Utility of the Peak Expiratory Flow Rate in the Differentiation of Acute Dyspnea*  
Cardiac vs Pulmonary Origin  
Robert M. McNamara, M.D.; and David J. Cionni, M.D.

This study examined the utility of a peak expiratory flow rate (PEFR) measurement in the differentiation of acute moderate to severe dyspnea secondary to congestive heart failure or chronic lung disease. A PEFR was determined in 41 episodes of acute respiratory distress in 40 patients prior to emergency department therapy. The mean PEFR ± SD for the congestive heart failure group (n = 18) was 224 ± 82 L/min, which was significantly higher (p < 0.001) than that of the chronic lung disease group (n = 23), which had a mean PEFR of 108 ± 49 L/min. No single cutoff value allowed 100 percent accurate classification, but the results suggest that the PEFR may be a useful adjunctive tool in the differentiation of acute dyspnea of cardiac vs pulmonary origin.  

(Chest 1992; 101:129-32)

CHF = congestive heart failure; CLD = chronic lung disease; ED = emergency department; PEFR = peak expiratory flow rate; PPV = positive predictive value

In the patient with acute respiratory distress, differentiation of cardiac and primary pulmonary causes is essential to proper management. On occasion, this may be difficult as clinical features, including wheezing, orthopnea, and edema, can overlap.1-3 Such diagnostic difficulty has been documented in the prehospital setting.4 Failure to distinguish dyspnea of cardiac or pulmonary cause may be deleterious if this results in misguided therapy.4

The purpose of this study was to examine the usefulness of the absolute peak expiratory flow rate (PEFR) in the differentiation of congestive heart failure or chronic lung disease in patients with acute, moderate, to severe dyspnea in the emergency department (ED).

METHODS

This was a prospective observational study conducted in the ED of the Medical College of Pennsylvania Hospital (Philadelphia), a 350-bed urban teaching hospital. The study period was November 1988 to March 1989. Adult patients, aged 40 years or greater, who presented with moderate to severe dyspnea were entered into the study. The clinical judgment of the initial examining physician, who was either a senior resident or faculty member of the Emergency Medicine residency program, was used to determine the degree of dyspnea. To assure that only patients with moderate to severe dyspnea were included, the study form requested a rating of the patient’s respiratory distress as either none, mild, moderate, or severe. This scale is identical to that of a previous study.4

A PEFR was obtained by the physician prior to ED pharmacologic intervention other than oxygen. A flowmeter (mini-Wright peak flow meter, Armstrong Industries Inc, Northbrook, IL) was used and the highest of three attempts was recorded as suggested by Wright and McKerrow.5 Prior to beginning the study, the involved physicians received instruction in the proper performance of a PEFR and these directions were also included on the data collection sheet.

Only those patients who had a data collection form completed at the time of the ED encounter were entered into the study. The information requested on this form included demographic information, presenting vital signs, and the medication history. Physical examination items documented were the presence or absence of diaphoresis and the upright position, findings on lung auscultation, and the physician’s rating of the degree of respiratory distress. The PEFR on arrival was recorded as well as the ability of the patient to cooperate with the performance of the PEFR. The final information collected was the chest roentgenogram interpretation, the final ED diagnosis, and patient disposition.

Patients were excluded if they were judged by the physician as unable to cooperate with the performance of a PEFR. On review of the records, only those patients whose acute episode of dyspnea could be principally attributed to pulmonary edema (congestive heart failure [CHF]) or to chronic lung disease (CLD) were subject to analysis. The diagnosis at the time of discharge from the ED or the discharge diagnosis on the inpatient record was taken to be the final diagnosis. Asthma, bronchitis, or emphysema were the only types of CLD considered for inclusion. Mixed presentations of CHF and CLD were excluded along with all other diagnoses producing respiratory distress.

