
Communications

Faulty Use of Canister Nebulizers for Asthma

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Patients with asthma frequently use canister nebulizers in order to take beta-adrenergic agonists and beclomethasone in aerosolized form. This mode of treatment is convenient, effective, generally well tolerated, and safe. Success, however, depends upon a proper technique of simultaneous canister activation and deep inhalation. This author, as well as others,¹⁻³ has noted that in many patients with asthma the technique of canister nebulizer use is faulty. The following study attempts to learn what proportion of patients with asthma use canister nebulizers incorrectly and why they do so.

Methods

All patients studied were referred by physicians or nurses in the primary care medical clinic of North Central Bronx Hospital to the pulmonary function laboratory for routine pulmonary function testing. The basis for selection into the study was that the request slip for pulmonary function

tests indicated the patient had asthma (physician diagnosis), was using a canister nebulizer, but had not taken bronchodilator within four hours prior to testing. Seventy-five consecutive patients were studied. The patients, the referring physicians, and nurses were unaware a study was being conducted, and knowledge of such a study was kept from the medical community to avoid influencing the results. No patient was studied, however, unless the primary care nurse or physician requested pulmonary function tests, and all the tests performed were the routine tests normally performed in the laboratory. An outline of the study protocol follows:

Part I (first week): All patients

1. Questionnaire (author)
2. Pulmonary function testing (lung volumes, flow rates, single-breath carbon monoxide diffusing capacity) (technician)
3. Patient demonstrates usage of canister nebulizer (author)
4. Repeat pulmonary function testing (flow rates) (technician)
5. Repeat pulmonary function testing (flow rates) (technician)
6. Physician administers isoproterenol by canister nebulizer to patient (one puff at five-minute intervals, two times)
7. Repeat pulmonary function testing (flow rates) (technician)
8. Training session for those patients not using canister nebulizer correctly (author)

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Part II (second week): Patients with improper technique

Steps 2 through 8 repeated

Part III (third week): All patients in part II

All pulmonary function testing was performed by the technician in the absence of the author and without knowledge regarding the patient's technique in using the canister nebulizer. The author did not know the pulmonary function results until completion of step 7. In step 3, patients were asked to "take two puffs of the Iuprel just as you would if at home," and following observation of their use of the canister nebulizer, the author predicted whether or not a bronchodilator response would occur. Following step 7, the data were analysed, and the patient's performance was assessed. Patients were judged to be using the canister nebulizer correctly if obstruction of airflow was significantly improved following self-administration of the canister nebulizer or if no obstruction was noted initially but the inhalational technique appeared correct. When obstruction of airflow was not improved following patient administration of the canister nebulizer but improved following physician administration of it, the technique was considered faulty. Patients using the canister correctly were not retested. All others underwent 20 minutes of training in the use of the canister nebulizer and were brought back for retesting 7 and 14 days later as outlined above.

A 20 percent improvement in two of the following was considered a significant bronchodilator response: forced expiratory volume in 1 second, midmaximal expiratory flow rate, and peak expiratory flow rate. The data were analysed using a paired *t* test, and differences were considered significant ($P \leq .05$).

Results

Seventy-five patients were studied. Of these, 14 patients proved not to meet the criteria for the diagnosis of asthma established by the American Thoracic Society,⁴ and 5 patients failed to return to repeat testing following part I. In the remaining 56 patients, a mean of 1.9 canister nebulizers per patient were used each month. Canister nebulizers

were used for an average of five years and were prescribed by an average of four nurses or physicians.

By the criteria described above, only 23 percent (13/56) demonstrated proper canister nebulizer inhalation technique. Four were predicted by observation to have a proper technique, but pulmonary function tests revealed no airways obstruction at the time of the study. Eight were predicted to have proper technique by observation and demonstrated a bronchodilator response following self-administration of the medication. One was predicted by observation to have faulty technique, but a bronchodilator response was noted after self-administration and this patient was thus included among those with proper technique. The remaining 43 patients (77 percent of the total study group) were predicted by observation to have faulty technique and showed no bronchodilator responsiveness following self-administration of the medication. Despite their faulty technique, 53 percent of these patients (24/43) felt this form of treatment was helpful. Between the groups with proper and faulty technique, the differences in age, sex, language, length of canister use, number used each month, and number of nurses or physicians prescribing them were not statistically significant.

