End-tidal carbon dioxide measured at emergency department triage outperforms standard triage vital signs in predicting in-hospital mortality and intensive care unit admission

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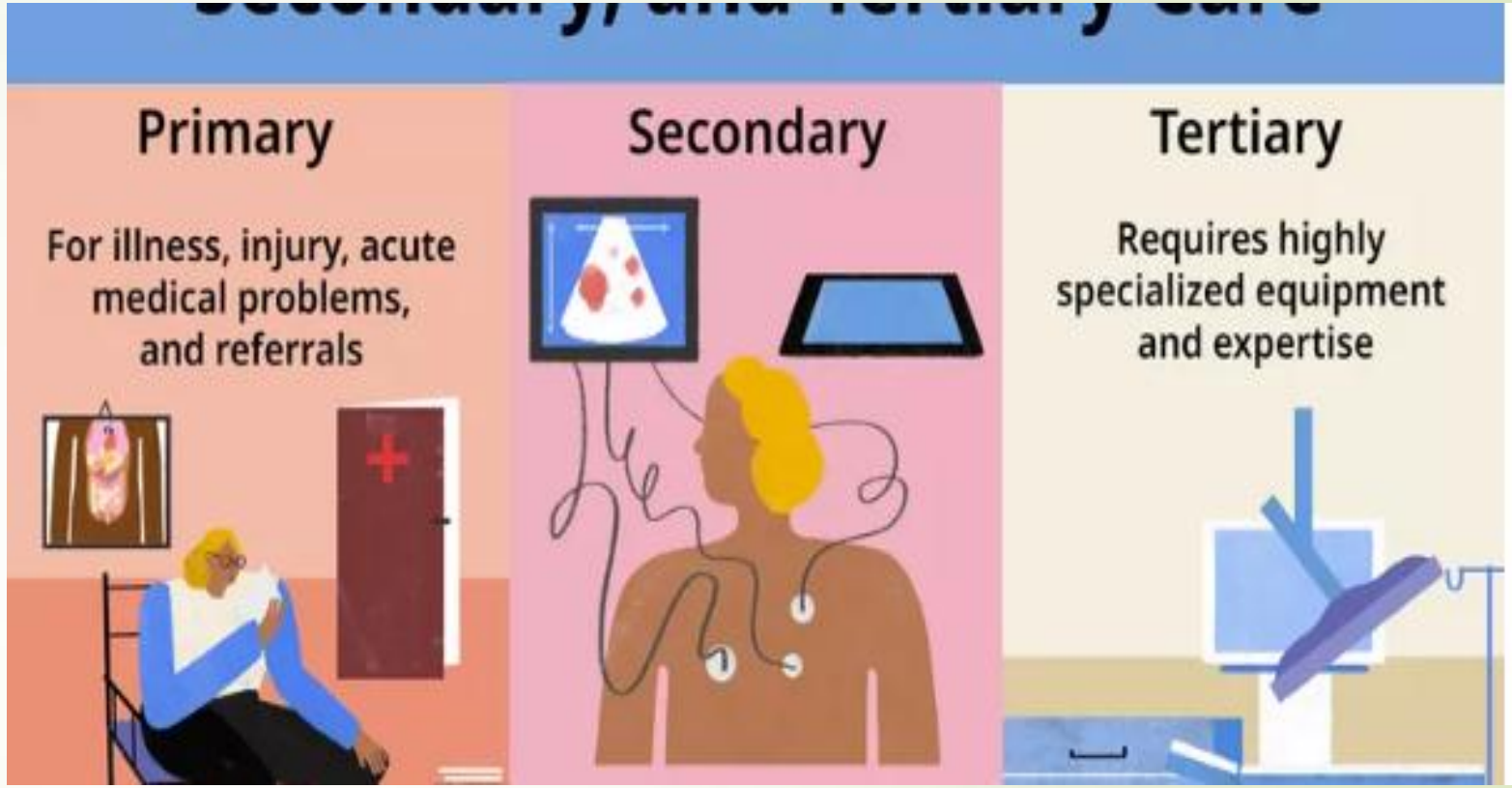
End-tidal Carbon dioxide

- End-tidal carbon dioxide ($ETCO_2$) is the level of carbon dioxide that is released at the end of an exhaled breath.
- $ETCO_2$ levels reflect the adequacy with which carbon dioxide (CO_2) is carried in the blood back to the lungs and exhaled.

