Guidelines Reduce X-ray and Blood Gas Utilization in Acute Asthma

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Using a retrospective chart review, we compared the use of chest radiography (CXR) and arterial blood gas testing (ABG) before (pre-P) and after (post-P) initiation of specific ordering guidelines for the use of these studies for patients presenting to the ED with acute asthma exacerbation. We noted the number of tests performed, the indication for the test, and the results when performed. There was a 55% reduction in the number of chest radiographs (85 of 213 patients pre-P had CXR as compared with 40 of 222 patients post-P, *P* <.001). Of the patients who did not have a chest x-ray in the ED, none had an abnormal chest x-ray obtained after admission or if they returned to the ED within 72 hours. There was a 57% reduction in the number of arterial blood gases post-P (9 of 222 patients) as compared with pre-P (20 of 213 patients, *P* <.001). Although patients with abnormal ABGs had a discernible indication for testing, all of the ABGs for which no indication could be found were normal. A protocol containing criteria for obtaining chest x-rays and arterial blood gas testing can reduce the use of diagnostic testing, thereby improving ED efficiency without adversely impacting patient care. (Am J Emerg Med 2003;21:451-453. © 2003 Elsevier Inc. All rights reserved.)

The evaluation and treatment of patients with acute asthma often includes chest radiography (CXR) and arterial blood gas testing (ABG) in addition to serial clinical assessments and the administration of multiple medications. Some studies suggest that CXR be performed only in selected patients,[1-4] whereas others advocate the routine use of CXR in acute asthma exacerbation.[5-8] There is similar controversy surrounding the use of ABG in acute asthma. Arterial blood gas testing does not accurately assess asthma severity[9] or predict respiratory failure.[10] Thus, routine ABG in acute asthma has been discouraged in favor of a more selective approach.[11]

National guidelines suggest a selective approach to diagnostic testing in acute asthma exacerbation. However, very few studies suggest specific indications for either CXR or ABG in acute asthma. In this study, we sought to determine if implementing an asthma protocol that included specific criteria for diagnostic testing could safely reduce the use of these tests for patients with acute asthma exacerbation.

METHODS

Patients with asthma aged 19 and older that presented to the ED of Temple University Hospital for acute exacerbation of asthma were included for study. The hospital's institutional review board waived consent. An evidence-based protocol was developed using recently reported studies on the treatment,[12-14] diagnostic testing,[15] and disposition decision-making in asthma,[16] as well as the National Asthma Education and Prevention Program Expert Panel Report.[11]

Treatment included early and aggressive B-agonist[12,13] therapy and oral or intravenous steroid[15] therapy. Patients were also treated with oxygen to maintain an SaO_2 of $\geq$90%, antibiotics if there was evidence of pneumonia, nebulized anticholinergic therapy if the peak expiratory flow rate (PEFR) was less than 50% of predicted, and intravenous fluids depending of the patient's hydration status.

Chest radiography was suggested only in the presence of fever >100.4°F with sputum production and rales, suspected barotrauma, suspected comorbid conditions, or for patients with no history of asthma.[2,11] Arterial blood gases were considered indicated only if the patient had severe dyspnea, a PEFR $\leq$30% predicted after initial treatment, appeared ill out of proportion to the PEFR, or had an SaO_2 of $\leq$90% (see Table 1).

The current study is a retrospective comparison of a post-protocol cohort using historical controls. Data were extracted from charts of patients seen in the ED from September 1, 1999, to October 31, 1999, after implementation of the protocol and over the same 2-month period of the preceding year. These comparisons were made to minimize the seasonal variability in the presentation and treatment of asthma exacerbation. Patients were excluded from the study if less than 19 years of age, pregnant, or had comorbid conditions such as chronic obstructive pulmonary disease or congestive heart failure. Data collected included documentation of vital signs, pulse oximetry, and PEFR. We recorded the frequency of CXR and ABG testing, the reason for ordering the test, and the findings. We also reviewed the

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TABLE 1. Indications for Use of Chest Radiography and Arterial Blood Gas Testing in the ED

Diagnostic Test	Indication
Chest radiography	Fever >100.4°F with sputum production and rales, suspected barotrauma, suspected comorbid conditions, or no history of asthma
Arterial blood gas	Severe dyspnea, PEFR < 30% predicted after initial treatment, ill out of proportion to the PEFR, SaO_2 of ≤90%.

Abbreviation: PEFR, peak expiratory flow rate.

charts of all admitted patients and all patients who returned to the ED within 72 hours, looking for any further chest x-rays or arterial blood gases and their results. Data means were used as the average and standard deviations used as the measure of variability. Before (pre-P) and after (post-P) demographic data was compared using paired and unpaired Student's *t* tests and analysis of variance. Categorical data such as individual ED treatments and frequency of diagnostic testing were compared using the Chi-square test.

RESULTS

Two hundred twenty-two patients during the months of September and October of 1998 (pre-P) and 259 patients during the same 2-month period of 1999 (post-P) were evaluated for acute asthma symptoms. Data were available for 213 and 222 patients during the 1998 and 1999 periods, respectively. Patients were similar in terms of age and gender pre- and post-P. The rates of admission were similar before (20%) and after (19%) protocol implementation as were the rates of return within 72 hours from ED discharge (4-5%). The average number of days that patients were hospitalized was similar before (3.83 ± 2.8) after (3.12 ± 1.6) protocol implementation ($P = .26$).

