Importance of Severity Assessment: Community-Acquired Pneumonia

Importance of Severity Assessment Important

Community-acquired pneumonia (CAP) represents a significant therapeutic challenge to physicians, as they have to decide whether the patient is to be treated in a clinic or a hospital setting. Therefore, it is vital to assess the severity of the disease, as it forms a starting point in the management algorithm and helps in achieving favorable patient outcomes.

Some of the main determinants of site-of-care decision include the cost of care, the intensity of diagnostic testing as well as the choice of empiric antibiotics. Generally, outpatient therapy is preferred because it is cost-effective, favored by patients, promotes faster convalescence and also reduces the risk of nosocomial complications. However, intensive care may be required in severe cases, which means hospitalization for an extended period of time. Thus, assessing the severity of the illness and whether it warrants hospitalization is probably one of the most critical decisions in the overall management of CAP.

Several scoring systems are available to help clinicians assess the severity of the illness. While clinical judgment can vary from person to person and place to place, objective decisions based on scoring systems would probably remain the same across the board. Hence, this helps in standardization of criteria required to judge the severity of CAP.

Predictive Models for Assessing Severity of CAP

Assessing severity of the disease is largely influenced by the experience of the caring physician, but studies have indicated that such an approach is fallible and may not yield a correct measurement of severity of the illness. Therefore, it is useful to rely on prognostic markers as well as severity assessment scales in order to arrive at site-of-care decisions.

Risk scores should only be considered as an aid to clinical decision-making in view of extent of additional investigation needed and hospitalization; however, sound clinical judgment is a must.

Ideally, a scoring system for severity assessment of CAP should be able to fulfill the following criteria:

- Should be simple with the fewest easy to remember parameters
- Should equally work for both older and young patients
- Should not be influenced by age or comorbidities and investigations
- Should take physiological derangements and organ dysfunction into consideration
- Should be able to define distinct patient categories based on management groups and hence decide the site of admission
- Should be able to predict the requirement for mechanical ventilation or vasopressor support
- Should predict 30-day mortality

There is no single system that incorporates all the above criteria, which means that the perfect scoring system does not exist. However, there are three scoring systems available for assessing the severity of CAP. These systems aim to assess the mortality risk associated with the illness and thus accurately determine the severity. The three scoring systems are:

- Pneumonia Severity Index (PSI)
- CURB 65
- CRB 65

Pneumonia-Specific Predictive Models

Pneumonia Severity Index

Pneumonia Severity Index is designed to predict CAP mortality and identify patients who are at a low risk of death and thus provide outpatient care for this cohort. It is a mortality prediction tool that was first introduced by Fine et al. in 1997. The rule was validated with 1991 data on 38,039 inpatients and with data on 2287 inpatients and outpatients in the Pneumonia Patient Outcomes Research Team (PORT) cohort study. It classifies CAP patients into five categories of an increased risk for short-term mortality based on 20 variables routinely available at presentation. Patients classified in classes I to III are defined as low risk, as they have a cumulated mortality of <1%, and those who are classified under classes IV and V are defined as 'high risk', as they have mortality rates between 9 and 30%. After being initially used to identify patients at a low risk of death, the PSI was eventually used to predict long-term outcomes in CAP. The Infectious Diseases Society of America (IDSA) guidelines recommend it as a tool for assessing the severity of CAP.

The PSI score is assigned after answering the following three questions:

- Is the patient >50 years of age?
- Does the patient have any coexisting abnormalities, such as neoplastic disease, congestive heart failure, cerebrovascular disease, renal disease or liver disease?
- Does the patient have altered mental status, pulse rate ≥125 beats/min; respiratory rate ≥30 breaths/min; systolic blood pressure <90 mmHg or temperature <35°C or ≥40°C?

The scores for each of the questions are assigned as depicted in Table. 1. Based on the total points, the approach for site-of-care is made.

