Study of Inferior Vena Cava Collapsibility Index in Patients with Community Acquired Pneumonia in Al-Azhar University Hospital in Damietta.

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Abstract: Introduction: Assessment of intravascular volume status is an essential parameter for the diagnosis and management of critically-ill patients specially in pneumonia. Ultrasonography measurement of inferior vena cava collapsibility index (IVC-CI) were used in the present study to evaluate the intravascular volume status of CAP patients. Subjects and methods: case study was conducted from January 2016 and September 2016. On 40 patients with CAP assessed by pneumonia scores (CURB65 score and SMARTCOP score) and classified according to CURB65 score to mild (0-1), moderate (2) and severe CURB65 (≥ 3). And classified according to SMART- COP score to low score in low score of requirement of intensive respiratory or vasopressin support (IRVS) (0-2), moderate (3-4), high (5-6) and very high (≥7). IVC-CI measured and correlated with (CURB65 & SMART-COP) in CAP Patients. Results: Of the 40 enrolled patients, with a mean age of 25.73±1.32, there was significant increase of IVC-CI (37.55+21.58) in mild CURB65 score (0-1); IVC-CI was (65.433+29.9) in moderate (2) (direct proportional), but in severe (≥3) IVC-CI decreased (56.66+30.6) in comparison to moderate (2); significant correlation was found between the CURB65 and IVC-CI ($p < 0.001$). In addition, there was a significant correlation between SMART-COP and IVC-CI ($P = 0.037$). (IVC-CI increased (36.09+24.80) in low SMART- COP score (0-2), in moderate (3-4) IVC-CI was (47.24+20.54) and high (5-6) IVC-CI was (55.02+30.77) (direct proportional), but in very high (≥7) the IVC-CI decreased (36.25+3.330) in comparison to moderate (3-4). **Conclusion**: The present study showed increased IVC-CI with the increase of CURB65 score in mild (0-1), in moderate (2) (directproportional), but in severe (≥ 3) IVC-CI decreased in comparison to moderate pneumonia (2). Increased IVC-CI with increase of SMART- COP score in low (0-2), in moderate (3-4), and in high (5-6) (direct proportional), but in very high (≥7) the IVC-CI decreased in comparison to moderate (3-4).

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1. Introduction:

Community-acquired pneumonia (CAP) is a leading infectious cause of death throughout the world. (WHOSIS; 2005), Prediction rules are useful adjuncts for clinical decision making. Several international organizations have developed guidelines. (Man et al., 2007). CURB is a modified version of the British Thoracic Society (BTS) assessment tool which relies on four parameters for scoring—namely, mental confusion, blood urea level, respiratory rate and diastolic blood pressure. In (2003) Lim et al. added age >65 years as a fifth prognostic variable to the CURB scoring system and turned it into a 6-point scoring scale (0–5) known as CURB65 which was adopted by the BTS as the new severity assessment strategy for CAP. (Macfarlane & Boldy. 2004). Severity assessment tools have been developed to help guide the sites of care for patients with CAP and, in particular, to identify patients whose condition can be managed safely at home (Charles et al., 2008). The ability to predict which patients will require ICU admission can be difficult because clinicians both overestimate and underestimate the severity of CAP (Alavi-Moghaddam et al., 2013).

Early recognition of such patients could improve outcomes, avoid inappropriate non-admissions, and potentially lead to a shorter length of ICU stay. (Charles et al., 2008).

Sepsis tends to occur from specific and consistent sources. Respiratory infections are invariably the most common cause of sepsis, severe sepsis and septic shock (Danai et al., 2007). Overall, respiratory infections account for approximately half of all cases of sepsis. The occurrence of acute organ dysfunction (i.e., severe sepsis) is related to the source of infection, as in patients with respiratory infections who are at higher risk for developing respiratory organ dysfunction. (Martin; 2012).

Moreover, a Canadian survey reported that 90% of intensivists used CVP to monitor fluid resuscitation in patients with septic shock (McIntyre et al., 2007).

However, CVP measurement requires invasive central venous catheter placement which is time-consuming and may be associated with a number of complications by the percutaneous insertion method e.g. arterial puncture, hemothorax, pneumothorax, venous air embolism (Ruesch et al., 2002).