There was 55% reduction in the number of chest radiographs post-P as compared with pre-P ($P < .001$). During the pre-protocol period, 85 of 213 patients (40%) who presented to the ED with acute asthma exacerbation had CXR performed. Ninety-five percent of admitted patients and 30% of patients discharged from the ED with acute asthma exacerbation had CXR. After protocol implementation, 40 of 222 (18%) asthmatics (47% of admitted patients and 12% of discharged patients) had CXR. Only 6 patients (7%) pre-P and 4 (10%) patients post-P had evidence of infiltrate or pneumonia on chest x-ray (P = not significant). Of the patients who did not have a chest x-ray in the ED, none had an abnormal chest x-ray obtained after admission or if they returned to the ED within 72 hours.

The number of arterial blood gases done in the ED for acute asthma exacerbation fell by 57% with the implementation of a protocol to guide such testing. Before protocol implementation, 20 of 212 (9.4%) patients had ABGs in the ED. Eleven of these ABGs (55%) were abnormal showing either respiratory acidosis, hypoxemia, or both. Abnormal ABGs were associated with severe dyspnea requiring intubation and mechanical ventilation in 5 patients, pulse oximetry readings less than 90% in 4 patients, PEFR of less than 60 in 1, and 1 was severely dyspneic and somnolent despite a PEFR greater than 100. Nine patients in the pre-protocol phase had normal ABGs in the ED for which no indication could be determined on chart review. Five additional ABGs were obtained by the admitting service during these pre-protocol months. A documented "indication" was found for the abnormal ABG, whereas no indication was found for the 4 normal ABGs. Post-protocol, 9 patients had blood gases measured in the ED, 7 (77%) of which were abnormal. The ABG abnormalities included respiratory acidosis in 6 patients and hypercarbia with hypoxemia in the seventh. The results were used to determine need for more intensive care, including intubation and mechanical ventilation, or used to alter the ventilator settings. The one ABG done without a discernible "indication" was normal. Seven additional patients had blood gas measurements done by the admitting service within 6 hours of hospitalization. Among these 7, the only patient with an abnormal ABG (pO_2 of 52) had had pulse oximetry readings of 88-90% in the ED. There was no identifiable indication for any of the other 6 tests and none of these showed significant abnormalities.

DISCUSSION

The management of acute asthma in the ED involves multiple clinical assessments and often includes CXR and ABG. The studies on the use of diagnostic testing in acute asthma are mixed. Some studies promote the routine use of chest radiography. These studies cite a 9-34%[7,8] incidence of clinically important abnormalities found on chest x-rays of patients with severe asthma. Tsai found a 21% incidence of clinically important chest x-ray abnormalities in patients admitted with obstructive airway disease. However, all but 1 of the 27 of these abnormalities were found in patients with "complicated" obstructive airway disease. Some complicating clinical features that correlated with a treatment-altering chest x-ray findings included chronic obstructive pulmonary disease, a history of fever and comorbid heart disease, or intravenous drug abuse and seizures.[2]

The routine use of ABG has fallen out of favor for 2 reasons. First, less invasive assessments of respiratory function are now widely available, including pulse oximetry, spirometry or peak expiratory flow measurement, and end-tidal CO_2 detection. Second, arterial blood gases do not correlate with asthma severity[9] or predict respiratory failure.[10]

National guidelines for the treatment of patients with acute asthma are available.[11,17,18] However, there is quite a bit of variation among EDs,[19] and the typical emergency physician is still often guided by institution-specific practices and by individual preferences.[20,21] Although this can provide effective, quality patient care, it might be less expedient and is often more costly.[22]

Outlining criteria for obtaining CXRs in acute asthma decreased x-ray use by 55%. Despite fewer CXRs in the ED, no patient who returned to the ED was found to have an abnormal CXR within 72 hours of the initial visit, and no patient had pneumonia or other pathology on CXR performed during hospitalization. This study confirms the relatively low incidence of abnormal chest x-rays found in acute asthma reportedly previously.[13,23]

Without a protocol to guide the use of arterial blood gas testing, 57% more patients had ABGs than after the protocol

was in place. Use of clinical criteria reduced the use of ABGs significantly. Despite fewer ABGs obtained in the ED, there were no unexpected abnormal ABGs obtained by the admitting service and no patients that required emergent intubation and ventilation after admission. Also, no patient was transferred from a general medical unit or asthma unit to an intensive-care unit in the post-P period. The criteria for obtaining an ABG used in this study might have helped to identify patients that require more aggressive treatment or intubation and mechanical ventilation. The number of ABGs could, perhaps, have been further reduced by eliminating hypoxemia as a criterion as oxygenation, which can often be monitored adequately with a pulse oximeter. Nonetheless, the use of relatively conservative, clinically based criteria still affected a substantial reduction in the number of ABGs ordered in the ED in this study.

Although larger prospective studies are needed to validate these criteria, this study supports the use of specific criteria to guide the use of CXR and arterial blood gases in acute asthma.

Several factors might have contributed to the success of this study. First, the guidelines were accepted and implemented locally. Second, the protocol required both nursing and physician participation. The nursing and physician staffs were probably motivated to improve the care they render to their own patients.

There are several limitations to this study. First, this was a retrospective study. Second, the ED staff was responsible for implementing the protocol. To minimize the effect of the study on ED staff behavior, the data collection phase was not announced and was delayed by 8 weeks from the introduction of the protocol. Another limitation of the study was the lack of direct patient follow up. Although patients' rate of return to the ED was measured and charts of patients admitted to the hospital were reviewed, they could have sought treatment at other EDs or doctors' offices.

Although limited in scope, this study does show that implementing an evidence-based protocol for the diagnostic testing of patients with acute asthma can safely reduce CXR and ABG utilization to improve ED efficiency in an academic ED. The study provides support for a prospective study to verify the data and to validate the criteria used for obtaining CXRs and arterial blood gases in acute asthma.

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