Performance of the CURB-65 Score in Predicting Critical Care Interventions in Patients Admitted With Community-Acquired Pneumonia

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Study objective: Confusion, uremia, elevated respiratory rate, hypotension, and aged 65 years or older (CURB-65) is a clinical prediction rule intended to stratify patients with pneumonia by expected mortality. We assess the predictive performance of CURB-65 for the proximal endpoint of receipt of critical care intervention in emergency department (ED) patients admitted with community-acquired pneumonia.

Methods: We performed a retrospective analysis of electronic health records from a single tertiary center for ED patients admitted as inpatients with a primary diagnosis of pneumonia from 2010 to 2014. Patients with a history of malignancy, tuberculosis, bronchiectasis, HIV, or readmission within 14 days were excluded. We assessed the predictive accuracy of CURB-65 for receipt of critical care interventions (ie, vasopressors, large-volume intravenous fluids, invasive catheters, assisted ventilation, insulin infusions, or renal replacement therapy) and inhospital mortality. Logistic regression was performed to assess the increase in odds of critical care intervention or inhospital mortality by increasing CURB-65 score.

Results: There were 2,322 patients admitted with community-acquired pneumonia in the study cohort; 630 (27.1%) were admitted to the ICU within 48 hours of ED triage and 343 (14.8%) received a critical care intervention. Of patients with a CURB-65 score of 0 to 1, 181 (15.6%) were admitted to the ICU, 74 (6.4%) received a critical care intervention, and 7 (0.6%) died. Of patients with a CURB-65 score of 2, 223 (27.0%) were admitted to the ICU, 127 (15.4%) received a critical care intervention, and 47 (5.7%) died. Among patients with CURB-65 score greater than or equal to 3, 226 (67.0%) were admitted to the ICU, 142 (42.1%) received a critical care intervention, and 43 (12.8%) died. The areas under the receiver operating characteristic for CURB-65 as a predictor of critical care intervention and mortality were 0.73 and 0.77, whereas sensitivity of CURB-65 score greater than or equal to 2 in predicting critical care intervention was 78.4%; for mortality, 92.8%.

Conclusion: Patients with CURB-65 score less than or equal to 2 were often admitted to the ICU and received critical care interventions. Given this finding and the relatively low sensitivity of CURB-65 for critical care intervention, clinicians should exercise caution when using CURB-65 to guide disposition. Future ED-based clinical prediction rules may benefit from calibration to proximal endpoints. [Ann Emerg Med. 2019;74:60-68.]

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INTRODUCTION

Background and Importance

Pneumonia is a leading cause of emergency department (ED) visits and hospital admissions.[1] Critical to the management of patients with pneumonia is initial disposition: whether to provide care in the outpatient setting, admit to the hospital ward, or admit to the ICU. To address this management decision, the Infectious Diseases Society of America/American Thoracic Society consensus guidelines and British Thoracic Society guidelines recommend incorporating clinical prediction rules into clinical decisionmaking alongside physician judgment.[2,3]

One such proposed prediction rule, the confusion, uremia, elevated respiratory rate, hypotension, and aged 65 years or older (CURB-65) score, was derived to estimate 30-day mortality in patients with community-acquired pneumonia. The score was derived and validated from approximately 1,000 patients admitted to the hospital with community-acquired pneumonia and was found to effectively stratify patients by increasing risk of 30-day mortality.[4] On the basis of a low predicted mortality, the

Editor's Capsule Summary

What is already known on this topic

Confusion, uremia, elevated respiratory rate, hypotension, and aged 65 years or older (CURB-65) predicts 30-day mortality in patients with community-acquired pneumonia and is recommended as an aid to disposition decisions.

What question this study addressed

How frequently do patients classified as being at low risk for mortality by CURB-65 require critical care interventions in the course of their illness?

What this study adds to our knowledge

Two thousand two hundred thirty-two eligible inpatients with community-acquired pneumonia were retrospectively identified. Of 480 patients in the lowest CURB-65 risk category, few died (0.6%) but 4.2% received vasopressors, assisted ventilation, invasive catheters, an insulin drip, or dialysis.

How this is relevant to clinical practice

Although somewhat useful in predicting mortality, CURB-65 does not appear to make clinically useful predictions about the level of inpatient care a patient will require.

authors of the original article suggested that patients with a CURB-65 score of 0 to 1 (mortality <2%) may be suitable for outpatient management and those with a score of 2 may be suitable for ward-level care or observation.[4] These suggestions have made their way into clinical practice, in which electronic incorporation of the score has been recommended to be used as a real-time decision support tool.[5,6] In our local observations, CURB-65 has been included electronically in the ED interface, and is often cited in discussions between ED clinicians and admitting teams in regard to disposition decisions.