While the PSI is a relatively reliable tool for mortality assessment in CAP, there remain some limitations that prevent its widespread use. One of the major limitations is that the tool relies heavily on the age of the patient, which may result in underestimation of the severity of the illness, especially in younger patients.

CURB 65

CURB 65 is a modification of the British Thoracic Society (BTS) rule in assessing pneumonia mortality risk. It uses five variables to arrive at overall death risk in CAP patients:

1. Presence of confusion (C)
2. Blood urea nitrogen (U) >7 mmol/L
3. Respiratory rate (R) ≥30/min
4. Blood pressure (B) <90 mmHg systolic or ≤60 mmHg diastolic
5. Age ≥65 years

Developed by Lim et al., the CURB 65 evaluates the risk of mortality in CAP by assigning a score of 1 for each of the above parameters. The risk and treatment options are suggested based on the total score (see Fig. 1).

The CURB is a simple risk assessment tool; however, the presence of the blood urea nitrogen (BUN) as a parameter hampers efficacy, as laboratory values may not be readily accessible at any given time. Hence, Lim et al. also examined the efficacy of this scoring system after excluding BUN. They developed a 4-point scale called CRB 65 that effectively categorizes patients according to the need for home care, hospital assessment or urgent (ICU) hospital admission (see Fig. 2).46

Unpublished data from Bauer et al., who examined data from the German competence network for the study of community-acquired pneumonia (CAPNETZ), have found that CURB and CRB 65 had an equivalent predictive power for 14-day mortality. Thus, CURB, CURB 65 and CRB 65 allow for similar predictions of death from CAP as compared to the PSI. Among these severity assessment scales, the CRB 65 is the only tool that can be applied to outpatients as well.4

PSI vs. CURB 65

Comparing the CURB 65 and the PSI system provides some food for thought as well. While the PSI is indicated for identifying low-risk patients, the CURB 65 is ideal for identifying high mortality risk patients with severe illness. The downside of the PSI is that it cannot predict the need for ICU care.7 A recent meta-analysis by Chalmers et al. did not find any significant differences in overall test performance between PSI, CURB 65 and CRB 65 for predicting mortality from CAP.8

In the Indian context, Shah et al. found that both PSI and CURB 65 had equal sensitivity in predicting the risk of death from CAP. The PSI was more sensitive in predicting ICU admission than CURB 65, although the latter had better overall specificity. In addition, both the scoring systems were found to positively correlate with parameters, such as mortality rate, need for ICU admission, prolonged need for intravenous (I.V.) antibiotics, prolonged duration of hospital stay and need for admission to ICU, which increased progressively with increasing scores.9

Recommendations

We recommend CURB 65/CRB 65 over PSI to be used in the Indian context for judging severity and deciding the site-of-care.

With the above recommendation, it must be admitted that...
both PSI and the CURB 65 have several limitations. These scoring systems are designed primarily to predict mortality. So, they are influenced by age and presence of comorbid conditions. They are not very effective for predicting ICU admission and are of limited use in the critical care environment. The assessment of a different set of parameters is required for this setting.

**Importance of Identifying Patients in Need of ICU Admission**

Rationales for specifically defining severe CAP are:

1. Identifying appropriate patients to optimize the use of limited ICU resources.
2. An increase in mortality is observed in patients who are transferred to the ICU for delayed respiratory failure or delayed onset of septic shock.
3. Microbial etiologies for ICU patients are different from that of CAP in general. This can significantly influence diagnostic testing and empirical antibiotic choices.
4. It is important to identify patients appropriate for immunomodulatory treatment.

**Need for a New Scoring System to Define ICU Care**

Studies have consistently demonstrated that risk for death does not always equate with the need for hospitalization or ICU care. This finding has rendered the PSI and the CURB 65 not very effective, simply because they are tailored to predict mortality risk only. Furthermore, almost 50% of all deaths in patients with pneumonia and more than one-quarter of deaths within 30 days are related to comorbidities rather than the condition itself. Just about 20% of patients in the severest class (Class V) of the PSI are thought to require ICU admission, which demonstrates that this scoring system has a limited value to critical care physicians.

