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ORIGINAL ARTICLE

Comparison of predictive value of CRB 65 and SMART COP in patients with community acquired pneumonia presenting in emergency ward at tertiary care hospital in eastern Nepal

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Abstract

Introduction: Pneumonia, a common emergency presentation presents in variable clinical urgency making decision tools useful. We aimed to compare two of such scores, CRB 65 and SMART COP to predict 30 days' mortality and intensive care requirement.

Method: A comparative observational study was done among 330 patients. CRB 65 and SMART COP scores were calculated and patients were followed up till the outcome of interest. Sensitivity, specificity, negative and positive predictive value were calculated at different cut offs for both the scores with 95% significance level and ROC curves were plotted with measure of Area under the curve(AUC).

Result: Three hundred thirty patients were evaluated for mortality, and 287 patients for ICU admission after loss to follow up and incomplete information. The mean ± SD age of patient was 59.41±20 years with mortality in 24.8% (including 4 mortality cases in emergency). ICU admission was required among 7% of patients. For predicting 30 days' mortality, the AUC of CRB 65 was 0.669, while that of SMART COP was 0.765 and the difference was statistically significant (p-value= 0.045). Similarly for predicting ICU admission, the AUC of CRB65 was 0.831 and that for SMARTCOP was 0.783 (p-value = 0.552). For both 30 days mortality and ICU admission, maximum sensitivity and specificity was obtained for cut-off of 2 for CRB65 and 7 for SMARTCOP.

Conclusion: CRB 65 was found to be equally capable of predicting need of ICU admission as by the SMART COP tool. It was also found to have good predictability of 30 days mortality with high sensitivity and specificity. Thus, it can be the useful tool in low resource setting for inpatient management or early referral.

Keywords: CRB 65, ICU, Mortality, Nepal, Pneumonia, SMART COP

INTRODUCTION

TThe diagnosis of community acquired pneumonia (CAP) mainly relies on clinical assessment including features of lower respiratory tract infection, radiological findings and an absence of recent health care exposure.[1,2] CAP is a common hospital presentation, with a study from a Teaching Hospital in Nepal showing an annual incidence of 27% admissions over a year.[3]

Since CAP can present with variable clinical urgency, early decision-making tools are helpful for resource allocation and appropriate referrals as necessary, especially, in developing countries and although different validated score systems are available, a focus on developing countries scenario is still warranted given their unique circumstances. There are different tools to assess severity of pneumonia. CRB65 (Confusion, Respiratory Rate, Blood pressure and Age ≥ 65) is recommended by Royal College of General Practitioners and the Primary Care Respiratory Society UK[1] and can aid in assessing the severity of illness in low resource settings. SMART COP (Systolic Blood pressure, Multilobar Xray, Albumin, Respiratory Rate, Tachycardia, Confusion, Oxygen Saturation and blood pH) uses eight variables including blood pH and oxygen level, X ray Chest and Serum albumin apart from other clinical features. Both the tools have been used in variable settings with good results. [4–6] Due to the complexity in these parameters of SMART COP, general practitioner in low resource settings can implement CRB 65 (simple non-invasive clinical assessment) in daily clinical practice.[7,8]

This study aims to compare “CRB 65” and “SMART COP” in CAP patients to predict prognosis and severity of pneumonia in an emergency department. This will provide evidence to use CRB 65 for predicting severity of CAP in low resource settings like ours.

METHOD

A descriptive observational study was conducted from January 2017 to December 2017 in the Emergency Department of a teaching hospital of eastern Nepal. Patients visiting the Emergency Department were recruited in the study by purposive sampling coinciding with the duty hours of any one of the researchers.

The sample size was calculated by comparing the Area Under Curve (AUC) of CRB 65 and SMART COP using MedCalc software [9] The sample size based on AUC of 0.890(CRB 65) and 0.918(SMART COP) obtained from the study done by Alici et al [5] was calculated to be 1030. However, in the past year the total number of cases during one year was found to be 432 in BPKIHS. So, applying finite population correction the minimum sample size was calculated to be 304, which was inflated to 334 to adjust for 10% non-responder. However, the data was collected from 330 respondent due to non-response.

