Comparison of two predictive rules for assessing severity of community-acquired pneumonia

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Abstract

Community-acquired pneumonia (CAP) is a leading infectious cause of morbidity and mortality worldwide The aim of our study was to compare the ability of the two validated prediction rules for CAP to predict severity and mortality in patients with CAP in the University of Nigeria Teaching Hospital (UNTH), Enugu: the six-point CURB-65 score adopted by the British Thoracic Society and the simpler CRB-65.

A prospective observational study of 80 consecutive patients with CAP (39 males mean age 56±18 years) was done in the UNTH in 2009. The patients were classified into three risk groups (low, intermediate, and high) according to each rule. The ability of the two rules to predict 30-day mortality was compared.

The results showed that as both CURB65 and CRB65 scores increased there was a significant increase in the proportion of admitted cases, intensive care unit (ICU) admissions, and mortality rate. The overall mortality and ICU admission rates were 15% and 10% respectively. CURB-65 and CRB-65 had similar performance in assessing severity of CAP.

The two rules had high negative predictive values but low positive predictive values at all cut-off points. Larger proportions of patients were identified as low risk by CURB-65 (55%) than by CRB-65 (16.3%).

The two predictive rules performed well in predicting severity and mortality in CAP patients. We concluded that CURB-65 is better than CRB-65 for use because it can identify more low risk patients; however, CRB65 is better in a rural hospital without the facility for serum urea measurement.

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Introduction

Community-acquired pneumonia (CAP) is a leading cause of morbidity and mortality worldwide including Nigeria and other developing nations.[1–3] There is little documentation on CAP in Nigeria and other developing countries of Africa but work done several years ago on CAP showed that about 11–22% of Nigerians with CAP would die.[2,4,5] The work done two decades ago recorded a mortality of 21.7%.[2] A later study in Eastern Nigeria[5] showed mortality to be 11.9%, which is still unacceptably high in our environment. CAP is the sixth or seventh cause of death in the USA, the number one cause of infection-related death and the reason for more than 1 million admissions.[6]

The current management of CAP involves the use of guidelines in the risk stratification of patients and sorting out patients who can be managed as out-patients, in the hospital ward, or in the intensive care units (ICU). The guidelines help in both severity assessment and rationale for the use of antibiotics. Different regions have adopted different guidelines for the management of CAP. The pneumonia severity index (PSI)[7] is adopted by the American Thoracic Society and widely used in North America. The British Thoracic Society (BTS) in 2004 adopted CURB-65 as a guideline for managing CAP. The CURB-65[8, 9] is a six-point scoring system (0–5) based on both clinical and laboratory parameters (confusion, serum urea, respiratory rate, blood pressure, and age >65 years) for assessing patients. A simpler model, the CRB-65, could be useful in a healthcare facility without adequate laboratory equipment because it is uses only clinical parameter's for scoring (without serum urea) and has comparable results to CURB-65.[9–11]

Many centres abroad have validated these guidelines in their context.[8] Recently, the CURB-65 score has been used to assess some Eastern Nigerian patients with CAP and found to be useful.[12] Also, a recently published work in Malawi by Birkhamshaw et al[13] showed that an alternative scoring system (SWAT- Bp) performed better than the CRB-65 in assessing mortality in patients with lower respiratory tract infections in that population. Though the SWAT-Bp assessment system proved useful in this population it was limited to only one hospital and has not been validated in many other countries within the sub-region and internationally.

The aim of this study therefore was to compare the effectiveness of these two validated rules (CURB-65 and CRB-65) to predict mortality and to evaluate their application as a guide for admission or discharge from the hospital.

The study investigated whether the null hypothesis that there is no difference between the risk stratification groups of the two rules for predicting 30-days mortality can be rejected.

