Predicting the Need for Mechanical Ventilation and/or Inotropic Support for Young Adults Admitted to the Hospital with Community-Acquired Pneumonia

James D. Chalmers, Aran Singanayagam, and Adam T. Hill
Royal Infirmary of Edinburgh, Edinburgh, United Kingdom

The UK Department of Health has published concerns that pneumonia severity scores determined at hospital admission may underestimate the severity of pneumonia in young adults. SMART-COP (systolic blood pressure, multilobar chest radiography involvement, albumin level, respiratory rate, tachycardia, confusion, oxygenation, and arterial pH) was superior to both the CURB65 (confusion, urea, respiratory rate, systolic or diastolic blood pressure, and age ≥65 years) score and the Pneumonia Severity Index in predicting the need for mechanical ventilation and/or inotropic support, but SMART-COP would still incorrectly stratify 15% of patients.

Severity assessment is an essential first step in the management of community-acquired pneumonia, and it guides decisions regarding route and type of antibiotic therapy, as well as decisions to discharge patients from the hospital or to admit them to higher levels of care [1, 2]. Existing severity-assessment tools such as the CURB65 (confusion, urea, respiratory rate, systolic or diastolic blood pressure, and age ≥65 years) score [3] and the Pneumonia Severity Index (PSI) [4] are based on the risk of 30-day mortality. They may be less accurate for consideration of other outcomes, such as the need for admission to the intensive care unit [5].

Although these scores have been widely used and validated for predicting mortality in large populations, no studies exist of outcomes of community-acquired pneumonia that affects young people. Death due to community-acquired pneumonia is rare in previously fit young adults [6]. As a result, the widely used severity indexes are based almost exclusively on the risk of death among older people. It is recognized that the presenting features of elderly patients with pneumonia are different from those in younger patients [7].

The UK Department of Health has claimed that the CURB65 score may underestimate the severity of pneumonia in young adults [8]. There are, however, no studies of the performance of the CURB65 score relative to young people with community-acquired pneumonia on which to base such a conclusion. Because mortality is low in patients <50 years of age who are admitted to the hospital with community-acquired pneumonia, the aim of our study was to evaluate current severity scores for their ability to predict the need for mechanical ventilation and/or inotropic support in this population.

Patients and methods. A prospective study was performed involving patients who presented with a primary diagnosis of community-acquired pneumonia from January 2005 through January 2008 at the National Health Service Lothian University Hospitals (Edinburgh, United Kingdom) [9]. The study was approved by the Lothian Research Ethics Committee.

Patients were included in the study if they were <50 years of age and presented with a new infiltrate on a chest radiograph and had ≥3 of the following symptoms or signs: cough, sputum production, breathlessness, pleuritic chest pain, hemoptysis, fever (temperature >37.8°C), headache, and signs consistent with pneumonia on chest auscultation. In addition to applying these criteria, we reviewed data at follow-up (including chest radiograph reports), to ensure that the diagnosis of pneumonia was correct and that no exclusion criteria had developed.

Exclusion criteria were hospital-acquired pneumonia (i.e., development of symptoms >48 h after hospital admission or discharge from an acute-care facility <2 weeks before hospital admission), active thoracic malignancy, immunosuppression, and pulmonary embolism. Patients for whom active treatment was not considered to be appropriate (e.g., those in palliative care) were also excluded.

For all patients admitted to the hospital with community-acquired pneumonia, a pro-forma (which included patient blood pressure, pulse, respiratory rate, and temperature) was completed at hospital admission, and standard blood tests (i.e., full blood count, urea and electrolyte analysis, liver-function tests, and assessment of C-reactive protein level) were performed for each patient. All examinations were performed in the emergency department within 4 h after patient arrival. Mi-
The primary end point was requirement for mechanical ventilation and/or inotropic support. The indications for mechanical ventilation and/or inotropic support were left to the discretion of the attending physicians.

All data were analyzed using SPSS, version 13 (SPSS), for Windows. A χ² analysis compared the severity scores in predicting the need for mechanical ventilation and/or inotropic support. The value of predictive tests was assessed using the following performance characteristics: sensitivity, specificity, positive predictive value, negative predictive value, and the area under the receiver operating characteristic curve. A P value <.05 was considered to be statistically significant for each analysis.