The calibration of prediction rules to mortality in admitted patients, however, fails to account for the potential benefit of interventions received by patients while hospitalized. These interventions may be in the pathway of survival or nonsurvival and therefore should be considered when disposition decisions are made. A young patient without significant comorbidities who presents with severe pneumonia, for example, may require a period of assisted ventilation but is likely to survive. The more proximal "need for critical care intervention" (or even elements of hospital care such as supplemental oxygen, vital signs monitoring, and intravenous antibiotics) may be more pertinent to the front-line provider than whether the patient ultimately lives or dies. As has been recently noted, the field of clinical prediction in pneumonia should move on from the endpoint of mortality and instead focus on proximal outcomes with more relevance to decisionmaking.[7] The relationship between the CURB-65 score and need for critical care intervention has yet to be comprehensively studied.

Goals of This Investigation

We performed a retrospective validation study of the CURB-65 prediction instrument on our own patient population, adding several transitional outcomes not addressed in previous studies. Specifically, we assessed the predictive performance of the CURB-65 score in patients with community-acquired pneumonia with respect to the proximal endpoint of critical care intervention. We further aimed to determine how frequently patients with a low predicted risk of mortality by CURB-65 score receive critical care interventions early in their hospital stay.

MATERIALS AND METHODS

Study Design and Selection of Participants

This was a single-center, retrospective study conducted at an urban tertiary care center with approximately 57,000 ED visits annually. Patients presenting to the ED between January 2010 and December 2014 with suspected infection and who were admitted to the hospital as inpatients with a primary admission diagnosis of pneumonia (as determined by the admitting emergency physician) were included in the study. The period was selected because our database was constructed with *International Classification of Diseases, Ninth Revision* (*ICD-9*) codes for certain variables. Our selection criteria were guided by the criteria for eligibility used in the original CURB-65 derivation study; thus, patients readmitted within 14 days, as well as those with a history of malignancy, tuberculosis, bronchiectasis, or HIV (as determined by *ICD-9* code), were excluded. The institutional review board at Beth Israel Deaconess Medical Center approved this study.

Data Collection and Processing

The electronic medical records for each included patient were queried, and demographic data, vital signs, and laboratory results were abstracted. Vital signs considered outside of the physiologic range were interpreted as chart documentation errors and were considered missing (ie, pulse rate <30 or ≥200 beats/min, respiratory rate <4 or ≥60 breaths/min, and systolic blood pressure <50 or ≥250 mm Hg). For all patients with missing vital signs, manual chart review was performed to extract vital signs.

Medical comorbidities were determined with previously established *ICD-9* codes for various conditions.[8]

For calculation of the CURB-65 score, the worst values for each criterion measured in the ED (for blood pressure) or in the first 24 hours after ED triage (for laboratory values) were used.

An *ICD-9* code suggesting altered mentation (780.0, 780.09, 780.02, 780.97, 349.82, and 348.31) documented by an ED clinician or a documented ED chief complaint suggesting altered mentation (eg, altered mental status, confusion, change in mental status) was used to determine whether an alteration in mental status was present. This methodology has been previously applied to determine mental status.[9]

Outcome Measures

The primary outcome of this study was "received critical care intervention" within 48 hours of ED triage. Interventions classified as critical care interventions were determined by review of the literature[10-12] and as used in a previous study.[9] Critical care interventions included receipt of vasopressor or ionotropic support agents (norepinephrine, phenylephrine, vasopressin, epinephrine, dopamine, dobutamine, and milrinone), receipt of assisted ventilation (either invasive or noninvasive), receipt of a continuous insulin infusion, receipt of greater than 4,000 mL of intravenous fluid within 12 hours of ICU admission, placement of invasive catheters (central venous line, pulmonary artery catheter, arterial line, or balloon pump), or renal replacement therapy (Figure 1). Critical care interventions were determined with structured data from our high-resolution ICU database. Patients initially admitted to a ward level of care but subsequently transferred to an ICU and provided a critical care intervention within 48 hours of ED triage were categorized as having received a critical care intervention. Therefore, any critical care intervention was included regardless of initial physician choice of admission location. Information in regard to inhospital mortality was also abstracted from the electronic medical record.