Methods

Study design and patients

Data were collected prospectively from consecutively recruited patients seen at the Accident and Emergency, medical outpatients, and medical wards of the University of Nigeria Teaching Hospital (UNTH) in Enugu. All patients with both clinical and radiological diagnosis of CAP between December 2008 and June 2009 were recruited for the study. Ethical approval was obtained from the Ethics Committee of the UNTH.

UNTH serves a population of over 1.5 million people and sees over 6000 patients annually. About 2.02% of these patients are treated for CAP annually.[5]

Definitions

CAP was defined as an acute infection of the pulmonary parenchyma that was associated with symptoms and signs of acute infection, followed by the presence of an acute infiltrate on chest X-ray in a patient who was not resident in a hospital or healthcare facility in the previous 14 days.[14] All patients were assessed by a specialist physician before admission and by a pulmonologist before discharge.

Inclusion and exclusion criteria

All consenting adults above 18 years of age were included for the study. Exclusion criteria include those admitted to the hospital in the previous 14 days, patients whose symptoms developed 48 hours following admission,[15] patients with tuberculosis or previous chest X-ray which may conflict with diagnosis of CAP, and patients who were unwilling to participate.

Radiological evaluation

All the chest X-rays were postero-anterior and were reported by a consultant radiologist. The same radiologist was used for all the reports throughout the period of the study. The machine used was Siemens SI 400, model GM 0388B2.

Data collection

A standard questionnaire designed to cover personal data and review symptoms of CAP was used for the study. All the patients were physically examined with emphasis on the respiratory system. Data collected during subject assessment included age, gender, and co-morbidity. Documented physical signs included pulse, axillary temperature, respiratory rate, and blood pressure. Blood pressure was done prior to fluid resuscitation or inotropic support.[15] Confusion was assessed in this study as a new disorientation in time, place, or person. Specimens for complete blood count, erythrocyte sedimentation rate (ESR), electrolytes, and urea were collected promptly and sent to the laboratory and result were obtained and analysed. Sputum was collected in sterile screw containers. Adequacy of sputum was defined as greater than 2 mL of sputum and containing less than 15 epithelial cells on microscopy.[16] Patients with CAP were classified into low-, intermediate-, and high-risk groups according to the two scoring systems – CURB-65 and CRB-65, using the BTS guidelines as follows:[8,9]

C = confusion defined as new disorientation in time, place, or person = 1.
U = serum urea ≥7.0 mmol/L = 1.
R = respiratory rate ≥30 cycles/minute = 1.
B = systolic BP < 90 mmtlg or diastolic BP ≤60 mmtlg = 1.
65 = age ≥ 65years = 1.

For CURB-65 each subject scored a minimum score of 0 or a maximum score of 5. Scores 0–1, 2 and 3–5 were classed as low-, intermediate-, and high-risk for mortality associated with CAP, respectively. While for CRB-65 scores each subject had a minimum score of 0 and a maximum score of 4 were classified as follows: score 0 for low, 1–2 for intermediate, and 3–4 for severe. The CRB-65 only uses clinical assessment as serum urea is clearly omitted.

Both rules were then compared for their ability to predict 30-days all-cause mortality.

Data analysis

The statistical package Epi-info version 3.4 was used for data analysis. Data were presented in tables and charts. Sample mean, standard deviation, and the chi-square test were used for statistical significance. Severity was assessed using CURB-65 and CRB-65 scoring systems. Primary interest was the number of admissions and outpatient visits depending on CURB-65 and CRB-65 scores. The outcome of interest was 30-day mortality and the need for ICU admission. Event rates were based on the first episode of CAP and did not include multiple events per person. In all, a P value of 0.05 was regarded as significant and conclusions were drawn based on this level of significance. The confidence interval was set at 95%.

Results

A total of 80 patients with diagnosis of CAP were recruited for the study. The baseline characteristics of the 80 patients are shown in Table 1. Thirty-nine (48.8%) were males and 41 (51.2%) females. Male:female ratio was 1.0:1.05 with mean age 56±18 years and age range 19–89 years. All patients were treated based on the BTS guidelines for management of CAP.

