inhalers and nebulizers: which to choose and why

S. PEDERSEN

Department of Pediatrics, Kolding Sygehus, Denmark

The title of this review raises a simple question which, some years ago, when our knowledge about inhalation therapy was not so advanced, would probably have been answered in a fairly straightforward manner. However, recent findings have made the issue of inhalation therapy much more complex. The ideal inhaler does not exist, so it is not possible to give a simple answer to a simple question. Instead, general features and the advantages and disadvantages of each individual inhalation system have to be considered.

At present, four different groups of inhalation systems constitute the cornerstone in inhalation therapy in asthma:

(1) conventional metered dose inhalers (MDI);
(2) MDI with a spacer attached;
(3) dry powder inhalers (DPI); and
(4) nebulizers.

Within and between each group there are marked differences with respect to design, construction, aerosol cloud generation, output characteristics, deposition pattern of the inhaled particles, optimal inhalation technique and ease of use. In addition to these variables, there are other factors to consider when prescribing an inhaler:

(1) Conclusions from studies with one drug delivered from one inhaler may differ from the conclusions from another drug from the same inhaler; i.e. terbutaline delivered from a MDI with an Aerochamber results in about 7% deposition within the intrapulmonary airways whereas salbutamol MDI or fenoterol MDI with an Aerochamber produce 12% and 21% intrapulmonary deposition, respectively (1). Similarly, a nebulizer may produce a high deposition of salbutamol in the intrapulmonary airways whereas little or no drug delivery to this region is achieved when the same nebulizer is used with beclomethasone.

Correspondence to be addressed to: Department of Pediatrics, Kolding Sygehus, DK-6000 Kolding, Denmark.

(2) Conclusions from adult studies may not be transferable to children. The nominal dose of budesonide particles $\leq 5\,\mu m$ reaching a cascade impactor through a model of an anatomical adult throat is around 20% from a MDI and 40% from a MDI with a Nebuhaler. The corresponding figures are 8% (MDI) and 27% (Nebuhaler) through a model of an anatomical child throat. Similar, often unpredictable differences between adults and children have been reported with other inhalers and drugs.

(3) Some, but not all, of the new CFC-free MDIs have completely different *in vitro* output characteristics as compared with the present CFC containing inhalers. This means that in the future we may see marked differences in effects between two MDIs delivering the same drug so that equi-effective doses of the same drug may be $25\,\mu g$ and $100\,\mu g$ from two different MDIs. This will further complicate simple prescription and comparisons of inhalers.

(4) Within the childhood population, drug delivery to the patient varies with the age of the child (2) and many inhalers cannot be used at all by young children or older people.

Thus each inhaler should ideally be characterized for difference age groups with each drug used in the inhaler. This has not been done. Therefore, inhaler choice has to be based upon some more general, superior considerations.

The most important questions to consider when prescribing an inhaler are:

(1) Which inhaler is the most simple and easiest to use optimally for various age groups of patients?
(2) Which inhaler most reproducibly delivers the highest fraction of the delivered dose to the intrapulmonary airways in different age groups using the inhaler optimally? As mentioned earlier, this may vary from one drug to another.

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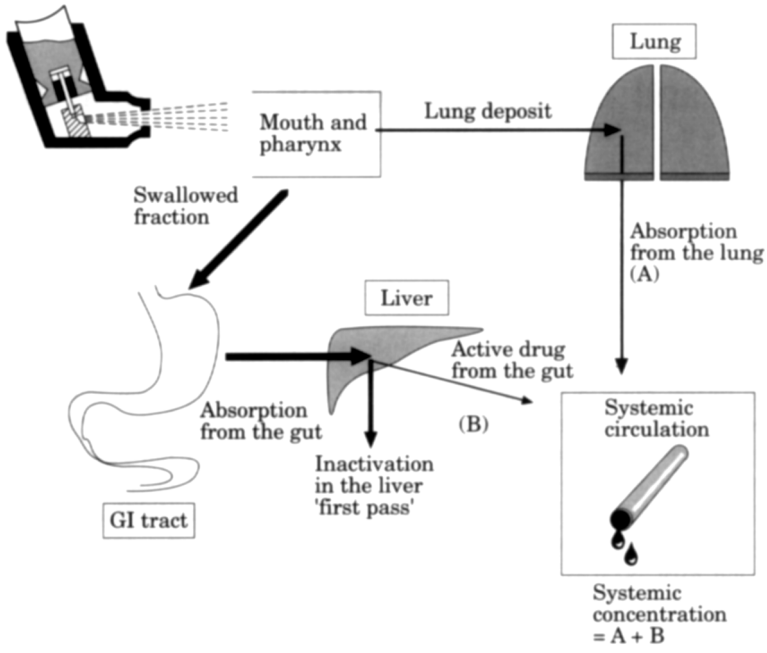