Critical Care Interventions

- Vasopressor or Ionotropic Support
- Assisted Ventilation
  - Invasive mechanical ventilation
  - Non-invasive positive pressure ventilation
- Continuous Insulin Infusion
- ≥ 4,000ml of Intravenous Fluid within 12-hours of ICU admission
- Placement of Invasive Catheters
  - Central venous catheter
  - Arterial catheter
  - Pulmonary artery catheter
  - Intra-aortic balloon pump
- Renal Replacement Therapy

Figure 1. Critical care interventions.

Primary Data Analysis

Descriptive data are presented as means with SD or medians with interquartile ranges, depending on the distribution of the data. Categorical data are presented as counts with relative frequencies. Between-group comparisons were made with χ^2 tests for categorical data and 2-sample t tests or Wilcoxon rank sum tests for continuous data as appropriate. Standard normal values were imputed for missing values, as has been done in other studies exploring prognostic scores.[13] Overall, data loss was very low for all CURB-65 variables (<1%).

Model discrimination was determined on the basis of the area under the receiver operating characteristic (AUROC). Sensitivities and specificities were calculated at a cutoff of CURB-65 score greater than or equal to 2, as has been previously suggested.[2,3] CURB-65 test characteristics were also explored at other cutoff points. Logistic regression was used to assess the stepwise increase in odds of receiving a critical care intervention or experiencing inhospital mortality by increasing CURB-65 score. To compare stepwise mortality in our cohort with that of the CURB-65 derivation cohort, we created a new data set using data from the original CURB-65 study that included the number of patients in the cohort with each CURB-65 score and the number of patients with each CURB-65 score who died. Logistic regression was used in the new data set to assess the stepwise increase in odds of mortality with increasing CURB-65 score.

A 2-tailed $P<.05$ was considered statistically significant. All statistics were performed with Stata (version 14; StataCorp, College Station, TX).

RESULTS

Characteristics of Study Subjects

A total of 24,164 patients presented to the ED and were admitted to the hospital with suspected infection during the study period. Of these, 2,322 patients (9.6%) were admitted with a primary diagnosis of community-acquired pneumonia. The mean age of patients admitted with pneumonia was 69.0 years (SD 17.6 years) and 50.0% were women. For complete characteristics of the study cohort, see Table 1. There were 489 patients (21.1%) who were initially admitted to the ICU and 1,833 (78.9%) initially admitted to a ward level of care (Figure 2).

Of the 2,322 patients in the cohort, 1,159 (49.9%) had a CURB-65 score of 0 to 1, 826 (35.6%) had a score of 2, and 337 (14.5%) had a score greater than or equal to 3. For a complete breakdown of score distribution, see Table 2.

Of the 1,833 patients initially admitted to a ward level of care, 1,040 (56.7%) had a CURB-65 score of 0 to 1, whereas 793 (43.3%) had a score greater than or equal to 2.

Table 1. Baseline characteristics.

Characteristics	All Patients (n=2,322)	Received Critical Care Intervention (n=343)	No Critical Care Intervention (n=1,979)
Demographics			
Mean age (SD), y	69.0 (17.6)	68.8 (17.6)	69.0 (17.6)
Women, No. (%)	1,162 (50.0)	151 (44.0)	1,011 (51.1)
Vital signs, mean (SD)			
Systolic blood pressure, mm Hg	120.7 (24.1)	106.8 (26.2)	123.2 (23.8)
Respiratory rate, breaths/min	22.6 (6.2)	26.7 (7.7)	21.9 (5.6)
Temperature, °F, °C	99.5 (1.8), 37.5 (0.68)	99.5 (2.0), 37.5 (0.68)	99.5 (1.7), 37.5 (0.68)
Pulse rate, beats/min	97.8 (20.5)	105.0 (23.6)	96.5 (19.7)
Mental status			
AMS, No. (%)	153 (6.7)	32 (9.3)	124 (6.3)
Laboratory measurements, median (IQR)			
WBC count, K/uL	11.3 (8.0–15.4)	13.4 (9.6–18.0)	11.0 (7.8–14.8)
BUN, mg/dL	21.0 (14.0–31.0)	31.0 (20.0–50.0)	19.0 (14.0–29.0)
Lactate, mmol/L	1.6 (1.3–2.2)	2.2 (1.6–3.3)	1.5 (1.3–2.0)
Comorbidities, No. (%)			
CHF	624 (26.8)	142 (41.4)	482 (24.4)
Renal disease	551 (23.7)	94 (27.4)	457 (23.1)
Liver disease	131 (5.6)	25 (7.3)	106 (5.4)
Diabetes	661 (28.5)	118 (34.7)	542 (27.4)

AMS, Altered mental status; *IQR*, interquartile range; *BUN*, blood urea nitrogen; *CHF*, congestive heart failure.