Ethical approval was obtained from Institutional Review Board, B.P. Koirala Institute of Health Sciences (Reference number 297/074/075). Verbal and written consent was obtained from patient or their attendants present before the study.

Patients more than 18 years of age, fulfilling working diagnosis of CAP were included in the study.[1,6] Patient not giving consent. hospital acquired pneumonia, immunosuppression and active tuberculosis were excluded from the study. The participants were interviewed based on a semi structured proforma.

CAP was defined as presence of symptoms of an acute lower respiratory tract illness and/or features of systemic illness (cough with or without expectoration and at least one other lower respiratory tract symptom, temperature >38°C and/or the symptom complex of sweating, fevers, shivers, aches and pain), focal chest signs (altered breath sounds and/or signs of lung consolidation) and X ray findings.[1,6] SMART COP score (total 11) for less than 50 years was calculated as Systolic BP less than 90 mm Hg-2 points, Multi lobar Chest X ray involvement-1 point, Albumin less than 35 g/l-1 point, Respiratory rate 25 breaths/min or more, 1 point, Tachycardia of 125 bpm or more- 1 point, Confusion (Acute)-1-point Oxygen low PaO_2 less than 70 mm Hg, or O_2 saturation 93% or less, or PaO_2/FiO_2 less than 333 -2 points and pH less than 7.35- 2 points. For the patients whose age was more than 50 years, cut off level for low Oxygen was PaO_2 less than 60 mm Hg, or O_2 Saturation 90% or less, or PaO_2/FiO_2 less than 250-2 points was provided while other parameters of scoring remained similar to that of patient age less than 50 years. [10]

CRB 65 (total 4) was calculated as one point each for Confusion, Respiratory rate ≥30 minutes, Blood pressure (SBP;90mmHg or DBP ≤ 60mmHg and Age ≥65 years. [8]

The outcome used for comparing predictability were mortality at 30 days or need of Intensive Care Unit (ICU) admission. Variables tested were from the two scores used for the study. The outcome of ICU admission versus other disposition from emergency excluded mortality and referred cases for ICU requirement. Mortality at 30 days of initial admission from emergency was determined by phone call made to all the patient or primary caretaker.[11]

Microsoft Excel (2010), SPSS software (version 26) and MedCalc (version 22.032) were used for statistical analysis. Descriptive analysis was used. Categorial characters such as gender, ATS were compared with 30 days mortality and ICU admission using chi-square test or Fischer t-test (as appropriate), while continuous variable like age, vitals, lab parameters were compared across 30 days mortality as well as ICU admission using t test. Sensitivity, specificity, positive and negative predictive value was calculated at different cut

offs for both the scores with 95% significance level. Receiver Operating Characteristic (ROC) curves were plotted along with measure of AUC for both the tools for each outcome.

RESULT

A total of 330 patients were included in the study. The mean±SD age of the population was 59.41 ±20 years. Female: Male ratio was 1:1. The common presenting complaints were cough 321(99.1%) and among them 303 (92%) had productive cough, followed by dyspnoea or shortness of breath 295(89.42%) and fever 294(89.17%). Smoking was present in 256(77.61%) and 218(66.11%) patients consumed alcohol. Chronic Obstructive Pulmonary Disease was the common co morbidity presenting in 80(24.24%), other co-morbidities being pulmonary tuberculosis 27(8.20%), hypertension 22(6.73%), diabetes mellitus 10(3%) and ischemic heart disease 9(2.72%). The triage score at presentation as per Australasian Triage score was one and two in 132(37.7 %) patients (more urgent presentation). Four patients died during the emergency stay and were not included in the group needing ICU care. Mortality up to 30 days of emergency presentation was 82(24.8%) and ICU admission was required in 23(8%). The final analysis of ICU admission versus other characters included only 287 cases due to missing data and excluded mortality in emergency (Table 1 & Table 2).

The predictability of 30 days mortality was assessed via AUC and sensitivity and specificity at different cut off . The maximum sum of sensitivity and specificity was obtained for cut off of 2 or more for CRB65 and 3 or more for SMART COP (Figure 1 and Table 3).