**Predictive Models for Severe CAP**

There are three scoring systems available for identifying severe CAP that necessitates ICU admission. These include:

- ATS/IDSA Criteria
- SMART-COP Rule
- SCAP Rule

**ATS/IDSA Criteria**

The ATS/IDSA criteria used for ICU admission are summarized in Box 1.

**SMART-COP Tool for Assessing Severity of CAP**

The ‘SMART-COP’ (systolic blood pressure, multilobar chest radiography involvement, albumin level, respiratory rate, tachycardia, confusion, oxygenation, and arterial pH) is a simple tool that is the result of an extensive study on CAP called the Australian CAP Study (ACAPS). The tool was designed to overcome the limited ability of PSI and CURB 65 to predict which patients will require intensive respiratory or vasopressor support (IRVS). The basics of the system are depicted in Fig. 3.

The interpretation of SMART-COP score is as follows:

- **0-2 points**: Low risk of needing intensive respiratory or vasopressor support (IRVS)
- **3-4 points**: Intermediate risk of needing IRVS
- **5 or more points**: High risk of needing IRVS

---

**Box 1: SMART-COP Criteria**

\[
\text{SMART-COP} = S + M + A + R + T + C + O
\]

- \(S\): systolic blood pressure less than 90 mmHg
- \(M\): multilobar chest radiography involvement
- \(A\): albumin level less than 35 g/L
- \(R\): respiratory rate 25 breaths/min or more
- \(T\): tachycardia 125 bpm or more
- \(C\): confusion
- \(O\): oxygenation

\[
\text{Pa}_2 < 70 \text{ mmHg, or}\]
\[
\text{Pa}_2 < 93\% \text{ or less, or}\]
\[
\frac{\text{Pa}_2}{\text{FiO}_2} < 333
\]

\[
\text{pH} < 7.35
\]

- \(P\): pH less than 7.35

**Fig. 3: SMART-COP scoring system**
Box 1: ATS/IDSA criteria for ICU admission in CAP.

Criteria for ICU Admission

Major criteria
- Invasive mechanical ventilation
- Septic shock with the need for vasopressors

Minor criteria
- Confusion, disorientation
- BUN > 30 mg/dL
- Respiratory rate > 30/min
- PaO₂/FiO₂ ratio < 250 mmHg
- Multilobar infiltrates
- White blood cell count < 4000 cells/mm³
- Platelet count < 100,000 cells/mm³
- Core temperature < 36°C (96.8°F)

Direct admission to ICU is recommended if the patient has 1 major criterion (strong recommendation) or 3 minor criteria (moderate recommendation).

- 3-4 points: Moderate risk (1 in 8) of needing IRVS
- 5-6 points: High risk (1 in 3) of needing IRVS
- 7 or more points: Very high risk (2 in 3) of needing IRVS

In summary, SMART-COP is a simple, practical clinical tool for accurately predicting the need for IRVS and helps determine CAP severity. However, it has some limitations as well. There are different cut-off values for different age groups in this system, which pose problems when it comes to decision-making. Furthermore, the need for albumin test delays critical decisions and may compromise overall care.

Severe Community-Acquired Pneumonia score determines the need for ICU admission by the presence of one of the following two major criteria:

1. Arterial pH < 7.30
2. Systolic blood pressure < 90 mmHg

In the absence of these major criteria, severe CAP can be assessed by the presence of two of six minor criteria, such as confusion, BUN > 30 mg/dL, respiratory rate > 30/min, PaO₂/FiO₂ ratio < 250, multilobar infiltrates and age of at least 80 years.

A prospective validation study for SCAP by Yandiola et al. has concluded that the tool is ‘as accurate as or better than other current scoring systems in predicting adverse outcomes in patients hospitalized with CAP while helping classify patients into different categories of increasing risk for potentially closer monitoring’.