Twelve (15%) of the patients died within 30 days of the diagnosis, 8 (10%) needed ICU care.

Variables	Frequency (%)
Age range	
< 65 years	53 (66.3)
> 65 years	27 (33.7)
Total	80 (100.0)
Mean age = 56±18 years	
Range = 70 years (19-89 years)	
Sex	
Male	39 (48.8)
Female	41 (51.2)
Total	80 (100.0)
Outcome measures	
Total admitted	37 (46.3%)
Total outpatient	43 (53.7%)
ICUnit admission	8 (10%)
30-day mortality	12 (15%)

Table 1 Baseline characteristics and outcome measures of patients with CAP

In-patient vs out-patients

Thirty-seven (46.2%) patients were managed as out-patients and 43 (53.8%) as in-patients. A significant proportion of the outpatients were those with CURB-65 score 0 to 1 (low risk); that is 100% of those with score 0 and 67.7% of those with score 1. No patient with CURB-65 score 4 was managed as an out-patient. A major proportion of those admitted were also from CURB-65 score 3 and 4 (high risk). No patient with CURB-65 score 0 was admitted. Using the CRB-65 scoring system, no patient with score 0 (low risk) was admitted. All admissions were from intermediate- (1–2) and high-risk (3–4) score (see Table 2).

Risk group CURB-65	Out-patients n=37	In-patients n=43	Total n=80
0	13 (100)	0 (0)	13 (16.3)
1	21 (67.7)	10 (32.3)	31 (38.7)
2	2 (12.5)	14 (87.5)	16 (20.0)
3	1 (7.1)	13 (92.9)	14 (17.5)
4	0 (0.0)	6 (100)	6 (7.5)
5	0 (0.0)	0(0.0)	0 (0.0)
χ^2 for linear trend = 36.539; p = 0.000 (significant)			
Risk group CRB-65	**Out-patients n=37**	**In-patients n=43**	**Total n=80**
0	13 (100)	0 (0)	13 (16.2)
1	21 (60.0)	14 (40)	35 (43.8)
2	3 (13.0)	20 (87.0)	23 (28.8)
3	0 (0.0)	8 (100.0)	8 (10.0)
4	0 (0.0)	1 (100.0)	1 (1.2)
χ^2 for linear trend = 32.749; p = 0.000 (significant) Percentages are shown in parentheses.			

Table 2: Number of in-patients/out-patients using CURB-65/CRB-65 score

Comparison of mortality and ICU admission rates

Table 3 shows the patient distribution and 30-day mortality in each risk classes for CURB-65 and CRB-65 score. When the subjects were stratified into low-, intermediate-, and high-risk groups (see Table 4) according to the original study methodology; the two predictive rules show a similar trend in increasing mortality with worsening risk groups (p<0.000). The mortality rate of the low-risk group was 2.2% in CURB-65 and 0% in CRB-65; while the mortality rate of the high-risk group was 45% in CURB-65 and 66.6% in CRB-65. CURB-65 classified a significantly larger proportion of patients (55%) as low-risk compared with CRB-65 which classified is 16.3%.

ICU admission rates also increased with increasing risk level of each rule, and these were statistically significant with both rules (p=0.0102 for CURB-65, and p=0.0217 for CRB-65) (see Table 5). When the patients were risk

Risk group CURB-65	No. of patients n=80	30-day mortality n=12
0	13 (16.3)	0 (0)
1	31 (38.7)	1(3.3)
2	16 (20.0)	2 (12.5)
3	14 (17.5)	5 (35.7)
4	6 (7.5)	6 (100)
5	0 (0.0)	0 (0.0)
χ^2 for linear trend = 19.701; p= 0.000 (significant)		
Risk group CRB-65	**No. of patients n=80**	**30-day mortality n=12**
0	13 (16.3)	0 (0)
1	35 (43.8	1 (2.9)
2	23 (28.7)	5 (21.7)
3	8 (10.0)	5 (62.5)
4	1 (1.2)	1 (100.0)
χ^2 for linear trend = 14.124; p = 0.000 (significant) Percentages are shown in parentheses.		