Bedside ultrasonography is nowadays apopularly-used technique that is available in mostintensive care units. In addition, it is a safe, noninvasive, and portable tool. Accurate measurement of internal structures, and also large blood vessels including the IVC, are readily achieved with ultrasound (Maecken & Grau., 2007).

The combination of IVC size and the percentage change during inspiration, termed sonospirometry, has been shown to accurately estimate the CVP.

M-mode ultrasonography of the IVC provides an excellent means to measure and document the degree of inspiratory IVC collapse. (Seif et al., 2012).

To the best of our knowledge, no data are available on the exact profile of CAP patients with IVC-CI.

Aim of this study: to evaluate the IVC-CI as a guidance as a severity parameter of CAP and correlating it with the severity indices (CURB65 & SMART-COP) in Patient with Community-acquired pneumonia (CAP).

2. Subjects and methods:

2.1. Subjects:

This study was conducted from January 2016 and September 2016. On 40 patients with Community Acquired Pneumonia assessed by pneumonia scores (CURB65 score and SMARTCOP score) and classified according to CURB65 score to three groups to mild (0-1), moderate pneumonia (2) and severe pneumonia CURB65($\geq$ 3). And classified according to SMART- COP score to four groups to low score (in low score of requirement of intensive respiratory or vasopressor support (IRVS) (0-2), moderate score (3-4), high score (5-6) and very high SMART- COP score ($\geq$7). IVC-CI measured for all groups to conduct a prospective, cross-sectional study to evaluate the IVC-CI as a guidance as a severity parameter of CAP and correlating it with the severity indices (CURB65 & SMART-COP) in Patient with Community-acquired pneumonia (CAP).

2.2.2.2. Methods:

2.2.1. Complete medical history: detailed medical history taking including age, sex, occupation and history of other medical diseases which may be risk for CAP infection.

2.2.2. Full clinical examination: that divided into two stages, the first is general examination reviewing all systems of the body except the chest. The second stage included the chest and run in standard order starting by inspection, palpation, percussion and auscultation.

2.2.3. Plain chest radiography: containing consolidation.

2.2.4. IVC-CI measurement: In the present work we follow a special method to measure IVC collapsibility index similar to those done by (Mandeville and Colebourn, 2012). Study which recommended that the inferior vena cava (IVC) diameter should be measured in a supine patient in the sagittal (long-axis) subxyphoid window, making sure to angle the transducer to the patient's right The technique is performed using a 2–5-MHz phased array transducer. The anteroposterior diameter of inferior vena cava (IVCD) was measured duplicately, using images frozen according to operator judgement, at end of inspiration (iIVCD) and end of expiration (eIVCD) where the anterior and posterior wall of the IVC are easily visualized and lie parallel to each other (Lyon et al., (2005). expressed by the following equation: IVC-CI = (eIVCD-iIVCD)/eIVCD x 100 (Schefold et al., 2010).

2.2.5. Assessment of patients according to pneumonia scores: CURB65and SMART- COP score.

2.2.6. Laboratory investigation: (complete blood count, arterial blood gas, glucose, electrolytes and urea).

Significance level (P) value was expressed as follows: P>0.05=Insignificant. P<0.05=Significant.

3. Results:

3.1. Study and control subjects characteristics

3.1.1. Demographic characteristics:

A total of 40 CAP patients with a mean age of 25.73±1.32 and the total number of patients (40) (23 males (57.5%) and 17 females (42.5.5%)), number and percent of smokers (14 (35%)) to nonsmokers (26 (56%)). mean systolic BL PR 106.50$\pm$16.87, Mean diastole 64.25$\pm$13.93, Mean Pulse 91.3+7.08, Mean RR33.2+6.03, Mean Temp. 38.14+0.55. number and percent of patients whose admitted in patient ((28)70%), and whose admitted in ICU ((12)30%). relation between IVC-CI % and places of admissions of patients in which IVC-CI was (41.77+21.58) in ICU Admission, and IVC-CI which increased significantly to become (46.92+82.40) in patient whose admitted in word.