Of the 489 patients initially admitted to the ICU, 119 (24.3%) had a CURB-65 score of 0 to 1, 174 (35.6%) had a score of 2, and 196 (40.1%) had a score greater than or equal to 3.

There were 141 patients (6.1%) initially admitted to a ward level of care who were transferred to the ICU within 48 hours of ED triage. Among these patients, 62 (44.0%) had a CURB-65 score of 0 to 1 and 49 (30.5%) had a score of 2. Overall, 181 patients (15.6%) with a score of 0 to 1 and 223 (27.0%) with a score of 2 were admitted to the ICU within 48 hours. See Figure 2 for the patient flow diagram. Higher CURB-65 score was a predictor of need for ICU transfer for patients initially admitted to the floor (odds ratio [OR] 1.6; 95% confidence interval [CI] 1.4 to 2.0).

Including ward transfers, there were 630 patients admitted to the ICU within 48 hours of ED triage, and 343 (54.4%) of these patients received at least one critical care intervention. Of patients with a CURB-65 score of 0 to 1, 74 (6.4%) received a critical care intervention compared with 127 (15.4%) patients with a score of 2 and 142 (42.1%) with a score greater than or equal to 3. For a complete distribution of critical care interventions received by CURB-65 score, see Table 2.

Compared with patients with a CURB-65 score of 0 to 1, those with a score of 2 (OR 2.7; 95% CI 2.0 to 3.6; $P<.001$) and those with a score of 3 to 5 (OR 10.7; 95% CI 7.8 to 14.7; $P<.001$) were more likely to receive critical care interventions. Among patients receiving critical care interventions, central venous line (n=200; 61.9%), intubation (n=169; 49.3%), and vasopressor administration (n=144; 42.0%) were the most common.

Of patients with a CURB-65 score of 0 to 1 who were admitted to the ICU, 36 (19.9%) underwent intubation and 14 (7.7%) received noninvasive positive-pressure ventilation but were not intubated. See Table 2 for rates of all critical care interventions by score.

Overall, 97 patients (4.2%) died inhospital. Among patients with CURB-65 score 0 to 1, 7 (0.6%) died compared with 90 (7.7%) with a score greater than or equal to 2. We found that there was a stepwise increase in mortality for each increase in the CURB-65 score, with lower levels of mortality than those in the original study (Figure 3). Specifically, when the cohort was split into groups based on CURB-65 scores 0 to 1, 2, and 3 to 5, there was a stepwise increase in mortality by increasing score in both the original CURB-65 derivation study[4] and in the present study cohort. Compared with patients with a CURB-65 score of 0 to 1, patients in the present study cohort with a score of 2 (OR 9.9; 95% CI 4.5 to 22.1) and those with a score of 3 to 5 (OR 24.1; 95% CI 10.7 to