Results. There were 335 patients <50 years of age who were admitted to the hospital with community-acquired pneumonia. Five patients (1.5%) died within 30 days after hospitalization. Mechanical ventilation and/or inotropic support were required for 33 patients (9.9%). Seventy-eight patients (23.3%) were discharged from the hospital within 24 h after hospital admission. Among the patients included in the study, the median age was 36 years (interquartile range, 28–43 years), and the median duration of hospital stay was 4 days (interquartile range, 2–7 days). Five patients (1.5%) had chronic cardiac disease, 31 (9.2%) had chronic liver disease, 7 (2.1%) had neurological disease, 5 (1.5%) had chronic renal failure, and 12 (3.6%) had diabetes mellitus as a comorbid illness(es). Eleven patients (3.3%) had chronic lung disease.

There were no missing data in the study. Both the PSI and SMART-COP score require arterial blood gas data; 58 patients did not have arterial blood gases analyzed, but this group all had oxygen saturation levels ≥92% while breathing room air and normal serum bicarbonate concentrations. Hydrogen ion levels were assumed to be within normal range in this group.

A definite microbiological diagnosis was made for 92 patients (27.5%). The organisms most frequently isolated were Streptococcus pneumonia (51 patients; 15.2%), methicillin-susceptible Staphylococcus aureus (10 patients; 3.0%), Mycoplasma pneumonia (9 patients; 2.7%), Haemophilus influenza (6 patients; 1.8%), Legionella pneumophila (5 patients; 1.5%); influenza virus (4 patients, 1.2%; i.e., influenza A virus, 2 patients; influenza B virus, 1 patient; parainfluenza virus, 1 patient), Klebsiella pneumonia (3 patients; 0.9%), Staphylococcus aureus positive for the Panton-Valentine leukocidin gene (PVL; 2 patients; 0.6%), Escherichia coli (1 patient; 0.3%), and Chlamydia pneumonia (1 patient; 0.3%).

All of the patients who died within 30 days after hospitalization had at least 1 comorbidity. Because of the low mortality rate, analysis of the severity scores was limited to the primary outcome of requirement for mechanical ventilation and/or inotropic support.

Performance of admission severity scores for young people with community-acquired pneumonia. The SMART-COP score was superior to both the CURB65 score and the PSI in predicting the requirement for mechanical ventilation and/or inotropic support. The performance characteristics of these predictive tests are shown in Table 1.

SMART-COP had performance characteristics superior to those of both CURB65 and PSI, with a higher sensitivity and higher negative predictive value. Both CURB65 and PSI had high specificity but low sensitivity. Fifteen (45.5%) of 33 patients who required mechanical ventilation and/or inotropic support were classified as having low-intermediate risk (score,
0–2) with use of the CURB65 score, and 15 (45.5%) of 33 patients at high risk were classified as having low-intermediate risk (score, 1–3) with use of the PSI. In contrast, fewer patients (5 [15.2%] of 33 patients; \( P = .02 \)) classified as having low risk (score, 0–2) with use of the SMART-COP score required mechanical ventilation and/or inotropic support.

**Discussion.** To our knowledge, this is the first study to consider the role of severity assessment in young patients admitted to the hospital with community-acquired pneumonia. Our study confirmed that mortality is rare (1.5%), but the requirement for mechanical ventilation and/or inotropic support is a more frequent complication (9.9%) among these patients. Therefore, for patients <50 years of age who were admitted to the hospital with community-acquired pneumonia, we evaluated current severity scores for their ability to predict the need for mechanical ventilation and/or inotropic support.

The UK Department of Health has claimed that the CURB65 score may underestimate the severity of pneumonia in young adults [8]—in particular, the severe necrotizing pneumonia caused by *Staphylococcus aureus* carrying the PVL gene [8]. Our results confirm that, although the predictive value of CURB65 appears to be good (the majority of patients are appropriately identified to be at low risk), 45% of patients who required mechanical ventilation and/or inotropic support were inappropriately classified as having low-to-intermediate risk (score 0–2). Similarly, 45% of patients at high risk were classified as having low-to-intermediate risk with use of the PSI (score, 1–3). No statistically significant difference was found between the performances of the CURB65 score and the PSI. SMART-COP performed better but still did not identify 15% of patients who required mechanical ventilation and/or inotropic support.