Statistical analysis consisted of a two-tailed unpaired Student’s t test or Fisher’s exact test. A p value of < 0.05 was considered significant. Sensitivity, specificity, and positive predictive value (PPV) were calculated in the usual method. The PEFR values are reported in absolute numbers as a previous study indicates that the absolute PEFR works as well as the percent predicted in the ED setting.6 Use of the absolute PEFR precludes the need for computations based on age and height and this time saving is desirable in the emergency setting.

RESULTS

Completed data collection sheets were available for 66 episodes of acute dyspnea in 65 patients. Of these, 13 were excluded as the degree of respiratory distress was rated as mild. This assessment was supported by the fact that only one patient was admitted from this

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group and this patient had a diagnosis of pneumothorax. Five patients were unable to cooperate with the proper performance of a PEFR. Five more patients were excluded as their final diagnosis was not CHF or CLD alone. Two additional patients, aged 31 and 38 years, were excluded as they were younger than 40 years of age. This left a total of 41 episodes in 40 patients with 18 episodes principally attributed to CHF and 23 principally due to CLD.

As demonstrated in Table 1, there was no statistically significant difference between the groups with regard to age, sex, or presenting vital signs. The presence of diaphoresis was similar and virtually all patients assumed an upright posture. The groups were also similar in the percentage rated as in severe respiratory distress. The higher number of patients with CHF admitted probably reflects the concern for ischemic cardiac events in patients presenting with moderate to severe CHF.

The mean absolute PEFR ± SD was 224 ± 82 L/min for the CHF group and 108 ± 49 L/min for the CLD group. These values were significantly different (p<0.001), but as can be seen in Figure 1, overlapping values are present. The single PEFR reading that is most useful as a cutoff value was 150 L/min. A PEFR >150 L/min as diagnostic of CHF had a sensitivity of 0.78, specificity of 0.87, and a PPV of 0.82. Looked at from the other view, a PEFR ≤150 L/min as diagnostic of CLD had a sensitivity of 0.87, specificity of 0.78, and a PPV of 0.83.

The findings on lung auscultation are, as expected, helpful in distinguishing the two groups. Wheezing alone was reported in 17 (74 percent) and wheezing with rales was reported in three (13 percent) of the CLD group. In the patients with CHF, two (11 percent) presented with wheezing alone and ten (56 percent) had wheezing with rales. This total of 67 percent of the CHF group with some degree of wheezing indicates the potential for confusion of CLD and CHF by clinical assessment. Further breath sounds reported for the CLD group were rales alone in one (4 percent) patient and neither wheezes nor rales in two (9 percent). The remaining six (33 percent) patients with CHF presented with rales alone.

The medication history would be expected to be a useful differentiating tool and this was found to be partly true. Of the 18 patients reporting current drug therapy (aminophylline or β-agonist) only directed at CLD, 17 had a final diagnosis of CLD and one had CHF. Conversely, all six patients receiving agents (digoxin or furosemide) directed primarily at CHF had this as a final diagnosis. Unfortunately, nine subjects were receiving combination therapy and eight reported taking neither group of these drugs, making the medication history useless for classification in 44 percent of the study group.

**Discussion**

The absolute PEFR appears to be a useful adjunctive tool in differentiating the patient with moderate to severe dyspnea secondary to CHF as a cardiac cause or CLD as a pulmonary cause. We are unaware of any previous reports examining pulmonary function testing to differentiate these entities in the acutely decompensated state.

No single value allowed 100 percent accuracy, but a PEFR above 150 L/min is suggestive of CHF (PPV = 0.82) while a reading ≤150 L/min (PPV = 0.83) suggests a diagnosis of CLD. The PPV is the number of true positives divided by the sum of true and false positives and indicates the proportion of patients with a positive test (eg, PEFR >150 L/min) that are