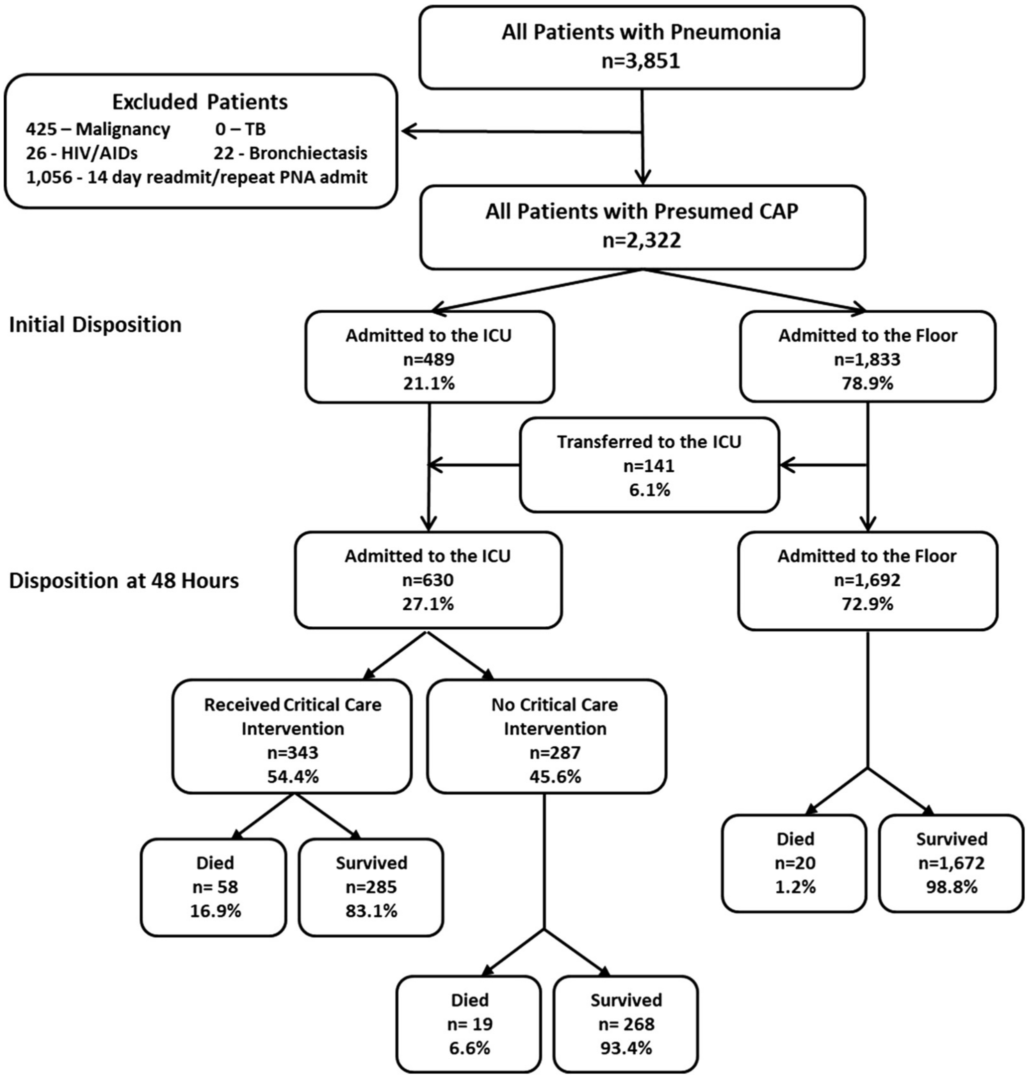

Figure 2. Disposition of patients admitted with pneumonia. *PNA*, Pneumonia; *CAP*, commonly acquired pneumonia.

54.1) were more likely to experience inhospital mortality. In the original study cohort, patients with a CURB-65 score of 2 (OR 6.5; 95% CI 2.4 to 17.9) and 3 to 5 (OR 18.4; 95% CI 7.2 to 47.2) had a higher likelihood of 30-day mortality compared with those with a score of 0 to 1. For a detailed distribution of critical care intervention and mortality by CURB-65 score, see Figure 3.

The AUROC for CURB-65 score was 0.73 (95% CI 0.71 to 0.76) (Figure 4) for critical care intervention and 0.77 (95% CI 0.73 to 0.81) for mortality. The sensitivity of CURB-65 score greater than or equal to 2 in predicting critical care intervention was 78.4% (95% CI 73.7% to 82.7%) and was lower than that for mortality, at 92.8% (95% CI 85.7% to 97.0%), whereas the specificity was low for both outcomes, at 54.8% (95% CI 52.6% to 57.0%) and 51.8% (95% CI 49.7% to 53.9%), respectively, when a cut point of greater than or equal to 2 was chosen. See Table 3 for CURB-65 test characteristics at additional cut points.

LIMITATIONS

Our study is subject to a number of limitations. Similar to the original CURB-65 derivation,[4] the study was conducted at a tertiary care center in an urban setting, thereby limiting the generalizability of the results. In particular, because it is a tertiary care referral center, many patients presenting with pneumonia have multiple medical comorbidities, which may increase the apparent clinical severity of patients with low CURB-65 scores. Related to this, we estimate that less than 10% of patients presenting to our ED with pneumonia are discharged home. As in the original CURB-65 derivation study, our cohort included only patients admitted to the hospital after presenting with pneumonia and excluded those who were being readmitted

Table 2. Critical care interventions and mortality by CURB-65 score.