In conclusion, patients <50 years of age who were admitted to the hospital with community-acquired pneumonia have a low 30-day mortality but a frequent need for mechanical ventilation and/or inotropic support. The current pneumonia severity scores (CURB65, PSI, and SMART-COP) all have high areas under the receiver operating characteristic curve for predicting the need for mechanical ventilation and/or inotropic support. SMART-COP performed better but still did not identify 15% of patients who required mechanical ventilation and/or inotropic support. These scores should be used only in conjunction with a formal clinical assessment.

**Acknowledgments**

**Financial support.** J.D.C. is supported by a Clinical Research Training Fellowship from the Medical Research Council (London, United Kingdom).

**Potential conflicts of interest.** All authors: no conflicts.

**APPENDIX**

**SEVERITY-ASSESSMENT SCORES**

The Pneumonia Severity Index (PSI) [4], the CURB65 score [3], and the SMART-COP score [10] were used to assess severity of illness at presentation. The PSI [4] is a well-validated prediction scale for 30-day mortality for patients with community-acquired pneumonia and comprises the following characteristics:

- **Demographic characteristics**
  1. Age,
  2. Sex, and
  3. Nursing home residency;

- **Comorbid illness(es)**
  1. Neoplastic disease,
  2. Cerebrovascular disease,
  3. Congestive cardiac failure,
  4. Chronic renal disease, and/or
  5. Chronic liver disease;

- **Physical examination findings**
  1. Altered mental status,
  2. Respiratory rate >30 breaths/min,
  3. Systolic blood pressure <90 mm Hg,
  4. Temperature <35°C or >40°C, or
  5. Pulse >125 beats/min;

- **Laboratory findings**
  1. pH <7.35,
  2. Blood urea level >10.7 mmol/L,
  3. Sodium level <130 mmol/L,
  4. Glucose level >13.9 mmol/L,
  5. Hematocrit <30%, and/or
  6. Partial pressure of oxygen <60 mm Hg; and/or

- **Radiological findings**
  1. Pleural effusion, determined by radiograph.

With use of these data, patients were classified into 5 risk classes (1–5) according the criteria created by Fine at al. [4]. In the original Pneumonia Patient Outcome Research Team cohort study, 30-day mortality ranged from 0.1% for patients with a class 1 rating to 27% for patients with a class 5 rating. CURB65 is a validated method of predicting inpatient mortality associated with community-acquired pneumonia that is recommended by the British Thoracic Society [3]. The criteria are:
1. New-onset mental confusion,
2. Urea level $>7$ mmol/L,
3. Respiratory rate $\geq 30$ breaths/min,
4. Systolic blood pressure $<90$ mm Hg or diastolic blood pressure $=60$ mm Hg, and/or
5. Age $\geq 65$ years.

British Thoracic Society guidelines suggest that patients with a CURB65 score of 0–1 be considered for outpatient treatment; that patients with a CURB65 score of 2 be considered for short inpatient hospital stay; and that patients with a CURB65 score $\geq 3$ have severe pneumonia that requires inpatient management, and intensive care or high dependency environment care should be considered, particularly for patients with a CURB65 score $\geq 4$ [3].

SMART-COP [10] is a recently reported tool designed to predict whether patients admitted to the hospital with community-acquired pneumonia are likely to require intensive respiratory and/or vasopressor support (IRVS). The score was retrospectively calculated from prospectively collected data. It is composed of the following factors:

1. Systolic blood pressure $<90$ mm Hg (2 points),
2. Multilobar involvement determined by chest radiograph (1 point),
3. Albumin level $<35$ g/L (1 point),
4. Respiration rate (age-adjusted cutoff: for patients $\leq 50$ years of age, $\geq 25$ breaths/min; for patients $>50$ years of age, $\geq 30$ breaths/min (1 point),
5. Tachycardia, $\geq 125$ beats/min (1 point),
6. Confusion of new onset (1 point),
7. Oxygenation (age-adjusted cut off: for patients $\leq 50$ years of age, $<70$ mm Hg or oxygen saturation $\leq 93\%$; for patients $>50$ years of age, $<60$ mm Hg or oxygen saturation $\leq 90\%$ (2 points), and/or
8. pH (arterial) $<7.35$ (2 points).

The developers of this scoring system recommend the following interpretation:

- 0–2 points, low risk of needing IRVS,
- 3–4 points, moderate risk (1 in 8) of needing IRVS,
- 5–6 points, high risk (1 in 3) of needing IRVS, and
- $\geq 7$ points, very high risk (2 in 3) of needing IRVS.

References