Fig. 1 Pharmacokinetics of inhaled drugs. The majority of drug deposited in the lungs is systemically absorbed. Drug deposited in the mouth and oropharynx is swallowed and subsequently absorbed from the gut with subsequent inactivation in the liver. The various drugs differ in percentage that is inactivated by first pass metabolism in the liver and hence systemic bioavailability.

(3) Which inhaler has the best clinical effect for a given systemic effect (therapeutic ratio) in the day-to-day treatment?
(4) Which inhaler is preferred by the patient?

Over the years, many investigators have reported high frequencies of improper inhaler use as a direct and major cause of treatment failure (3). Therefore, accurate knowledge among physicians about the nature and magnitude of the problems patients experience with inhalation therapy, and about which age groups can normally use the various inhalation devices correctly is important for correct inhaler prescription. For the average patient, a simple inhalation technique, easy handling, and a smart, convenient design are probably more important than a 25% higher drug delivery to the intrapulmonary airways.

Therapeutic Ratio

The therapeutic ratio is the ratio between the clinical effect and the systemic effect of an inhalation (clinical effect/systemic effect ratio). The systemic effect of a corticosteriod depends upon the amount of drug deposited in and systemically absorbed from the intrapulmonary airways, and the amount absorbed from the gastrointestinal tract (Fig. 1). The clinical effect only depends upon the deposition in the intrapulmonary airways. Therefore, a clinically effective inhaler with high intrapulmonary drug deposition will also be expected to have a higher systemic effect than an inhaler which is less effective clinically. In contrast, the contribution of the orally deposited drug to the systemic effect is higher for an inhaler with a low intrapulmonary and high oral drug deposition. When an inhaler is studied it is important to evaluate both the effect and side-effect profile so that an effect/side-effect ratio can be defined. If this is not done, false conclusions may be drawn from inhaler or drug comparisons; i.e. if 1000 μg corticosteroid from Inhaler A reduces urinary cortisol excretion by 20% and 1000 μg from Inhaler B reduces it by 40% it may be concluded that Inhaler A is preferable to Inhaler B. If, however, Inhaler B is twice as clinically effective as A, then there is no difference between the two inhalers since the dose in Inhaler B can be reduced by 50% and still be as effective as A. So, for the same clinical effect, the two inhalers have similar systemic effects. Similar results on cortisol excretion could also be seen after inhalation of a corticosteroid with a low first pass metabolism from an ineffective inhaler with high oropharyngeal deposition, and a corticosteroid