	CURB-65 Score (n=2,322)					
Outcome	**0 (n=480)**	**1 (n=679)**	**2 (n=826)**	**3 (n=267)**	**4 (n=67)**	**5 (n=3)**
ICU intervention, % (95% CI)						
Any	4.2 (2.6–6.4)	8.0 (6.0–10.2)	15.4 (13.0–18.0)	35.6 (29.8–41.7)	67.2 (54.6–78.2)	66.7 (9.4–99.2)
Vasopressor	0.4 (0.0–1.5)	1.9 (1.0–3.3)	5.6 (4.1–7.4)	19.1 (14.6–24.3)	46.3 (34.0–58.9)	33.3 (0.8–90.6)
IPPV	1.9 (0.8–3.5)	4.0 (2.6–5.7)	6.7 (5.0–8.6)	17.2 (12.9–22.3)	44.8 (32.6–57.4)	66.7 (9.4–99.2)
NIPPV	1.7 (0.7–3.3)	1.3 (0.6–2.5)	4.5 (3.2–6.1)	8.2 (6.4–11.6)	6.0 (3.6–14.9)	0
Insulin gtt	0.2 (<0.1–1.1)	0.9 (0.3–1.9)	0.7 (0.2–1.6)	1.12 (0.2–3.2)	0	0
Invasive catheter	1.9 (0.9–3.5)	4.4 (3.0–6.3)	11.0 (9.0–13.4)	26.6 (21.4–32.3)	56.7 (44.0–68.8)	33.3 (0.8–90.6)
>4 L IVF	0.6 (0.1–1.8)	2.2 (1.2–3.6)	1.5 (0.7–2.4)	5.2 (2.8–8.6)	10.5 (4.3–20.3)	33.3 (0.8–90.6)
RRT	1.0 (0.3–2.4)	2.5 (1.5–4.0)	1.6 (0.8–2.7)	1.1 (0.2–3.2)	0	0
Mortality, % (95% CI)						
All	0.6 (0.1–1.8)	0.6 (0.1–1.5)	5.7 (4.2–7.5)	12.0 (8.3–16.5)	14.9 (7.4–25.7)	33.3 (0.8–90.6)
Admitted to floor (n=1,692)	0.5 (<0.1–1.7)	0.2 (<0.1–1.0)	2.0 (1.0–3.5)	2.9 (0.6–8.4)	12.5 (0.3–52.7)	100.0
Admitted to ICU (n=630)	2.0 (<0.1–10.6)	2.3 (0.4–6.6)	15.7 (11.1–21.1)	17.6 (12.1–24.3)	15.3 (7.2–27.0)	0

IPPV, Invasive positive pressure ventilation; *NIPPV*, noninvasive positive-pressure ventilation; *gtt*, continuous infusion; *IVF*, intravenous fluid; *RRT*, renal replacement therapy.

within 14 days and those with a history of malignancy, HIV, bronchiectasis, or tuberculosis. However, because of limitations of the available data, we were unable to exclude patients presenting from a nursing facility, as was done in the original study. Given that nursing home patients may represent a cohort with more compromised immune systems and different microbacterial exposures, our findings may be distorted if they were included in substantial numbers in our population. Nevertheless, we would expect the overall patterns of the findings (ie, that patients with CURB-65 scores 0 to 2 not infrequently receive critical care interventions despite very low mortality) to be unchanged. Additionally, it is possible that we were unable to identify patients recently admitted to other health care facilities. Although inhospital mortality was not the central focus of our investigation, we used it, whereas the original study used 30-day mortality as their primary endpoint.

In this study, we measured specific critical care interventions but did not include other aspects of ICU management such as close monitoring and high nurse-to-patient ratio. Furthermore, given the retrospective nature of the work, we were limited by available data and used unstructured ED data in addition to *ICD-9* codes in calculating the CURB-65 score. Although most follow-up investigation in regard to the CURB-65 score has relied on retrospective review using electronic medical records and administrative codes, this methodology may result in a decreased sensitivity for certain comorbidities.

The decision to perform a critical care intervention may be based on a combination of factors, some of which relate to the patient's clinical condition (eg, physiologic changes) and others that relate to the practice environment (eg, physician training, unit staffing). Nevertheless, we believe the decision to perform a critical care intervention compared with other outcome measures (eg, ICU admission) is more reflective of patient need as opposed to external factors. To this end, we have additionally captured critical care interventions received by patients initially admitted to the floor and then transferred to the ICU. Still, there is likely some residual subjectivity in the outcome of critical care intervention.