<table>
<thead>
<tr>
<th></th>
<th>CHF (n=18)</th>
<th>CLD (n=23)</th>
<th>P</th>
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</thead>
<tbody>
<tr>
<td>Age, yr*</td>
<td>65±11</td>
<td>64±11</td>
<td>NS</td>
</tr>
<tr>
<td>Sex, M/F</td>
<td>10/8</td>
<td>10/13</td>
<td>NS</td>
</tr>
<tr>
<td>Heart rate, beats per min*</td>
<td>115±22</td>
<td>112±20</td>
<td>NS</td>
</tr>
<tr>
<td>Respiratory rate, breaths per min*</td>
<td>34±5</td>
<td>33±8</td>
<td>NS</td>
</tr>
<tr>
<td>Mean arterial blood pressure, mm Hg*</td>
<td>120±25</td>
<td>114±19</td>
<td>NS</td>
</tr>
<tr>
<td>Diaphoretic, No. (%)</td>
<td>7 (39)</td>
<td>4 (17)</td>
<td>NS</td>
</tr>
<tr>
<td>Upright posture, No. (%)</td>
<td>18 (100)</td>
<td>22 (96)</td>
<td>NS</td>
</tr>
<tr>
<td>Rating: severe/moderate</td>
<td>9/9</td>
<td>11/12</td>
<td>NS</td>
</tr>
<tr>
<td>Admitted, No. (%)</td>
<td>16 (89)</td>
<td>13 (56)</td>
<td>&lt;0.05</td>
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*Mean ± SD.

**Table 1 — Results**

**Figure 1. Peak expiratory flow rate (PEFR) values.**

PEFR for Differentiation of Acute Dyspnea (McNamara, Cionni)
correctly ruled in for a given diagnosis (eg, CHF). Very low PEFR values (<100 L/min) occurred exclusively in the CLD group, while relatively high values (>220 L/min) were found only in patients with CHF. A PEFR <100 L/min, however, only identified 10 of 23 patients with CLD while a PEFR >220 L/min picked out 9 of 18 patients with CHF. Using these cutoffs, the specificity of the test (100 percent) is excellent, but the sensitivity is poor since there is much overlap.

Pulmonary function testing has been previously recommended as a useful adjunct in the differentiation of cardiac and primary pulmonary dyspnea. In the early stages of pulmonary edema, obstruction of small airways occurs as they are compressed by engorged vessels in the bronchovascular sheath and by peribronchial interstitial edema. As the disease progresses, there can be actual narrowing of larger airways and the leakage of macromolecules into the airway may cause bronchoconstriction of larger airways. The PEFR is a measure of large airway obstruction that correlates well with FEV1. Previous clinical reports regarding pulmonary function in CHF were conducted in stable patients and demonstrated only mild decreases in the PEFR or FEV1. In our study, the PEFRs in the CHF group, although significantly higher than those for the patients with CLD, are distinctly abnormal for this age group. Normal patients older than 60 years would be expected to have much higher PEFRs (men ≥500 L/min; women ≥400 L/min). The lower values found in our patients with CHF as compared with previous reports probably reflect the more severe degree of illness selected for study and the greater expected dysfunction of the large airways.

As measures of airway obstruction are almost always dramatically reduced in patients with CLD and, as mentioned previously, such obstruction occurs relatively late in CHF, it was postulated that for a similar degree of respiratory distress, the PEFR would be higher in patients with CHF. Our results support this belief. Patients with mild or no dyspnea were excluded as the primary goal of the study was to determine the utility of the PEFR in those patients likely to require emergent, potentially deleterious treatment prior to diagnostic studies such as chest roentgenography. Such studies are not available in the prehospital setting and may be delayed in the hospital while the PEFR can be rapidly obtained at the bedside. While differentiating mild dyspnea due to CLD and CHF may be difficult, the diagnostic workup may be more deliberate and therapeutic intervention can be delayed until the cause of the dyspnea is more certain. Pulmonary function testing may be useful in mildly dyspneic patients, but this study primarily focused on the PEFR as an aid for rapid decision making in clinically unstable patients.