NB: all patients admitted in ICU receiving mechanical ventilation (SIMV mode with PEEP support (3-5). Table (1).

3.1.2. Chest ultrasonography:

Percent and number of patients presented with Pleural effusion (9) (22%), and the patients without Pleural effusion (31) (77.5%), and presence of Chest ultrasonography consolidation in (100%) of cases. Table(2).

3.1.3. Relation betweenCURB65 score and IVC-CI, there was significant increase of IVC-CI(37.55+21.58) in mild score (0-1); IVC-CI was (65.433+29.9) in moderate (2)(direct proportional), but in severe (≥3) IVC-CI decreased (56.66+30.6) in comparison to moderate (2); Table (3).

3.1.4. Correlation between CURB 65 and IVC-CI:

There was significant positive correlation between CURB 65 and IVC-CI p.value<0.001. Table (4) Figure (1).

3.1.5. Relation between IVC-CI %&SMART-COP.

IVC-CI increased(36.09+24.80)in low SMART-COP score (in low score of requirement of intensive respiratory or vasopressor support (IRVS) (0-2), in moderate score (3-4) IVC-CI was (47.24+20.54) and high (5-6) IVC-CI was (55.02+30.77) (direct proportional), but in very high score (≥7) the IVC-CI decreased (36.25+3.330) in comparison to moderate (3-4), Table (5).

3.1.6. Correlation between SMART- COP score and IVC-CI:

There was significant positive Correlation between IVC-CI and SMART- COP p.value=0.037. Table (6) Figure (2).

3.1.7. Relation between DIVC and Mortality.

Relation between DIVC and Mortality (direct proportional), when DIVC >2cm Mortality was 66.6% and When DIVC<2cm Mortality was 2.9%. Table (7).

3.1.8. Relation between IVC-CI before and after resuscitation.

IVC-CI decreased after resuscitation (500cc saline iv infusion) in 10 patient with IVC-CI more than 50% whom improved from (85.43) to (36.19). Table (8):

3.1.9. Correlation between IVC-CI before and after resuscitation.

There was significant positive correlation between IVC-CI Before and after resuscitation. P.value 0.001. Figure (3).

3.1.10. Relation between IVC-CI % and patient outcome.

There was positive correlation between IVC-CI % and patient outcome, mean IVC-CI % was (47.22+27.75) in patient whose improved, and mean IVC-CI % decreased to become (32.48+10.15) in patients whose died.(P. 0.001). Table (9).

Table (1): IVC-CI % & Admissions (In patient or ICU).

IVC-CI %	Admissions	
	In patient	ICU
No. (40)	28(70%)	12(30%)
Range	17.60-100	17.60-100
Mean±SD	46.92±82.40	41.77±21.58

Table (2): Chest ultrasonography.

	No.(40)	
	No	Yes
Pleural effusion	31 (77.5)	9(22.5%)
lung ultrasonography consolidation	0(0%)	40(100%)

Table (3) Relation between CURB 65 and IVC-CI.

IVC-CI %	CURB65		
	0-1	2	≥ 3
No. (40)	25(62.5%)	3(7.5%)	12(30%)
Range	17.60-100	47.40-100	21.20-100
Mean±SD	37.55±21.58	65.433±29.9	56.66±30.6
P. value	<0.001		

Table (4) Correlation between CURB 65 and IVC-CI.

IVC-CI	CURB 65	
	r	P.Value
	0.051	<0.001

Table (5) relation between SMART- COP score and IVC-CI.