Of those patients with faulty technique, 79 percent (34/43) were able to learn the proper technique. Compared with those able to learn, those unable were significantly older and had used canister nebulizers significantly longer ($P < 0.05$).

Twenty-nine of the 34 patients able to learn the proper technique did so in a single training session. One week later, however, 4 of these 29 (14 percent) had not retained what they learned. These four and five other patients required a second training session to learn the proper technique.

Comment

Canister nebulizer aerosols of beta-adrenergic agonists and corticosteroids are convenient, effective, specific, and safe forms of therapy for patients with asthma provided they use a proper technique of canister nebulizer inhalation.⁵⁻⁹ This

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KLOTRIX®

(POTASSIUM CHLORIDE) SLOW-RELEASE TABLETS, 10 mEq

DESCRIPTION KLOTRIX is a film-coated (not enteric-coated) tablet containing 750 mg potassium chloride (equivalent to 10 mEq) in a wax matrix. This formulation is intended to provide a controlled release of potassium from the matrix to minimize the likelihood of producing high localized concentrations of potassium within the gastrointestinal tract.

INDICATIONS—BECAUSE OF REPORTS OF INTESTINAL AND GASTRIC ULCERATION AND BLEEDING WITH SLOW-RELEASE POTASSIUM CHLORIDE PREPARATIONS, THESE DRUGS SHOULD BE RESERVED FOR THOSE PATIENTS WHO CANNOT TOLERATE OR REFUSE TO TAKE LIQUID OR EFFERVESCENT POTASSIUM PREPARATIONS OR FOR PATIENTS IN WHOM THERE IS A PROBLEM OF COMPLIANCE WITH THESE PREPARATIONS.

1. For therapeutic use in patients with hypokalemia with or without metabolic alkalosis; in digitalis intoxication and in patients with hypokalemic familial periodic paralysis.
2. For prevention of potassium depletion when the dietary intake of potassium is inadequate in the following conditions: Patients receiving digitalis and diuretics for congestive heart failure; hepatic cirrhosis with ascites; states of aldosterone excess with normal renal function; potassium-losing nephropathy, and certain diarrheal states.
3. The use of potassium salts in patients receiving diuretics for uncomplicated essential hypertension is often unnecessary when such patients have a normal dietary pattern. Serum potassium should be checked periodically, however, and, if hypokalemia occurs, dietary supplementation with potassium-containing foods may be adequate to control milder cases. In more severe cases supplementation with potassium salts may be indicated.

CONTRAINDICATIONS In patients with hyperkalemia, since a further increase in serum potassium concentration in such patients can produce cardiac arrest. Hyperkalemia may complicate any of the following conditions: chronic renal failure, systemic acidosis such as diabetic acidosis, acute dehydration, extensive tissue breakdown as in severe burns, adrenal insufficiency, or the administration of a potassium-sparing diuretic (eg, spironolactone, triamterene).

Wax-matrix potassium chloride preparations have produced esophageal ulceration in certain cardiac patients with esophageal compression due to enlarged left atrium. All solid dosage forms of potassium supplements are contraindicated in any patient in whom there is cause for arrest or delay in tablet passage through the G.I. tract. In these instances, potassium supplementation should be with a liquid preparation.

WARNINGS Hyperkalemia: In patients with impaired mechanisms for excreting potassium, administration of potassium salts can produce hyperkalemia and cardiac arrest. This occurs most commonly in patients given potassium intravenously but may also occur when given orally. Potentially fatal hyperkalemia can develop rapidly and be asymptomatic. Use of potassium salts in patients with chronic renal disease, or any other condition which impairs potassium excretion requires particularly careful monitoring of the serum potassium concentration and appropriate dosage adjustment.