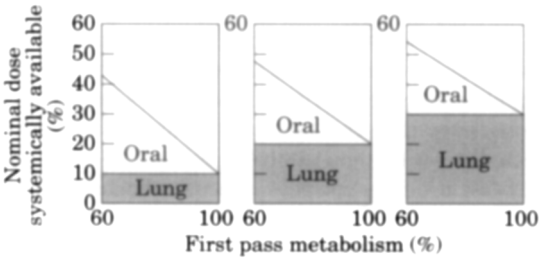

Fig. 2 Systemic availability (and hence systemic activity) of corticosteroid delivered from three different inhalers (A, B and C). All inhalers deliver 90% of the nominal dose to the patient. Inhaler A delivers 10% of the nominal dose to the intrapulmonary airways and 80% to the oropharynx. Inhaler B delivers 20% to the intrapulmonary airways and 70% to the oropharynx. Inhaler C delivers 30% to the intrapulmonary airways and 60% to the oropharynx. The amount of systemically bioavailable drug depends upon lung deposition and upon the amount absorbed from the gastrointestinal tract; the latter being inversely related to the first pass metabolism of the drug. If 400 μg corticosteroid from Inhaler B reduces urinary cortisol excretion by 40% and 400 μg from Inhaler A only reduces it by 20%, it may be concluded that Inhaler A is preferable to Inhaler B. If, however, Inhaler B is twice as effective as A clinically (as is the case in the figure), then there is no difference between the two inhalers since the dose in Inhaler B can be reduced by 50% and still be as effective as A. So, for the same clinical effect the two inhalers have similar systemic effects. In fact Inhaler B may even be preferable to A if the steroid used has a low first pass metabolism! Similar results on cortisol excretion could also be seen if the corticosteroid used had a high systemic bioavailability of drug deposited in the oropharynx, and Inhaler C was three times more effective than Inhaler A but delivered at a substantially lower dose to the oropharynx than Inhaler A.

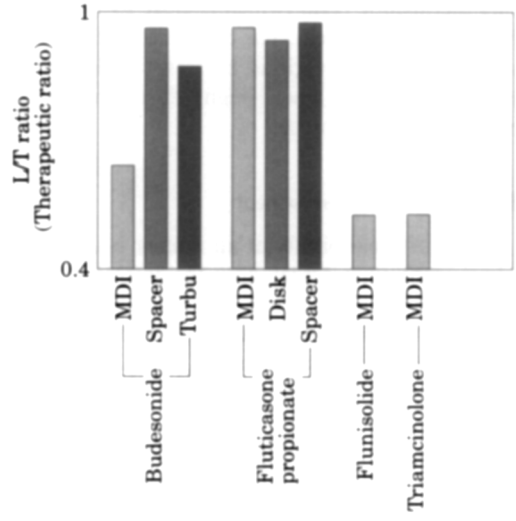

Fig. 3 Approximate therapeutic ratio of different corticosteroid–inhaler combinations. L, drug becoming systemically bioavailable by absorption from the lung (intrapulmonary airways); T, total amount of systemically bioavailable drug (the sum of absorption from the lungs and from the oropharynx and gastrointestinal tract). The ratios have been calculated upon data available in the literature. No published data exist for beclomethasone dipropionate. The therapeutic ratio expresses how much of the systemic bioavailability of an inhaled drug is derived from absorption of drug from the lung. A ratio of 1 is ideal since it means that all systemically available drug comes from drug deposited in the intrapulmonary airways. MDI, metered dose inhaler; Turbu, Turbuhaler; Disk, Diskhaler.

with a high first pass metabolism inhaled from a very effective inhaler delivering three times as much drug to the intrapulmonary airways (Fig. 2)!

Most studies evaluating the use of inhaled corticosteroids have only compared the systemic effect of the same dose of a corticosteroid delivered from two different inhalers, without considering the question of clinically equi-effective doses of the two inhalers studied. In such studies, it has been shown that beclomethasone delivered via a spacer (Volumatic) has less systemic activity than the same dose delivered from a MDI or a Diskhaler (4–6). Since the Volumatic seems to be at least as effective as these inhalers, the clinical effect/systemic effect ratio for the Volumatic is probably better than the ratio for these inhalers. Furthermore, budesonide from a Nebuhaler has the same systemic effect as budesonide from a MDI, and less systemic effect than budesonide from a Turbuhaler (7,8). However, the Turbuhaler is more effective than these inhalers. So, the higher systemic effect of the Turbuhaler is mainly due to a higher intrabronchial deposition, and hence the therapeutic ratio is almost the same for this inhaler and the Nebuhaler (Fig. 3).

At present, there is no knowledge about the clinical therapeutic ratio for the various nebulizer systems, although a recent study suggested that important differences may exist (9). Nose breathing, which is common in young children, would be expected to filter off the large particles, which for some drugs are likely to be absorbed and cause systemic effects without adding to the clinical effect. Jet nebulizers with spacer-like reservoirs, which filter off the large particles, are likely to improve the therapeutic ratio.

In summary, if the therapeutic ratio was the only determining factor for inhaler choice, spacer systems should be preferred to other inhalers for delivering inhaled steroids, which have a high systemic bioavailability of drug deposited in the oropharynx. However, recent findings with the dry powder inhaler, Turbuhaler, show that the therapeutic ratio of this inhaler is quite similar to that of a spacer. Furthermore, the low oral bioavailability of fluticasone dipropionate also means that this drug has almost the

same therapeutic ratio (which is close to 1) independent of delivery system. The difference in therapeutic ratio between the various inhalers is clinically of most importance when high doses of inhaled corticosteroids are used.