Table 3: Outcome in terms of 30-day mortality in each risk class using CURB-65/CRB-65 score

Risk group CURB-65	No. of patients n=80	Mortality n=12
Low (score 0–1)	44 (55)	1 (2.2)
Intermediate (score 2)	16 (20)	2 (12.5)
High (score 3–5)	20 (25)	9 (45)
χ^2 = 12.32; p = 0.002 (significant)		
Risk group CRB-65	**No. of patients n=80**	**Mortality n=12**
Low (score 0)	13 (16.3)	0 (0,0)
Intermediate (score 1–2)	58 (72.5)	6 (10.3)
High (score 3–4)	9 (11.2)	6 (66.6)
χ^2 = 12.32; p = 0.002 (significant) Percentages are shown in parentheses.		

Table 4 Risk stratification using CURB-65/CRB-65 (outcome 30-day mortality)

Risk group score CURB-65	Total admitted n=54	Admitted ICU n=8
0	0 (0)	0 (0)
1	10 (23.3)	0 (0)
2	14 (32.6)	2 (14.3)
3	13 (30.2)	3 (23.1)
4	6 (13.9)	3 (50.0)
5	0 (0)	0 (0)
χ^2 for linear trend = 5.778; p = 0.0162 (significant)		
Risk group score CRB-65	**Total admitted n=43**	**Admitted ICU n=8**
0	0 (0)	0 (0)
1	14 (32.6)	0 (0)
2	20 (46.5)	4 (50.0)
3	8 (18.6)	3 (37.5)
4	1 (2.3)	1 (12.5)
χ^2 for linear trend = 5.272; p = 0.0217 (significant)		

Table 5 Outcome in terms of ICU admission in each group of CURB-65/CRB-65

stratified the ICU admission rate of low-risk groups was 0% in both scoring systems. The ICU admission rates were 44.4% in the high-risk group of CRB-65 which was higher than that of CURB-65, 31.6% (see Table 6).

Comparison of predictive accuracy
Table 7 shows the sensitivity, specificity, and positive and negative predictive values for 30-day mortality at different cut-off points in both scoring systems. Both rules showed high sensitivity and high negative predictive values and low specificity and low positive predictive values.

Discussion

Prediction rules are useful aids for clinical decision-making. This study showed no significant clinical difference in performance between CURB-65 and CRB-65 for a considerable number of Eastern Nigerian populations.

The study found that most of the patients affected by

Risk group CURB-65	Total admitted n=43	Admitted ICU n=8
Low (score 0–1)	10 (23.3)	0 (0)
Intermediate (score 2)	14 (32.6)	2 (14.3)
High (score 3–5)	19 (44.1)	6 (31.6)
χ^2 = 4.57; p= 0.102 (not significant)		
Risk group CRB-65	**Total admitted n=43**	**Admitted ICU n=8**
Low (score 0)	0 (0)	0 (0)
Intermediate (score 1–2)	34 (79.1)	4 (11.8)
High (score 3–4)	9 (20.9)	4 (44.4)
χ^2 exact in 2 tailed test; p value = 0.179 (not significant)		
Chi square cannot be done when a row or column total is 0		

Table 6 Risk stratification using CURB-65/CRB-65 (outcome in terms of ICU admission)

CURB-65 score	Sensitivity	Specificity	PPV	NPV
0	100	19.1	17.9	100
1	91.7	45.6	22.9	96.9
2	83.3	23.5	16.1	88.9
3	58.3	20.6	11.5	73.7
4	66.7	9.7	11.4	60.0
5	N/A	N/A	N/A	N/A
CRB-65 score	**Sensitivity**	**Specificity**	**PPV**	**NPV**
0	100	19.1	17.9	100
1	91.7	51.5	25.0	97.2
2	58.3	33.8	13.5	82.1
3	58.3	13.3	10.4	61.5
4	91.7	1.5	14.1	50.0
Note: These values show that CURB-65 and CRB-65 have high sensitivity and NPV but low specificity and PPV.				