IVC-CI %	SMART- COP			
	Low(0-2)	Moderate(3-4)	High(5-6)	VeryHigh≥7
No. (40)	18(45%)	7(17.5%)	13(32.5%)	2(5%)
Range	17.60-100	31.30-89.58	21.20-100	12.70-59.80
Mean±SD	36.09±24.80	47.24±20.54	55.02±30.77	36.25±3.330
P. value	0.001			

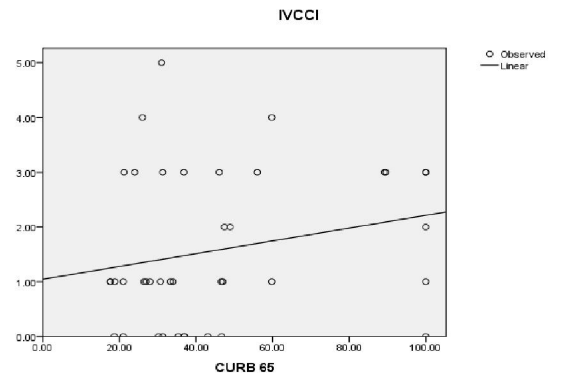

Figure (1) Correlation between CURB 65 and IVC-CI

Table (6): Correlation between IVC-CI and SMART-COP.

IVC-CI	SMARTCOP	
	r	P.Value
	0.109	0.037

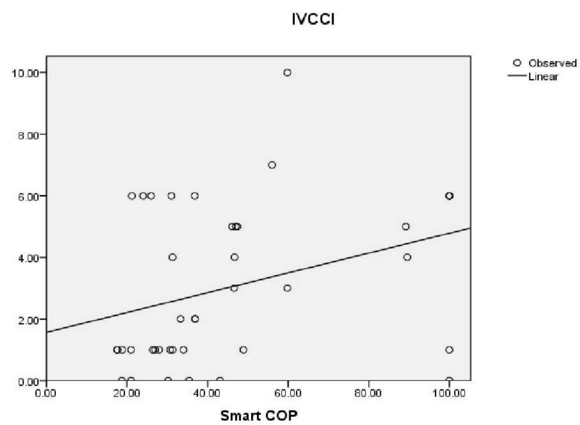

Figure (2): Correlation between IVC-CI and SMART-COP.

Table (7): Relation between DIVC and Mortality.

	Outcome	
	DIVC >2cm	DIVC<2cm
No. (40)	6(15%)	34(85%)
Mortality	4 (66.6%)	1(2.9%)
Mean + SD	23.370±1.86	14.88±2.90

Table (8) IVC-CI Before and After resuscitation

IVC-CI	Before	After
No. (10)	10 (100%)	10 (100%)
Range	56-100	26.5-47.9
Mean±SD	85.43±19.06	36.19±6.418
P.Value	0.001	0.001

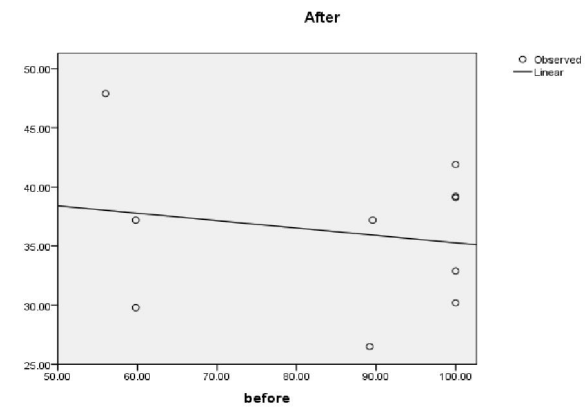

Figure (3) Correlations between IVC-CI Before and After resuscitation.

Table (9) Relation between IVC-CI % and patient outcome.

IVC-CI %	Outcome	
	Improved	Died
No. (40)	35(87.5%)	5(12.5%)
Range	17.60-100	21.20-47.40
Mean±SD	47.22±27.75	32.48±10.15
P.Value	0.001	

4. Discussion:

In the present work, we found that presence of Chest ultrasonography consolidation with percent of (100%) of cases.

These results are agreed with those reported by (Liu et al, 2015) reported that study of 179 patients that compared the accuracy of LUS and CXR for the diagnosis of CAP, LUS was found to be better than CXR (sensitivity of 94.6 versus 77.7 % and accuracy of 96.1 versus 83.8 %, respectively; $p < 0.001$).

Also These results are agreed with those reported by (Bourcier et al,. 2014) which compared the duration of symptoms with the respective performance of LUS and CXR for the diagnosis of CAP and observed that LUS detected more cases of CAP compared with CXR in the first 24 h of care (76 versus 23 %). This result further suggested that LUS was more sensitive than CXR in the early diagnosis of CAP. During the follow-up of patients with CAP, LUS could effectively monitor the changes in the lesion area.