Objectives :

This study assessed the ability of end-tidal carbon dioxide (ETCO2) in predicting in-hospital mortality and intensive care unit (ICU) admission compared to standard vital signs at ED triage as well as comparing to measures of metabolic acidosis.

This prospective study enrolled adult patients presenting to the ED of a tertiary care Level I trauma center over 30 months. Patients had standard vital signs measured along with exhaled ETCO2 at triage. Outcome measures included in-hospital mortality ;ICU admission; and correlations with lactate, sodium bicarbonate (HCO3), and anion gap.



Traditional vital signs are quick and noninvasive values that have a critical role in the risk stratification of patients arriving to an emergency department (ED). Previous literature, however, has suggested that our current vital signs alone may be insufficient for initial patient assessment.

Exhaled end-tidal carbon dioxide (ETCO2) is a noninvasive measurement that is a byproduct of a patient's current state of metabolism, circulation, and ventilation.
ETCO2 has become an invaluable tool in a number of prehospital and in-hospital scenarios. It has been widely accepted as the criterion standard for confirming proper endotracheal tube placement and as a useful prognostic indicator of initial outcome of resuscitation in cardiopulmonary arrest. It has a significant association with lactate and anion gap elevation and has found to be an indicator of DKA in pediatric and adult populations. Furthermore, numerous studies have shown ETCO2 to have a strong association with acute disease severity and mortality in sepsis, trauma, and shock. Prior studies have explored the clinical utility of adding ETCO2 to the initial triage assessment of patients. Such studies have suggested that an aberrant ETCO2 may be a sensitive indicator of illness or injury and when compared to all prehospital vital signs,

Results :

There were 1136 patients prospectively enrolled in the study and 1091 patients with both ETCO2 and outcome data available Patients . 53% were male .

And the age was at the range of 56 +/- 19 years .

Clinical characteristics of the survivors and non survivors is shown in Table 1. Survivors were significantly younger (55 years vs. 68 years) and had a higher proportion of normal mental status (88% vs. 35%).