The history and physical examination are obviously important in the assessment of acute dyspnea, but previous literature documents the difficulty in distinguishing CHF and CLD on clinical grounds alone. The reported breath sounds in this study were a useful but not completely accurate distinguishing tool. The presence of wheezing in 67 percent of the CHF group confirms the potential for confusion regarding these diagnoses. The medication history, while useful, was limited by the fact that it could not correctly classify 44 percent of our study group.

Physical examination maneuvers have been investigated as adjuncts to the diagnosis of CHF. Marantz et al investigated the usefulness of hepatojugular reflux and the Valsalva maneuver for detecting CHF in patients in the ED. The severity of illness was not described. Hepatojugular reflux, while highly specific (0.96), was rarely present (sensitivity 0.24) and the Valsalva maneuver, while sensitive (0.73), was uninterpretable in 37 percent. Additionally, the Valsalva maneuver test described is complicated and difficult to interpret relative to the PEFR. The flow meter (mini-Wright peak flow meter) used in this study is a reusable lightweight (72 g) 15 x 5-cm cylinder that is relatively inexpensive ($60), completely portable, and requires no electrical power. A disposable short cardboard cylinder mouthpiece is required for each new patient. PEFR measurements using this device correlate highly with readings from the larger peak flow meter (Wright's) and a pneumotachograph. A potential weakness of the PEFR is its effort-dependent nature. Poor effort will result in falsely low PEFR values. We sought to minimize this by having only physicians instructed in the technique perform the test. Five patients who were unable to adequately cooperate with the test were excluded from the data analysis.

A major entry criteria involved an assessment of dyspnea by the treating physician that may be somewhat subjective. However, the involved physicians were experienced observers, either attendings or senior residents in an Emergency Medicine residency program, and the presenting vital signs and high admission rates support their assessments. Obviously, there are other causes of respiratory distress in patients who present to the ED and the results are not helpful for this group nor can they be applied to patients with a mixed presentation of CHF and CLD. Additionally, not every patient will be able to cooperate with the performance of a PEFR.

The classification of patients as CHF or CLD was not based on a “gold standard” or a specific set of criteria that may represent a limitation to the study. All patients, however, were significantly ill and it is unlikely that further evaluation, particularly chest
roentgenography, would have led to significant difficulty in ascribing a cause to this acute episode. All patients underwent chest roentgenography and the majority (71 percent) were admitted. This combined with a complete history and physical and evaluation of the response to treatment by experienced physicians would likely have produced accurate classification at the time of hospital discharge.

The treating ED physician was not blinded to the PEFR and this may have influenced the initial impression of the patient. However, the final diagnosis used to classify the patients was not rendered by the ED physician in the 71 percent who were admitted. In those discharged home from the ED, the diagnosis at time of discharge was used for classification. This diagnosis, again, was reached only after further evaluation and assessment of therapeutic response and would have not solely depended on the initial PEFR value.

Only patients aged 40 years or older were studied as younger patients with moderate to severe dyspnea are generally asthmatics and therefore in less need of a differentiating tool. Interestingly, the 31-year-old patient excluded had a PEFR of 360 L/min and a final diagnosis of CHF. He presented with severe dyspnea and only wheezing by lung examination suggesting these results may be useful in younger patients when the diagnosis is unclear.

The patients were studied on arrival in the ED and their prehospital care was not analyzed as we were examining only the ED usefulness of the PEFR. A previous study reported that of 57 patients with suspected prehospital pulmonary edema, 23 percent turned out to have another diagnosis with CLD, the most commonly missed diagnosis. The simple, economical, portable nature of this test suggests that it would be worth studying the utility of the PEFR in the prehospital setting where lung auscultation may be difficult and chest roentgenograms nonexistent.

**Conclusion**

In patients presenting to the ED with acute moderate to severe dyspnea, the PEFR will generally be higher in patients with CHF alone vs those with CLD as the source of respiratory distress. The results suggest that the PEFR, particularly relatively high or low values, may be a useful adjunct to a rapid clinical assessment in patients requiring emergency intervention for acute dyspnea prior to more extensive evaluation.

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