The sensitivity of SCAP to identify severe CAP is 92% and is more accurate than the PSI or CURB 65 criteria, although not quite as specific as the CURB 65 rule. In the study, SCAP was found to be effective in predicting adverse outcomes such as ICU admission, mechanical ventilation, development of severe sepsis and therapeutic failure.

SCAP vs. Other Scoring Systems

The SCAP is easier to implement as compared to PSI because it uses only eight variables as compared to 20 for the PSI. When compared to CURB 65, SCAP is more accurate at predicting adverse outcomes. The CURB 65 is also hampered by the fact that it lacks a formal assessment of vital signs like hypoxemia, which is a major drawback as oxygenation needs to be assessed immediately on arrival at the ED.

Why SCAP for Defining Severe CAP in Indian Context?

The SCAP score appears to be ideal in the Indian context for judging the severity of CAP because it needs only two additional parameters, compared to the CURB 65 components [chest radiograph and arterial blood gas analysis (ABG)] to judge the severity of the illness. Chest radiograph would usually be done at the time of admission as a routine, while ABG facilities are often available at all tertiary centers. Additionally, results of both these investigations are available within an hour. Hence, urgent decisions regarding the site-of-care can be taken without delay.

What if ABG facility is not available/affordable?

It is an unfortunate fact that sometimes ABG facilities might not be readily available or affordable. As pH is a major criterion
in deciding severity, SCAP score cannot be as accurate in the absence of ABG. Although there is no substitute, \( \text{PaO}_2/\text{FiO}_2 \) ratios can be assessed by pulse oximetry. The exact cut-off for this parameter needs to be finalized.

Keeping in view the limitations of the ATS and the SMART-COP scoring systems, SCAP may be more suited in the Indian scenario. The SCAP score is:\(^{12}\)
1. More practical in predicting ICU admission
2. Cost-effective
3. Accessible
4. Useful in taking quick decision for ICU admission.

**Role of Biomarkers\(^{13-16}\)**

Research has demonstrated that many biomarker tests can be considered as independent prognostic factors for either 30-day or in-hospital mortality. Biomarkers together with clinical parameters can aid clinicians in assessing the severity of the illness and the need for the use of antibiotics, as there are issues related to accurate estimation of viral and bacterial pathogens on the basis of clinical assessment.

Biomarkers can help differentiate patients with pneumonia from heart failure and chronic obstructive pulmonary disease (COPD) exacerbation, with the latter not requiring antibiotics. Another advantage of biomarkers is that serial measurements can be used to assess the treatment response. In future, biological markers may become a part of routine diagnostic testing for CAP.\(^{14}\)

Three prognostic markers, C-reactive protein (CRP), procalcitonin (PCT) and cortisol, have been investigated to assess CAP severity and predict outcome.\(^{13}\)

**Procalcitonin as a Biomarker for Predicting CAP Severity\(^{14}\)**

Studies have shown that PCT levels correlate with the severity of pneumonia. Significantly higher PCT levels have been observed in patients with a higher PSI score or with complications or death than those with an uncomplicated clinical course.

In the CAPNETZ study, Krüger et al. reported comparable predictive potential of PCT as compared to CRB 65. Nonsurvivors had significantly higher median PCT levels than survivors (1.2 vs. 0.3 mmol/L; \( p=0.0001 \)).

Even in patients with high CRB 65, low PCT was able to accurately predict patients who are at very low risk of death.

Procalcitonin has a high negative predictive potential (98.9% with PCT level of \(<0.6 \text{ mmol/L}\)). Therefore patients with low PCT might be safely treated as outpatients.

The use of PCT to assess the severity of CAP has several advantages which include:

- Identifying need for aggressive management
- Identifying patients to be treated on outpatient basis
- When PCT is used as a prognostic marker, patients can be counseled appropriately for adverse events.