Modes of Inhaler Assessment

When information about an inhaler is assessed, it is important to consider how the information was derived since inhalers can be evaluated in many different ways (10), including *in vitro* measurements, radioactive deposition studies, pharmacokinetic studies, filter studies, and clinical effect studies, which may be divided into *laboratory studies*, and *clinical trials* of the day-to-day treatment of patients.

The various methods are complementary since they provide somewhat different information. At present, the clinical implications of the small — but statistically significant — differences obtained under standardized laboratory conditions which may be rather different from the daily treatment of outpatients when simplicity and ease of use may be more important.

In the following, some important aspects of the four most widely used inhaler systems will be discussed.

Pressurized Metered Dose Inhalers

EASE OF USE

MDIs are convenient, portable inhalers which are very difficult to use correctly, mainly because of the high velocity of the aerosol particles (100 km h^{-1}) when leaving the mouthpiece: problems with correct coordination of actuation and inhalation, stopping inhalation when the cold aerosol particles reach the soft palate (cold freon effect), actuation of the aerosol into the mouth followed by inhalation through the nose, and a rapid inhalation (3,11–13). All these problems are associated with a reduced clinical effect. As a consequence, more than 50% of patients receiving inhalation therapy with a MDI can be expected to gain reduced or no clinical benefit from the prescribed medication (11) as compared with spacers or dry powder inhalers. Therefore, all prescriptions of a MDI should be accompanied by repeated, thorough tuition of correct inhaler use followed by the patient's demonstration of inhalation technique. Conventional MDIs are not normally the best choice for children or elderly patients if alternative devices are available.

Use of a breath-actuated MDI (Autohaler) will reduce tuition time, abolish coordination difficulties (14) and hence improve the dose to the intrapulmonary airways in patients with this problem (15). The cold freon effect and the problem of nasal inhalation are unaffected, however, and this inhaler should mainly be reserved for patients older than 6–7 years since they can be taught a correct inhalation technique with the Autohaler within 2–3 min, and also use it during episodes of acute wheeze (16,17).

INHALATION TECHNIQUE

Generally about 80% of the dose from a conventional PA lodges in the oropharynx, 10% is retained in the inhaler and 10% is deposited in the intrapulmonary airways (3,18–20). There may be some differences between the various MDI brands. The mode of inhalation influences the pulmonary deposition. Very slow inhalations (~ 30 l min^{-1}) followed by a breath-holding pause of 10 s after the inhalation have been found to enhance pulmonary deposition as compared with fast inhalations (about 90 l min^{-1}) with and without a breath-holding pause (3, 19–23). Actuating the aerosol 4 cm from the wide-open mouth has been suggested to increase pulmonary deposition when compared to actuations with the lips closed around the mouthpiece of the inhaler. However, the results from studies evaluating this have been inconsistent (3). Consequently, it is very difficult to teach most patients an optimal inhalation technique.

Spacers

Various holding chambers (spacers) may be attached to the mouthpiece of a conventional pressurized aerosol. These devices ensure that the aerosol particles have a slower velocity and a smaller particle size when they reach the patient which is a theoretical advantage. Many spacers have a one-way valve that opens during inspiration and closes during expiration. This makes them easier to use than a MDI. A substantial amount of drug may be lost through the valve when the aerosol is fired into a straight tube spacer if the valve is not tight.

EASE OF USE

All spacers reduce the risk of the cold freon effect and the occurrence of coordination problems. Therefore, spacers are easier to use than a MDI (3) and some produce a better clinical effect, particularly if they have a valve system. Virtually all adults and school children can learn how to use these devices and also use them effectively during attacks of acute bronchoconstriction when they are as effective as nebulizers (24,25). Furthermore, at present, spacers are probably the inhaler of choice in preschool

children (26–32). During episodes of acute wheeze, however, many young children may not be able to open or close the valve system of some spacers like Nebuhaler and Volumatic and therefore not gain optimal benefit. The main problem with spacers is that they are bulky and difficult to carry about. They are more suitable for prophylactic treatment given at home, morning and evening.