Also These results are agreed with those reported by (Schirg E et al., 1999) reported that pneumonias may be first discovered at the bedside, extent of infiltration may be underestimated owing to artifacts on sonography, reventilation is well correlated with clinical progression, the value of chest sonography in pneumonia lies in the assessment of accompanying pleural fluid, timely detection of abscess formation, sonography-guided collection of pathogens, and controls particularly in pregnant women and children, in cases of tuberculosis and diseases of the frame of the lung, sonography is the optimum method to visualize small pleural effusions and subpleural consolidations; therefore, it is indispensable to control the progress of the disease ultrasonography has also been found to be more sensitive than chest radiography (CXR) in diagnosis of pleural effusion (Loculated and Free), Lung consolidation, also it is a portable tool that can be carried at any time, any place especially patients in RICU even mechanically ventilated and in comparison to C.T there is no radiation and it is able to perform dynamic evaluations.

In the present work, we found that ultrasonography has also been found to be more sensitive than chest radiography (CXR) in diagnosis of pleural effusion (Loculated and Free). These results are agreed with those reported by (Schirg et al, 1999) reported that ultrasonography has been found to be more sensitive than chest radiography (CXR) in diagnosis of pleural effusion (Loculated and Free).

In the present work, we found that IVC-CI significantly increased with the increase of CURB65 score in mild (0-1) (37.55+21.58) and moderate pneumonia (2) (65.433+29.9) (directly proportionally), but in severe pneumonia CURB65 (≥3) IVC-CI decreased (56.66+30.6) in comparison to moderate pneumonia CURB65 (2). And IVC-CI significantly increased with increase of SMART- COP score (in low score of requirement of intensive respiratory or vasopressor support (IRVS) (0-2) (36.09+24.80), moderate (3-4) (47.24+20.54)and high (5-6) (55.02+30.77) (directly proportionally), but in very high SMART- COP score (≥7) the IVC-CI decreased (36.25+3.330) in comparison to moderate (3-4) SMART- COP score, which indicated poor prognosis.

This result was agreed with (Peter and Meghan, 2014) study, in which Sixty-five patients with undifferentiated dyspnea had a point of care (poc) IVC US. Common diagnoses were (34%), COPD (20%), pneumonia (20%) and asthma (9%). Twenty-four patients had a plethoric IVC, of which 7 (29%) expired during hospitalization. Comparatively, 41 patients had a non-plethoric IVC, of which 1 (2%) expired during the hospitalization. Patients with a plethoric IVC were significantly more likely to experience in-hospital mortality, with an odds ratio of 17 (p=0.005, 95% CI 2-128).

In the present work, we found that there was positive correlation between IVC-CI and outcome: mean IVC-CI % was increased (47.22+27.75) in patient whose improved, and mean IVC-CI % decreased to become (32.48+10.15) in patients whose died, in comparison to patient whose improved.

This result agreed with (Peter and Meghan, 2014) study, in which Patients with a plethoric IVC were significantly more likely to experience in-hospital mortality, with an odds ratio of 17 (p=0.005, 95% CI 2-128). In the present work, we found that in patients with high IVC-CI values (>50%) (10 cases) there were association with fluid responsiveness; IVC-CI decreased after resuscitation (iv infusion of 500cc) in 10 patient with IVC-CI more than 50% from (85.43) to (36.19) (all cases with IVC-CI values (>50%) improved).

This result agreed with (Muller et al., 2012) study In which reborted that In spontaneously breathing patients with ACF, high cIVC values (>40%) are usually associated with fluid responsiveness while low values (<40%) do not exclude fluid responsiveness.

In the present work, we found that there was positive correlation between DIVC and mortality, When DIVC >2cm Mortality was 66.6% and When DIVC<2cm Mortality was 2.9% This result agreed with (Peter and Meghan, 2014) study In which Patients with a plethoric IVC were significantly more likely to experience in-hospital mortality, with an odds ratio of 17 (p=0.005, 95% CI 2-128).

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