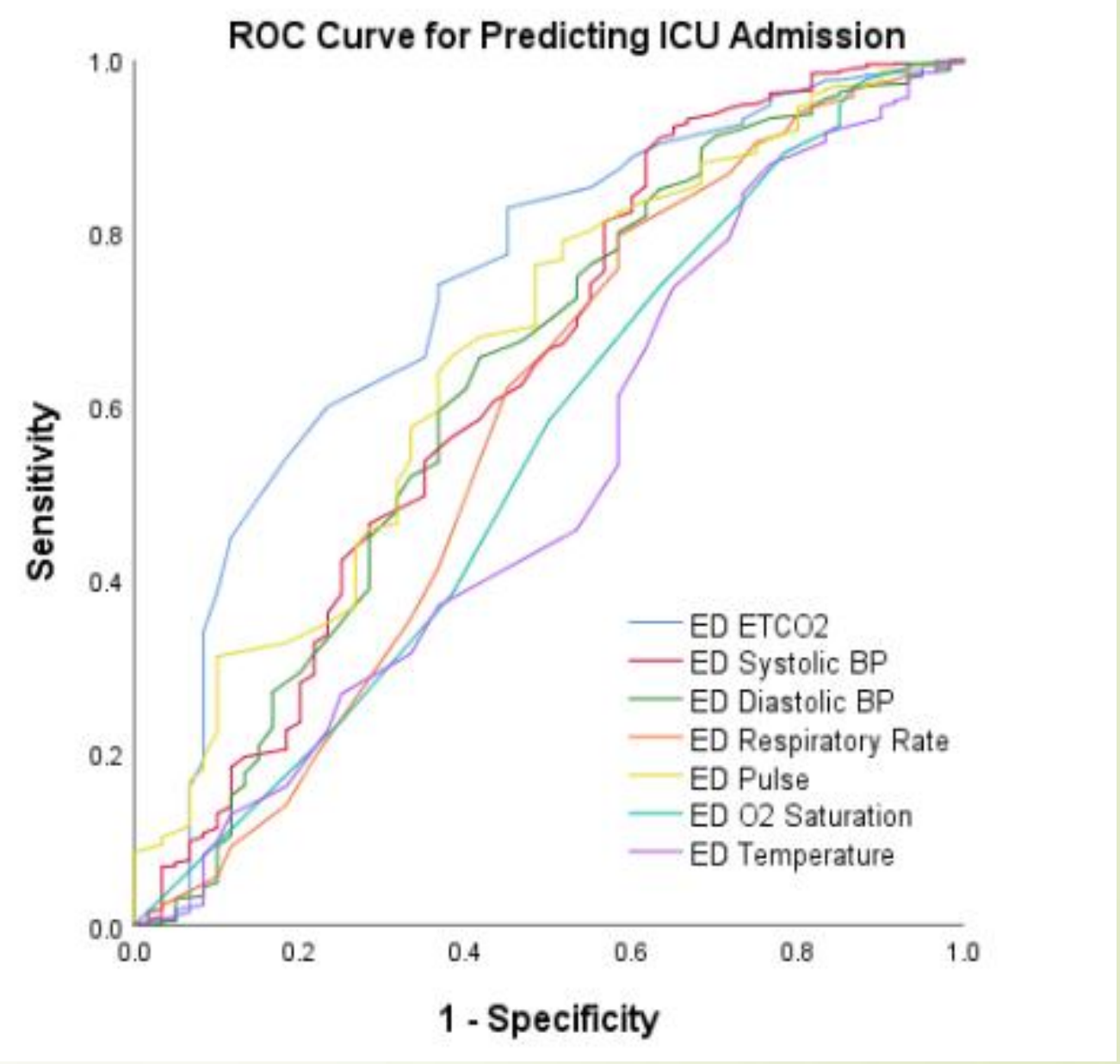
There were no significant differences in gender. There were significant differences in race with a higher proportion of Hispanics and Blacks among survivors and more "unknown" and "other" races in non survivors.

Hospital admission and admission to the ICU were both significantly higher in the non survivors. the mean level of ETCO2 at triage in all patients was 34 . There were 26 (2.4%) patients with in-hospital mortality and mean ETCO2 levels in survivors versus non survivors were 34 versus 22 .

TABLE 1 Comparison of characteristics of patients who did and did not survive to hospital discharge.