DISCUSSION

In this study, we assessed the predictive performance of the CURB-65 score, but used critical care interventions as

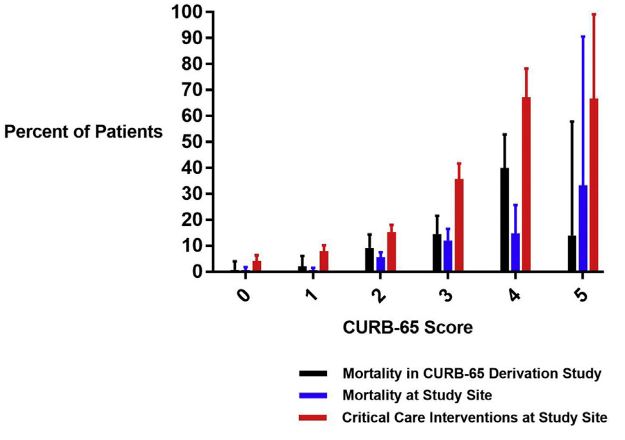

Figure 3. Mortality and critical care intervention rate by CURB-65 score.

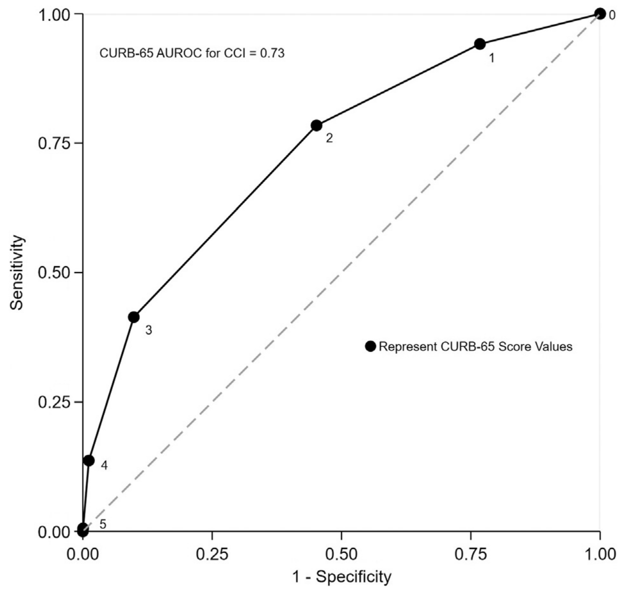

Figure 4. AUROC for CURB-65 in predicting critical care intervention.

our primary outcome of interest as opposed to 30-day mortality. In our study cohort, we found a stepwise increase in rates of critical care intervention and mortality for each point increase in the CURB-65 score. For patients with CURB-65 scores of 0 to 1, overall mortality was low (0.6%), as previously shown; however, many of these patients required ICU admission and received a critical care intervention. For example, 19.3% of patients with a CURB-65 score of 1 were admitted to the ICU and 8.0% received a critical care intervention. Among patients with a CURB-65 score of 2, for whom a short inpatient stay or closely supervised outpatient treatment has been suggested, 1 of every 6 received a critical care intervention. Thus, our overall findings suggest that patients with CURB-65 scores of 0 to 2 have a significant likelihood of receiving a critical care intervention despite low mortality rates.

The CURB-65 score was initially derived through the application of multiple logistic regression with an outcome of 30-day mortality to a population of 1,068 patients who presented to the ED and were admitted to the hospital with pneumonia. Since publication, the use of CURB-65 has been incorporated into clinical practice guidelines. The Infectious Diseases Society of America/American Thoracic Society guidelines, for instance, recommend that severity-of-illness scores, such as CURB-65, be used to identify patients with community-acquired pneumonia who may be candidates for outpatient treatment (strong recommendation, level 1 evidence).[2] They additionally recommend that severity-of-illness scores be supplemented with physician determination of subjective factors, ie,

Table 3. CURB-65 test characteristics at various score cut points.

	Sensitivity, %		Specificity, %	
CURB-65 Cut Point	Critical Care Intervention	Mortality	Critical Care Intervention	Mortality
≥1	94.2	96.9	23.2	21.4
≥2	78.4	92.8	54.8	51.8
≥3	41.4	44.3	90.2	86.8
≥4	13.7	11.3	98.8	97.4

ability to safely and reliably receive oral medications and appropriate resource availability (strong recommendation, level II evidence).[2] The British Thoracic Society guidelines suggest that patients who have a CURB-65 score of 0 or 1 are at low risk of death and may be suitable for outpatient treatment.[3] Moreover, the BTS guidelines state that "patients with a CURB-65 score of 0 have a low risk of death and do not normally require hospitalization." However, we found that 15.6% of patients with a CURB-65 score of 0 to 1 were admitted to the ICU and 6.4% received a critical care intervention. The guidelines further state that "patients with a score of 2 should be considered for short inpatient stay or hospital-supervised outpatient treatment." Yet our study demonstrates that 27.0% of patients with a CURB-65 score of 2 were admitted to the ICU and 15.4% received a critical care intervention.