Table 7 Sensitivity, specificity, positive and negative predictive values (PPV/NPV) of 30-day mortality for CURB-65 and CRB-65.

CAP were elderly people >65 years, supporting several studies that CAP is more common in elderly people.[12,17,18] In this study, 33.7% of them were affected. Atypical pneumonias, co-existing illness, and more severe CAP are more common in this age group. A good assessment scheme is important in selecting these patients for admission in order to avoid exposure to hospital-acquired infections.

The mortality rate in this study was 15% and mortality was higher in the elderly and patients with co-morbidities. Both CURB-65 and CRB-65 showed that the majority of the patients classed as low-risk were managed as out-patients and mortality was also lower in these patients; while the majority with intermediate- and high-risk scores were managed as in-patients and mortalityb was higher in these groups. This confirmed a previous work which showed that both scoring systems are simple clinical approaches that can be applied in the community setting to augment clinical judgment regarding the need for hospital admission.[12,19]

The two rules are useful in guiding emergency departments on admission and discharge policies because of their high sensitivity and high negative predictive values. The CURB-65 score identified more low-risk patients (55%) as opposed to CRB-65 (16.3%). This supported a previous work done in Hong Kong[8] which showed that CURB-65 is more useful than CRB-65 for identifying patients with CAP for potential out-patient management. For identifying high-risk patients, the two rules have a low-positive predictive value, which makes them less useful in guiding decision-making for in-patient management.[8,20]

In this study, ICU admission increased with increasing risk score but when patients were stratified according to low-, intermediate-, and high-risk for ICU patients, the p-value for CURB-65 was 0.102 and for CRB-65 was 0.179, and these were statistically not significant. Both CURB-65 and CRB-65 did not appear to be useful for identifying patients requiring ICU care because of their low specificities and low positive predictive values, supporting the previous work in Hong Kong.[8]

The study found 10% ICU admissions. Other values are quoted in different settings (4%,10%,16.7%).[8,21,22] The variation is because the criteria for ICU admission differ from hospital to hospital and from one country to another. Disease severity is not the only factor to consider; premorbid status, age of patient, and availability of the resources are all considered by ICU physicians before admitting a patient into ICU.[8] Our study had lower ICU admission per cent than mortality (10% vs 15%) which showed that some of our patients with severe CAP died without getting ICU care. This study supports previous studies which showed that both rules are not very useful in predicting ICU admission, although they give indication of disease severity.

The strength of this study lies in its prospective design, wide age range, and use of BTS guidelines for management of patients.

All radiographs were reported by the same qualified radiologist giving rise to less potential bias in radiological interpretation.

This study was a prospective observational short-term study and could not look at the long-term effects of the disease on all the patients, especially those with complications.

A larger sample size is required to support the conclusions made in this study. The definition of confusion was a new disorientation in time, place, and person. This removed problems in assessing patients with stroke and dementia when using an abbreviated mental test score of <8.

The predictive rules serve as guidelines to the clinical management of patients. Severity is not the only factor that should be considered. Both social and home environment play a role in deciding on a management plan. Both specialists and non-specialist doctors should always exercise clinical judgement and common sense in making these sometimes difficult decisions.

Conclusion

In conclusion, both CURB-65 and CRB-65 showed no significant difference in predicting 30-day mortality. CURB-65 may be more useful in a centre with fully equipped laboratory services while the CRB-65 is more useful in a rural setting without the facility for serum urea testing.