Procalcitonin levels correlate better with Classes III–V PSI score compared to I and II. The values also correlate with CRB 65 for receiver operating characteristics for survival. Low procalcitonin levels can predict low risk of mortality.

Procalcitonin test is also more sensitive than CURB 65 in predicting prognosis. However, the limitations of this test are also quite formidable and include

- Availability
- Reporting time
- Serial assessment

**CRP as a Biomarker for Predicting CAP Severity\(^{15}\)**

C-reactive protein is an acute-phase protein synthesized in the liver. Previous studies have shown that inflammatory markers may have a huge role to play in assessing the severity of CAP. Chalmers et al. carried out a prospective study of 570 patients with CAP, enrolled over 2 years, and found that admission CRP \(<100 \text{ mg/L}\) has a high negative predictive value. The CRP levels \(<100 \text{ mg/L}\) indicated reduced risk, whereas failure of CRP to fall by 50% or more at day 4 was associated with increased risks for 30-day mortality, need for mechanical ventilation, and/or inotropic support, and complicated pneumonia.\(^{16}\)

Thus, CRP can be an independent marker of severity in CAP.

**PCT vs. CRP**

Simon et al. compared the predictive value of PCT and CRP in assessing the severity of CAP and found that PCT (88%) was more sensitive than CRP (75%) in the distinction of bacterial and noninfective causes of inflammation. Also, PCT (81%) was more specific than CRP (67%) in differentiating bacterial from noninfective causes of inflammation.\(^{14,16}\)

**Role of Biomarkers in Judging Severity\(^{14,17}\)**

The major problem with all SCAP criteria is that they are overly sensitive, suggesting ICU admission for many patients who could be adequately managed outside the ICU. Combining clinical SCAP criteria with the use of biomarkers is one potential solution. Procalcitonin seems to offer the greatest potential among all biomarkers.

At present, risk stratification of CAP identifies three groups at risk:

- **Low risk:** Ambulatory treatment
- **Intermediate risk:** Hospitalization
- **High risk:** ICU or intermediate care

However, it is clear that a subgroup at intermediate risk (and a very small one at low risk) is at risk of early deterioration and actually at high risk of death. This subgroup should be subjected to higher level of monitoring and intervention. There is an urgent need for the identification of predictors of this subgroup and biomarkers could be one solution.

**Summary**

- Pneumonia Severity Index and CURB 65 are the two most important prognostic scoring tools to predict mortality for patients with CAP. These tools accurately predict mortality but do not directly measure disease severity. The clinical assessment is still required to decide hospital admission or ICU care.

- Prognostic scoring systems have been used to assist in the site-of-care decisions, with limited success. PSI and CURB 65 are complementary to one another, as they identify different segments of the CAP population.

- The PSI developed to predict low-risk patients is complex to use. Also, its role in identifying critically ill individuals is limited because it may overestimate the mortality risk in old patients with comorbidity and may underestimate the need for ICU care in younger patients who have not been previously ill.
The CURB 65 is simple and is particularly useful for clinicians in identifying vital sign abnormalities that define severe illness. However, it is unable to detect patients with multiple comorbid illnesses effectively, particularly in the presence of decompensated illnesses associated with CAP.

At best, these scoring systems are decision-support tools, and cannot be used as ‘rules’ for site-of-care decisions.

In future, biomarkers such as PCT are likely to be used to predict CAP mortality and to guide management decisions.

Preliminary data indicate that measurement of PCT may be valuable and that the findings may complement the risk stratification results from prognostic scoring models.

**Recommendations**

- We recommend CURB-65/CRB-65 over the PSI to be used in the Indian context for judging severity and deciding site of care.
- Admission criteria should be based on CURB-65/CRB-65. This will reduce the chances of miss out.
- After the decision of hospital admission has been made, SCAP score (CURB-65+CXR+ ABG) should be used to decide ward or ICU admission.
- In patients admitted in ICU, in addition to SCAP, procalcitonin levels may be used as prognostic marker for patients at intermediate risk.

**References**