Interaction with potassium-sparing diuretics: Hypokalemia should not be treated by the concomitant administration of potassium salts and a potassium-sparing diuretic (eg, spironolactone or triamterene), since the simultaneous administration of these agents can produce severe hyperkalemia.

Gastrointestinal lesions: Potassium chloride tablets have produced stenotic and/or ulcerative lesions of the small bowel and deaths. These lesions are caused by a high localized concentration of potassium ion in the region of a rapidly dissolving tablet, which injures the bowel wall and thereby produces obstruction, hemorrhage, or perforation. KLOTRIX is a wax-matrix tablet formulated to provide a controlled rate of release of potassium chloride and thus to minimize the possibility of a high local concentration of potassium ion near the bowel wall. While the reported frequency of small-bowel lesions is much less with wax-matrix tablets (less than one per 100,000 patient-years) than with enteric-coated potassium chloride tablets (40-50 per 100,000 patient-years) cases associated with wax-matrix tablets have been reported both in foreign countries and in the United States. In addition, perhaps because the wax-matrix preparations are not enteric-coated and release potassium in the stomach, there have been reports of upper gastrointestinal bleeding associated with these products. The total number of gastrointestinal lesions remains less than one per 100,000 patient-years. KLOTRIX should be discontinued immediately and the possibility of bowel obstruction or perforation considered if severe vomiting, abdominal pain, distention, or gastrointestinal bleeding occurs.

Metabolic acidosis: Hypokalemia in patients with metabolic acidosis should be treated with an alkalinizing potassium salt such as potassium bicarbonate, potassium citrate, or potassium acetate.

PRECAUTIONS Potassium depletion is ordinarily diagnosed by demonstrating hypokalemia in a patient with a clinical history suggesting some cause for potassium depletion. In interpreting the serum potassium level, the physician should bear in mind that acute alkalosis *per se* can produce hypokalemia in the absence of a deficit in total body potassium, while acute acidosis *per se* can increase the serum potassium concentration into the normal range even in the presence of a reduced total body potassium. Treatment of potassium depletion particularly in presence of cardiac disease, renal disease, or acidosis, requires careful attention to acid-base balance and appropriate monitoring of serum electrolytes, electrocardiogram and clinical status of patient.

ADVERSE REACTIONS Most common to oral potassium salts: nausea, vomiting, abdominal discomfort, and diarrhea. These symptoms are due to irritation of the gastrointestinal tract and are best managed by diluting the preparation further, taking the dose with meals, or reducing the dose. One of the most severe adverse effects is hyperkalemia (see Contraindications and Warnings). There also have been reports of upper and lower gastrointestinal conditions including obstruction, bleeding, ulceration and perforation (see Contraindications and Warnings); other factors known to be associated with such conditions were present in many of these patients. Skin rash has been reported rarely.

DOSE AND ADMINISTRATION The usual dietary intake of potassium by the average adult is 40 to 80 mEq per day. Potassium depletion sufficient to cause hypokalemia usually requires the loss of 200 or more mEq of potassium from the total body store. Dosage must be adjusted to the individual needs of each patient but is typically in the range of 20 mEq per day for the prevention of hypokalemia to 40-100 mEq per day or more for the treatment of potassium depletion.

Note: KLOTRIX® slow-release tablets must be swallowed whole and never crushed or chewed. Following release of the potassium chloride, the expended wax matrix, which is not absorbed, may be observed in the stool.

HOW SUPPLIED Bottles of 100, 1000, and Unit Dose cartons of 100.

NEBULIZERS FOR ASTHMA

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study shows, however, that nearly 75 percent of patients with asthma selected randomly from a general medical primary care clinic used canister nebulizers with faulty technique and had done so for years. Age, sex, language, and level of education did not distinguish those with proper from those with faulty technique. Eighty percent of those with faulty technique easily learned proper technique after one or two brief training sessions. Those unable to learn were significantly older and had incorrectly used canister nebulizers significantly longer than those able to learn. The high degree of technical misuse appears to result from failure of physicians to teach their patients correct inhalation technique.

Physicians should teach their patients proper canister nebulizer inhalation technique and retest them periodically to make certain it is established.

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