INHALATION TECHNIQUE

Slow inhalations (around 30 l min^{-1}) improve the effect when a straight extension tube spacer is used in children, whereas breath-holding, tilting of the head during inhalation, or inhalation from functional residual capacity instead of residual volume does not influence the effect (3,33). This is in good agreement with the finding that slow, quiet tidal breathing results in an optimal effect when a Nebuhaler is used (34). In contrast, slow inhalations may not be of similar importance in adults. So, optimal inhalation from a spacer is easier than from a MDI.

Only one dose should be fired into the spacer at a time. When two or more doses are used at a time, the inhaled dose is reduced (35–37). An advantage of large volume spacers is that the inhalation can be delayed for a few seconds after actuation without any significant reduction in effect (38). However, too long a delay decreases the number of inhaled particles $<5\,\mu m$ diameter (36). In contrast, the inhalation from a low volume spacer should not be delayed since that would result in an even greater loss of drug in the device.

All spacers reduce the oropharyngeal deposition of drug substantially (19,21,39). As a result, the occurrence of oropharyngeal candida is reduced when corticosteroids are used. The amount of drug retained in the inhaler is increased markedly by all spacers (most by the low volume spacers) and hence the dose to the patient reduced. Yet the dose delivered to the intrapulmonary airways is often the same or higher than that from a MDI (18,19,21,39,40), though not all spacers have been thoroughly studied with respect to this.

OTHER STUDIES

The output of respirable particles from a spacer may be markedly improved by use of an antistatic lining in the spacer (36). Washing a spacer in soapy water will reduce the antistatic lining, which is normally produced by the daily actuations of drug into the spacer, and hence reduce drug output during the following days. Priming a new spacer or a newly washed spacer by firing some doses into it will improve output. It normally requires up to 15 doses to achieve optimal priming. The optimal frequency and mode of cleaning a spacer is not known. So maintenance of a spacer is more difficult than for a MDI. New metal spacers are now available in some countries. They totally eliminate the problems of static electricity. As a consequence, cleaning and washing do not influence output, and priming becomes redundant.

The optimal volume of a spacer is not known. It is often anticipated that a low volume is advantageous in preschool children. However, some studies have indicated that the volume of the spacer is not so important in these age groups as is normally anticipated. The reason for this seems to be that young children hyperventilate markedly when a tightly fitting face mask is placed around their mouth and nose (41).

Due to their many advantages, a variety of new spacer systems are being launched every year. Though deceptively similar in appearance, there may be marked differences in the amount of drug retained in them and dose delivered to the intrapulmonary airways (42). Therefore, uncritical use of any new spacer is not recommended until its value has been documented in controlled trials.

Dry Powder Inhalers

In dry powder inhalers, the drug is provided as a finely milled powder in large aggregates (diameter of about $60\,\mu m$), either alone or in combination with carrier particles. Most of the particles from dry powder inhalers are too large to penetrate into the lungs. However, the turbulent airstream created in the inhaler during inhalation causes the aggregates to break up into particles sufficiently small to be carried into the lower airways. Thus the effect of powder inhalers is dependent upon a certain minimum amount of energy from the patient's inhalation to create the correct particle size of the drug. Up to a certain point, increases in flow rate will increase the number of particles within the 'respirable range' and the clinical effect of the inhalation (3,43).

The most widely used dry powder inhalers are the Spinhaler, the Rotahaler, the Diskhaler and the Turbuhaler. These inhalers vary markedly in drug delivery characteristics.

In the *Spinhaler*, the gelatine capsule is placed in the middle of a rotor. Even with an optimal inhalation technique, around 25% of the nominal dose is retained in the capsule and only 6–12% is deposited in the intrapulmonary airways (43–46).

The *Rotahaler* also uses gelatine capsules. After the capsule is broken, a coarse net causes turbulence

during the inhalation. Intrabronchial deposition with the Rotahaler varies from 6–11% in different studies when an optimal inhalation technique is used. Oropharyngeal deposition is around 80% (46–49).

In the *Diskhaler*, active drug and lactose are kept in an air-tight aluminium blister that is pierced before inhalation. The Diskhaler also uses a coarse net to disintegrate the particles. Intrabronchial deposition was found to be around 11% in two studies (50,51). In one, the deposition after Diskhaler was only half the intrabronchial deposition of a Volumatic (50).