The negative predictive value of CRB 65 at cut off value of one was 98.9% where as high specificity of above 85% was seen across cut offs two and three to detect ICU admission from emergency. The negative predictive value of SMART COP for cut off score 7 was 97% with specificity of above 92% for cut off of 7. Sensitivity value was 69.5% when cut off of 7 was taken (Table 4).

Table 1. Patient characteristics and outcome

Characteristics	Mortality at 30 days (Mean±SD), Frequency (n=82)	No Mortality at 30 days (Mean±SD), Frequency (n=248)	Total	P value*	ICU admission Mean±SD), Frequency (n=23)	No ICU Admission (Mean±SD), Frequency (n=264)	Total	P value*
Age	65.04±13.06	58.37±20.01		0.029	65±13	58±214		0.043
Gender				0.610				0.734
Male	39	126	165		11	136		
Female	43	122	165		12	128		
ATS				0.001#				0.001#
1	1	1	1		0	0	0	
2	131	55	76		21	75	96	
3	185	23	162		2	176	178	
4	13	3	10		0	13	13	
Vitals								
Heart Rate	105±19	102±19		0.001	112±25	101±18		0.011
Respiratory Rate	29±6	26±6		0.001	33±5	26±5		0.001
Lab								
Albumin	31.76±4.8	35.55±3.9		0.001	30.22±3.7	35.61±3.7		<0.001
PaO2	76.112±16.8	84.011±13.31		0.001	81.27±18.9	83.29±13		0.311
SpO2	83.96±9.66	89.40±8.53		0.001	84.96±7.4	89.58±7.6		0.004
PaO2/FiO2	362.19±80.59	413.25±219		0.02	386.16±91.8	404.03±214		0.165
pH	7.25±0.137	7.36±0.06		0.001	7.23±0.14	7.36±0.05		<0.001
TLC	15953±1564	12275±4311		0.001	15539±2969	11956±4208		<0.001
Neutrophils	75.94±13.4	75.94±13.46		0.001	73±11	73±11		0.96
Lymphocytes	20.83±12	24.48±12.13		0.081	25±13	24±12		0.585
Platelets	175071±93399	238637±84887		0.001	211695±91321	235303±85943		0.243
RBS	95±31	106±43		0.022	103±29	105±39		0.744

*Chi square test (for frequency) or T-test (for Mean±SD), #Fischer's exact t test

Table 2. Scores and outcomes

Characteristics	Mortality at 30 days Mean±SD), Frequency (n 82)	No Mortality at 30 days (Mean±SD), frequency (n=248)	Total (n=330)	P value*	ICU admission Mean±SD), Frequency (n=23)	No ICU Admission (Mean±SD), Frequency (n=264)	Total	P value*
CRB 65				<0.001#				<0.001#
0	18	88	106		1	93	94	
1	26	120	146		6	132	138	
2	19	36	55		8	36	44	
3	17	4	21		7	3	10	
4	2	0	2		1	0	1	
SMART COP Cut off 3 and more				<0.001#				<0.001#
>=3	67	97	164		18	107	125	
<3	15	151	166		5	157	162	
SMART COP Cut off 7 and more								
>=7	37	26	63		16	21	37	
<7	45	222	267		7	243	250	

*Chi square test (for frequency) or t-test (for Mean±SD); #fischer's exact t test

Table 3. Comparison of CRB 65 and SMART COP in predicting 30-day mortality (n=330)

Score	Cut-off	Sensitivity (%) CI	Specificity (%) CI	PPV (%)	NPV (%)
CRB65	1	78.05(67.54-86.44)	35.48(29.53-41.79)	25.66	75.87
	2	46.34(35.25-57.5)	83.87(78.69-88)	48.72	82.54
	3	23.17(14.56-33.8)	98.39(95.92-99.5)	82.61	79.48
SMARTCOP	3	81.7(71.63-89)	60.89(54.51-67)	40.85	90.96
	7	45.12(34.10-56.51)	89.52(85.02-93.04)	58.73	83.15

Table 4. Comparison of CRB 65 and SMART COP in predicting ICU admission (n=287)