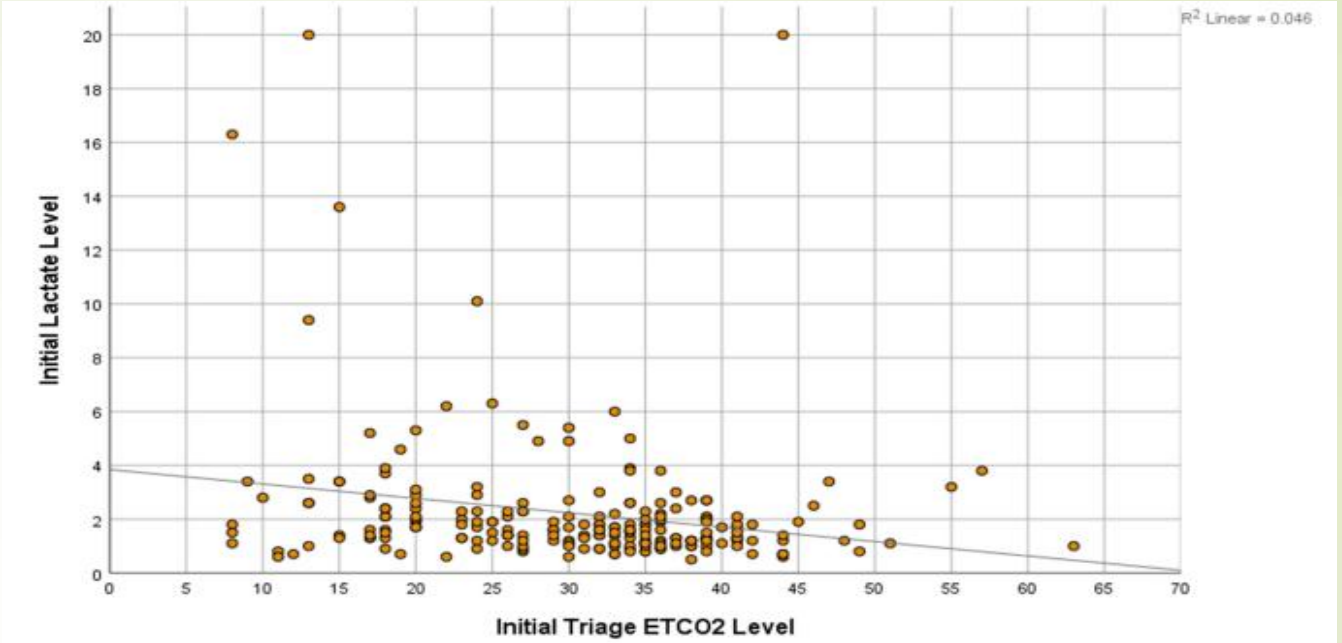
	Survivors (n = 1065)	Nonsurvivors (n = 26)	Total (N = 1091)	p-value
Age (years)				
Mean [95% CI]	55 [54-57]	68 [61-76]	56 [55-57]	0.001
Median (IQR)	57 (41-69)	70 (58-83)	57 (41-69)	
Gender, n (%)				0.072
Female	494 (46)	17 (65)	511 (47)	
Male	571 (54)	9 (35)	580 (53)	
Anion gap (n = 974)				
Mean [95% CI]	8.2 [7.8-8.6]	11.6 [9.3-13.9]	8.3 [7.9-8.7]	0.012
Median (IQR)	8 (5-10)	11 (7-17)	8 (5-10)	
$ETCO_2$				
Mean [95% CI]	32 [28-35]	22 [20-23]	24 [22-25]	<0.001
Median (IQR)	35 (30-38)	19 (15-28)	35 (30-38)	
Temperature (n = 1073)				
Mean [95% CI]	98.2 [98.2-98.3]	98.6 [97.9-99.3]	98.2 [98.2-98.3]	0.869
Median (IQR)	98.1 (97.7-98.6)	98.1 (97.8-98.8)	98.1 (97.7-98.6)	
RR (n = 1089)				
Mean [95% CI]	19 [18-19]	21 [18-24]	19 [18-19]	0.044
Median (IQR)	18 (16-20)	20 (16-25)	18 (16-21)	
SBP (n = 1090)				
Mean [95% CI]	137 [136-139]	112 [102-121]	137 [135-138]	0.114
Median (IQR)	134 (120-151)	111 (95-128)	134 (119-150)	
DBP (n = 1090)				
Mean [95% CI]	79 [78-80]	66 [58-75]	79 [78-80]	<0.001
Median (IQR)	78 (68-90)	68 (55-79)	78 (68-89)	
Pulse				
Mean [95% CI]	87 [86-88]	108 [98-118]	87 [86-89]	0.001
Median (IQR)	84 (72-98)	108 (88-124)	84 (72-99)	
SpO_2 (n = 1090)				
Mean [95% CI]	97 [97-98]	95 [92-98]	97 [97-98]	0.254