References

1. Egbagbe EE, Mordi RM. Aetiology of respiratory tract infections in Benin City. *J Med Biomed Res* 2006; 5: 22–7.
2. Nwosu CM, Anisuba BC. A hospital study of adults with CAP. 11 Clinical Course and Complications. *Orient J Med* 1991; 3: 196–9.
3. Jennings LC, Anderson TP, Beynon KA, et al. Incidence and characteristics of viral CAP in adults. *Thorax* 2008; 63: 42–8.
4. Sofowara EO, Onadeko B O. Complications and prognostic factors in pneumonia among Nigerians. *Nig Med J* 1973; 3: 144–5.
5. Onyedum CC, Chukwuka JC. Admission profile and management of CAP in Nigeria – 5 year experience in a tertiary hospital. *Respir Med* 2011; 105: 298–302.
6. Mokdad AH, Marks JS, Stroup DF, Gerberding JL. Actual causes of death in the USA. *JAMA* 2004; 291: 1238–45.
7. Fine MJ, Auble TE, Yearly DM, et al. A prediction rule to identify low-risk patients with CAP. *New Engl J Med* 1997; 336: 243–50.
8. Man SY, Lee N, Ip M, et al. Prospective comparison of the three predictive rules for assessing severity of CAP in Hong Kong. *Thorax* 2007; 62: 348–53.
9. Lim WS, Van der Eerden MM, Laing R, et al. Defining CAP severity on presentation to hospital: an international derivation and validation study. *Thorax* 2003; 58: 377–82.
10. Ewig S, Walter T. CRB-65 for assessment of pneumonia severity. Who could ask for more? *Thorax* 2008; 63: 665–6.
11. BTS Standard of Care Committee. BTS Guidelines for management of CAP in adults. *Thorax* 2001; 56: suppl: iv: 1–64.
12. Mbata GC, Chukwuka CJ, Onyedum CC, Onwubere BJC. CURB-65 scoring system in severity assessment of Eastern Nigerian patients with CAP: a prospective observational study. *Prim Care Respir J* 2013; 22: 175–80.
13. Birkhamshaw E, Waitt C J, Innes M, Waitt P. Severity assessment of LRTI in Malawi: derivation of a novel index. (SWAT-Bp) which out performs CRB-65. *PLoS One* 2013; 8: e82178. doi: 10.1371/journal.pone.0082178.
14. Johnson PDR, Irving LB, Turnidge JD. MJA Practice Essentials: Infectious Diseases 3: Community-acquired pneumonia. *MJA* 2002; 176 (7): 341-7.
15. Chalmers JD, Singanayagam A, Hill AT. Systolic blood pressure is superior to other haemodynamic predictors of outcome in CAP. *Thorax* 2008; 63: 698–702.
16. Paganin F, Lilienthal F, Bourdin A, et al. Severe CAP: assessment of microbial aetiology as mortality factor. *Eur Resp J* 2004; 24: 779–85.
17. Lutfiyya MN, Henlep E, Chang LF. Diagnosis and treatment of CAP. *Amer Fam Phys* 2006; 73: 442–50.
18. Ochoa-Gonder O, Vila-Corcoles A, Diego C, et al. The burden of CAP in the elderly: the Spanish Evan-65 study: http//biomed-central/ 1471-2458/8/222.
19. Capelastegui A, Espana PP, Quintana JM, et al. Validation of a prospective rule for the management of CAP. *Eur Resp J* 2006; 27: 6–8.
20. Ewig S, Ruis M, Mensa J, et al. Severe CAP: Assessment of severity criteria. *Am J Resp Crit Care Med* 1998; 158: 1102–8.
21. Ewig S, de Raux A, Bauer T, et al. Validation of predictive rules and indices of severity for CAP. *Thorax* 2004; 59: 421–7.
22. Aujesky D, Auble TE, Yearly DM, et al. Prospective comparison of three validated prediction roles for prognosis in CAP. *Am J Med* 2005; 118: 384–92.