Score	Cut-off	Sensitivity (95% CI)	Specificity (%) 95% CI	PPV (%)	NPV (%)
CRB65	1	95.6(78.05-94.98)	35.23(29.47-41.32)	11.4	98.94
	2	65.57(47.08-86.79)	85.23(80.36-89.28)	29.09	96.98
	3	34.78(16.38-57.27)	98.86(96.72-99.77)	72.73	94.57
SMARTCOP	3	79.17(57.85-92.87)	59.47(53.28-65.45)	15.08	96.91
	7	69.57(47.08-86.79)	92.05(88.10-98.01)	43.24	97.20

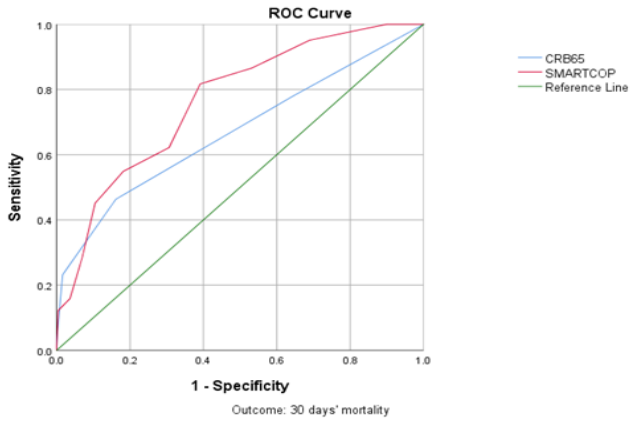

Figure 1. ROC curve of CRB 65 and SMART COP with 30 days'mortality

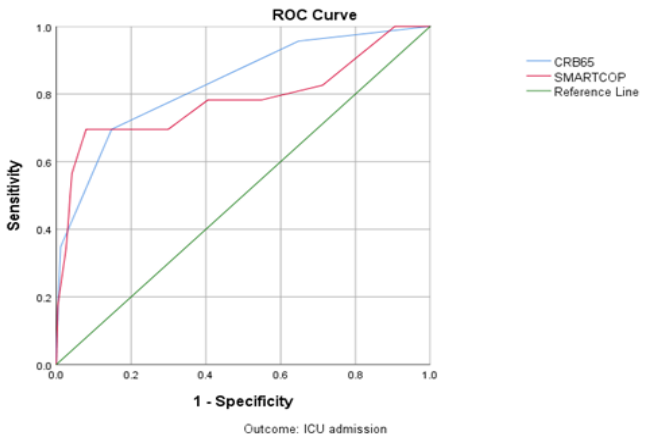

Figure 2. ROC curve of CRB 65 and SMART COP with ICU admission

ROC curve plot showed discriminating capacity with AUC of 0.669 for CRB 65 and 0.765 for SMART COP in predicting 30-day mortality; and AUC of 0.831 for CRB 65 and 0.783 for SMART COP in predicting ICU admission (Figure 1 and Figure 2). When comparing ROC of these determinants AUC of SMART COP was found to be significantly higher (p-value 0.045) compared to that of CRB65 in predicting 30 days mortality. Whereas comparison of AUC for predicting ICU

admission was higher in CRB 65 than SMART COP though it was not statistically significant (p-value 0.552).

DISCUSSION

This study assesses the predictability of 30 days mortality and ICU admission among community acquired pneumonia patients using non-invasive tool CRB65 by comparing with SMART COP. The predictability of CRB 65 was found to be similar to that of SMART COP for predicting ICU admission ($AUC_{CRB\ 65}$ =0.831, $AUC_{SMART\ COP}$ =0.783). However, the predictability of SMART COP was significantly higher than CRB65 for predicting 30 days mortality ($AUC_{CRB\ 65}$ =0.669, $AUC_{SMART\ COP}$ =0.765)

Pneumonia presents across a spectrum of severity and it is often difficult for the emergency physician to determine which patients may safely be selected for the outpatient treatment and which patients would benefit from additional resource like ventilators, ICU need and vasopressors. So, clinical scores like SMART COP and CRB 65 are beneficial for safe disposition strategy from emergency. CRB 65, a simple score with higher availability and similar predictability to some other scores like CURB, CRB also considers age that influences severity and mortality but eliminates the need for blood urea nitrogen and can be used for both hospital and outpatients.[5,8]

An association between a higher mean age, lower pH value, tachycardia and tachypnea with need of ICU and 30 days' mortality. Different studies have reported similar association.[5,12,13]

British guideline for community care has recommended a CRB 65 score of zero as a low risk of death.[1] In our study, there were 17 deaths in CRB 65 score of zero, whereas, a score of zero in SMART COP score had no mortality.