The use of mortality as an endpoint for decisionmaking does not account for outcomes modified by inpatient care. As we have shown in our study, 85% of patients admitted to the hospital with pneumonia and greater than 60% admitted to the ICU have a CURB-65 score of 0 to 2, and although mortality is low, the need for critical care therapies is relatively high (10.1%). The rate of critical care intervention does not include other therapies that may contribute to increased survival such as supplemental oxygen for hypoxia, intravenous antibiotics, or a modest amount of intravenous fluids for hypotension. The need for clinical decision rules in pneumonia calibrated to proximal outcomes (as opposed to mortality) has been recently noted.[7]

As did the original study in which the CURB-65 score was derived,[4] we included only patients who were admitted to the hospital after presenting to the ED with pneumonia and did not include those discharged to home. Although this is how the original study was performed, we readily acknowledge that this approach is not appropriate when the safety of outpatient management is assessed and fails to take into account that mortality may be modified by inpatient care. A recent study of greater than 21,000 ED patients with community-acquired pneumonia (both admitted and discharged) found that although CURB-65 score performed well in predicting mortality in discharged patients, rates of 7-day readmissions were relatively high: 4.2% for a CURB-65 score of 0 and 7.7% for a score of 1.[14] Moreover, rates of admission of patients with CURB-65 scores of 0 to 1 were substantial, at 36.2% and 66.9%, respectively, suggesting that physicians intuitively recognized that many patients with low scores likely needed inpatient care.

In our study, the sensitivity of CURB-65 score greater than or equal to 2 in predicting receipt of critical intervention in our cohort was 78%, suggesting that greater than 20% of patients presenting with pneumonia who ultimately require a critical care intervention might be classified as being at low risk and eligible for discharge. Although the AUROC was relatively high for critical care intervention, at 0.73, the CURB-65 score was not derived to prioritize sensitivity in an ED setting in which appropriate disposition and timely intervention are vital. The sensitivity for a CURB 65 score of greater than or equal to 3 for critical care intervention was quite low (41.4%), suggesting that many patients with low CURB-65 scores may need critical care interventions and highlighting the potential pitfalls of triaging patients to the ward on the basis of a low CURB-65 score. Consideration of specific test characteristics (ie, sensitivity, specificity, and positive and negative predictive value) as opposed to overall AUROC is critical when clinicians are considering the use of any clinical prediction tool for patients with potentially life-threatening conditions.[15-18]

Other studies have explored the need for certain critical care interventions in community-acquired pneumonia according to CURB-65 score. These studies were smaller than the present analysis and were less comprehensive with respect to included critical care interventions. In one study, 30 of 405 patients (7.4%) with a CURB-65 score of 0 to 1 required assisted ventilation or vasopressors, whereas just 5 died (1.2%).[19] Including the aforementioned study, the performance of CURB-65 score for predicting the need for vasopressor or ventilatory support has been explored in 3 studies, with a combined sensitivity of 57.2% and specificity of 77.2% at a cutoff of CURB-65 score greater than or equal to 3.[20] These findings are similar to those reported in our analysis.

The strengths of our study include the large sample size and availability of a high-temporal-resolution electronic ICU database. We used critical care intervention as a more proximal endpoint than mortality, as demonstrated in a previous study.[9] This is a novel endpoint that may be useful for future clinical decisionmaking tools for patients with pneumonia or other infections. Although we focused on critical care interventions in this study, other inpatient interventions (eg, intravenous antibiotics, guaranteed compliance with medications, supplemental oxygen) were not taken into account, and an even larger cohort of patients may have received some benefit from their care while hospitalized. Alternatively, we must highlight that whether receipt of critical care interventions leads to improved mortality among patients with pneumonia is unknown and beyond the scope of this project.

In summary, using CURB-65 score to support clinical decisionmaking based on 30-day mortality may classify as low risk patients who receive critical care interventions and ultimately survive. Patients in our study with low CURB-65 scores (0 to 2) were often admitted to the ICU and received critical care interventions. This finding highlights the need to consider the potential modifying effects of inpatient management on outcomes when applying clinical prediction tools tailored to mortality.

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