The *Turbuhaler* has a powder reservoir, which contains several doses of pure drug without any additives. During inhalation, the turbulence generated in spiral-formed channels in the mouthpiece de-aggregates the large particles. Intrabronchial deposition with this inhaler varies from 17–32% in various studies (mean 25%). Between 20–25% is retained in the inhaler and around 50% is deposited in the oropharynx. The intrabronchial deposition after Turbuhaler has been found to be twice the deposition of a correctly used MDI (20,49,52).

CLINICAL STUDIES: EASE OF USE

Even if an inhaler is somewhat more effective than other inhalers in the laboratory, it may not be advantageous in day-to-day treatment if it is more difficult to use. Dry powder inhalers are breath-actuated and therefore reduce/eliminate the co-ordination problems of actuation and inhalation, which are seen with the MDI (3). For many years, DPIs have been single dose inhalers and therefore less convenient but easier to use than the MDI. Some children have difficulties with correct loading and splitting of the capsules when using the single dose inhalers, particularly during episodes of acute wheeze (3,53). In accordance with this, several recent studies have found that the new multiple DPIs are easier to use and more convenient, so these inhalers are preferred to the single dose inhalers and MDIs in school children.

The main problem with multi-dose DPIs is to train the patient not to exhale through the inhaler before the inhalation, since that will blow out the dose of the inhaler. Furthermore, Turbuhaler should be loaded in an upright position. Otherwise, the metered dose will be reduced when less than half the doses are left in the powder reservoir.

INHALATION TECHNIQUE

Fast inhalations enhance the effect of all DPIs in children, whereas breath-holding, tilting of the head during inhalation, or inhalation from functional residual capacity instead of residual volume does not influence the effect (3,43,54). So the inhalation technique is simple. The number of respirable particles and the effect decrease with decreasing inspiratory flow rates. The inhalation effort and the inhalation flow rate needed to generate a therapeutic aerosol vary between different DPIs. Therefore, results obtained with one inhaler cannot be used to characterize another. At present, no correctly performed comparisons between the various DPIs have been done so the clinical importance of these differences is not known. They are most likely to be important in preschool children, who may not be able to generate such high inspiratory flow rates and therefore benefit less than older children from dry powder inhaler treatment (3,54). Until further studies are available, DPIs should preferably not be used in children younger than 5 years.

Nebulizers

In a jet nebulizer, air or oxygen from an electric compressor, hospital line or cylinder, passes through a narrow orifice, known as a venturi. Liquid from a reservoir is sucked up a tube and broken down into droplets. Only about 0·5% of this primary droplet mass (comprising the smallest droplets) leaves the nebulizer directly, the remaining 99·5% impacts on baffles within the nebulizer or on the internal walls (55). The liquid mass returns to the reservoir and is re-nebulized. Thus the nebulizer produces a continuous spray over a treatment period of several minutes.

During nebulization, a fall in temperature of the nebulizer and its contents is seen, typically 10–15°C, because the diluent evaporates during the nebulization. As a consequence, the drug concentration remaining in the nebulizer increases steadily during nebulization (56). It is not possible to deliver all the fluid as aerosol since some is trapped as a dead or residual volume within the nebulizer — even after nebulization to dryness, i.e. until no more spray is produced. Thus an initial volume fill of 4 ml might typically leave a dead volume of 1 ml, but it would be a mistake to think that three-quarters of the drug has been nebulized. If the drug concentration in the reservoir has doubled (as often occurs), then only 50% of the drug has been nebulized.

Drug output will vary according to the type of nebulizer, variation in dead volume, and the volume of fluid initially placed in the nebulizer. Nebulizers work more efficiently (deliver more drug) when higher volume fills are used. To give an example, it may be possible to release only 40% of the dose with a 2-ml fill, up to 60% with a 4-ml fill and even more

with a 6-ml fill (57). Furthermore, drug delivery can be markedly improved by using breath-actuated nebulizers, which deliver drug during inspiration alone. However, at present these devices are expensive and complicated.