SMART COP was originally developed for the prediction of intensive respiratory and vasopressor need.[10] We have used ICU admission as a surrogate outcome for early need of respiratory support or critical care as this suited our region often requiring early referrals for ventilator support /intensive care support. Use of SMART COP, although a good predictive tool may not suit all the settings in our country due to its need for lab and Arterial Blood Gas (ABG) parameters.

The ROC plot and Area under the curve between the two scores favor CRB 65 for acute need of ICU, however, SMART COP predicts 30 days' mortality better. So, CRB 65 also be a useful non-invasive scoring system for predicting ICU admission and 30 days mortality in low resource setting. Across the cut off of two and three for CRB 65 and cut off of seven for SMARTCOP specificity is more than 85% to predict ICU admission, CRB 65 showing an acceptable sensitivity (65%) at the cut off of two. The negative predictive value of SMART COP at both cut offs compares well with CRB 65 at all cut offs. Wang et al, using CRB 65 with cut offs of two reports sensitivity, specificity, PPV and NPV 46%, 75.3%, 26.1% and 88.4% respectively compared to our sensitivity, specificity, PPV and NPV of 65.57, 85.23%, 29.09% and 96.98% respectively. [14]

Alici, et al.[5] reported predictive performance of SMART COP with a cut off of ≥3 as sensitivity, specificity, PPV and NPV of 40.85%, 90.96%, 81.71% and 60.89% respectively compared to our values of 81.7%, 60.89, 40% and 90.96% for to predict 30 days mortality. A study in emergency setting, however, used a cut off of five with a good sensitivity and specificity to predict adverse prognosis in a select population of severe pneumonia patients**.** When we used a cut off of five, our sensitivity increased to 70 with specificity of 84 to predict ICU admission**.**[15]These reports suggest the set-up of study, resource availability, disease severity may influence the cut off level used and the choice of predictive score and clinical judgement also has a role.

Our study reported ICU need in 8%. This is the actual proportion of the patients in the study who needed ICU. The predicted proportion of ICU by the tools was 3.8 % for CRB65 and 12.895 for SMARTCOP that matches the 10% intensive respiratory support and/or vasopressors as reported by Charles et al.[10] The mortality rate of 24.8% falls under the wide of reported range of 5% to 48% and seems to differ by the setting of treatment.[5,10] The need for ICU and mortality in our study could also have been influenced by age, presence of comorbidity like COPD and tuberculosis present in our region. Initial tachycardia and tachypnoea, inclusive in scores, were also associated with bad prognosis similar to the study by Chen et al.[12]

This is a single centre study done among CAP patients which may not be representative. There might be measurement bias while assessing the confusion state of patients. Presence of co-morbidities among CAP patients might have affected the need for ICU admission and or 30 days' mortality, which might have affected the predictability of the tool.

CONCLUSION

CRB 65 incorporation is simple score that can help Emergency Department as well as outside hospitals in order to facilitate the decision whether a patient with suspected CAP needs intensive care or not. CRB 65 was found to be equally capable of predicting need of ICU admission as by the SMART COP tool. It was also found to have good predictability of 30 days mortality with high sensitivity and specificity. Thus, it can be the useful tool in low resource setting for inpatient management or early referral. More studies in different settings and geographical area can further validate the predictability of this tool.

DECLARATIONS

Conflict of Interest
None

Funding
None

Ethical Clearance
Ethical clearance was taken from BP Koirala Institute of Health Sciences.

Consent of the Study
Verbal and Written consent was taken from patient or patient attendants where appropriate.

Consent of Publication from Authors
All the author/s and participant consented for publication of the finding.

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