Information about droplet size provided by manufacturers of nebulizers is often sparse and sometimes misleading. It is common practice for manufacturers' data to quote the *number* of particles smaller than a given size, for instance to say that 80% of the droplets are smaller than 5 μm diameter. Since the mass of drug contained in any droplet is proportional to the cube of its radius, and a single 10 μm droplet will contain that same amount of drug as 100 1 μm droplets, it is likely that most of the droplet mass will be contained in the 20% of droplets larger than 5 μm in diameter. It is therefore essential to quote droplet sizes from nebulizers in terms of mass or volume distribution if they are to have any meaning. Finally, the output characteristics of the nebulizer change during ageing.

Ultrasonic nebulizers use a piezoelectric crystal vibrating at a high frequency to generate a fountain of liquid in the nebulizer chamber. They operate silently and normally produce droplets with a higher MMAD than jet nebulizers (55,58,59). Furthermore, they cannot be used for suspensions since they only nebulize the water and not the drug, they may not be able to make a spray from some viscous drug solutions, and they may cause damage to some drugs (58). For these reasons, ultrasonic nebulizers are not at present as widely used as jet nebulizers and they will not be discussed in detail.

CLINICAL STUDIES: EASE OF USE

Little coordination is required from the patient if continuous nebulization and a face mask with holes are used. Therefore, nebulizers are simple to use. However, compared with other devices, nebulizers are expensive, bulky, inconvenient, time consuming, inefficient delivery systems and, with our present knowledge, their use for daily treatment should be limited to patients who cannot be taught the correct use of another device or for drugs which cannot be delivered by any other inhaler system. In clinical practice, this means some children younger than 3–4 years, mentally retarded patients and some elderly patients.

In spite of all the problems with nebulized therapy, nebulizers are still the delivery system of choice in the treatment of acute severe asthma in all age groups, even if the same results can often be obtained with other inhalation systems (24,25,60,61). In the acute situation, it is advantageous that oxygen can be administered through the nebulizer at the same time as the β_2-agonist.

INHALATION TECHNIQUE

No controlled studies have been done in children on the optimal inhalation technique. However, quiet tidal breathing is normally recommended because it produces optimal results in adults (62). So, the inhalation technique with nebulizers is simple.

Inhalation through a face mask held 2–3 cm from the face reduces drug delivery by approximately 50%, with a corresponding increase in release of aerosol to the environment. In agreement with this, *in vitro* studies have reported an 85% reduction in the inhaled dose of respirable particles when the face mask was moved 2 cm from the inspiratory orifice (41). The effect appears to be the same whether the inhalation takes place through a mouth-piece or a face mask (60).

OTHER STUDIES

Simply varying the choice of compressor, jet nebulizer and volume fill has been shown to vary the mass of drug in respirable particles over a 10-fold range (63). Therefore, each nebulizer–drug combination should ideally be characterized separately. This is never done. Due to this enormous variation, it is not meaningful to discuss comparisons with other inhalers in general. However, nebulizers are generally far less effective per mg drug than other inhaler systems. Thus, higher doses are required to achieve the same clinical effect (24,64). This difference in delivery seems to be more pronounced for steroids (65) than for β_2-agonists because fewer respirable particles are generated from a steroid suspension.

Summary of Inhaler Strategy

It is obvious that many factors should be considered when an inhaler is prescribed. Based upon the information discussed above, a rational inhaler strategy could be as follows:

(1) Children ≤ 5 years and elderly patients are prescribed a spacer with a valve system (and a face mask for the children) for the delivery of all drugs. When they are severely obstructed, some may need a nebulizer. If the patient cannot be taught the correct use of a spacer, a nebulizer should be prescribed.

(2) Children ≥ 5 years and adults are prescribed a spacer or a Turbuhaler for the administration of inhaled corticosteroids and a dry powder inhaler (preferably multiple dose) or a

breath-actuated MDI for other drugs. If these alternatives are not available or the patient prefers, a conventional MDI can be used (preferably not for other corticosteroids than fluticasone propionate) provided that careful tuition is given. Fluticasone dipropionate may be given by DPI, Spacer or MDI.

(3) Nebulizers are mainly reserved for severe acute attacks of bronchoconstriction.

With this approach, most patients can be taught effective inhaler use with a minimum of instructional time. Finally, it must always be remembered to consider the patient's wish, since prescription of an inhaler which the physician likes but the patient does not is likely to reduce compliance.

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