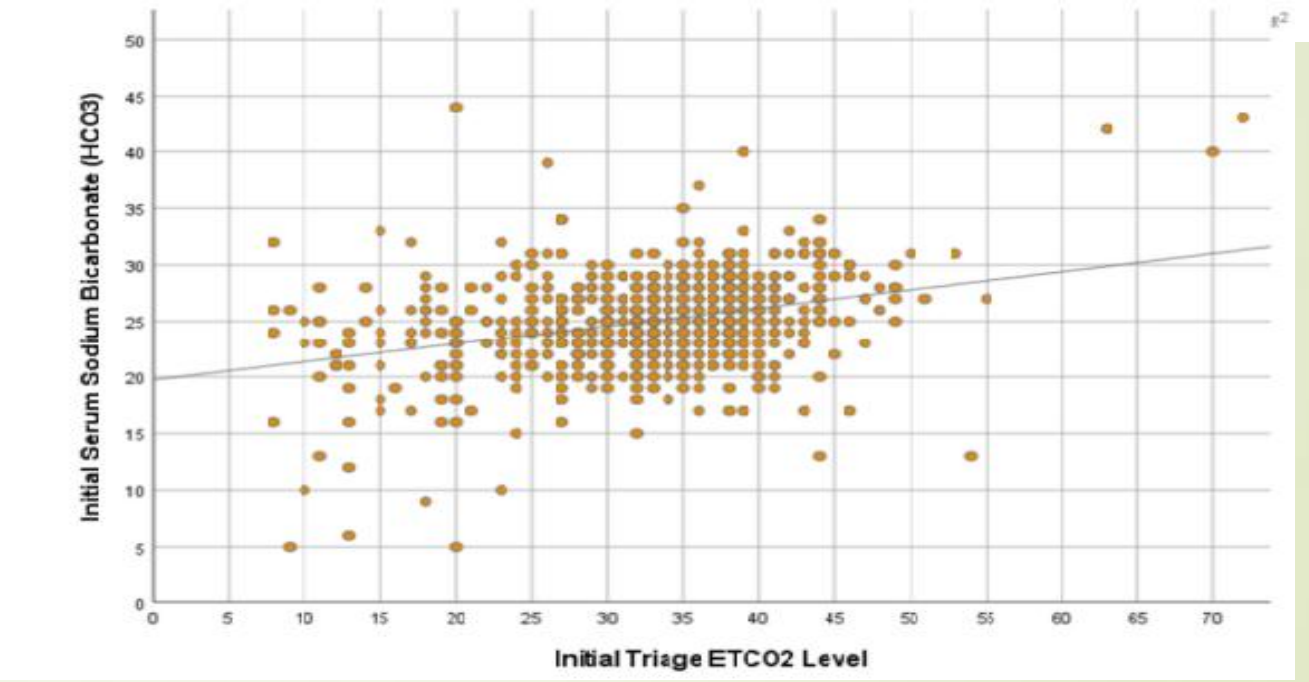
Vital Sign	Area Under the ROC Curve for Predicting ICU Admission
ETCO2	0.75 (0.67-0.80)
Systolic Blood Pressure	0.64 (0.56-0.72)
Diastolic Blood Pressure	0.63 (0.55-0.71)
Respiratory Rate	0.56 (0.47-0.65)
Pulse	0.66 (0.58-0.73)
Oxygen Saturation	0.53 (0.45-0.61)
Temperature	0.51 (0.42-0.59)



. ETCO2 levels were significantly lower in patients who died compared to those who survived and were associated with other measures of metabolic acidosis including HCO3, anion gap, and lactate levels. This supports the observation that capnography is a potential measure of metabolic acidosis and hypoperfusion .

Utilizing this measure as a prognostic indicator has the potential to decrease the time it takes to recognize acute illness severity and allow for early intervention. Exhaled carbon dioxide is a product of metabolism, ventilation, and perfusion. Thus, ETCO2 has been studied extensively in relationship to hypoperfusion, hypoventilation, HCO3, and lactate levels. The predictive qualities of ETCO2 for mortality may be secondary to its use as a marker for inadequate ventilation, metabolic disturbances such as acidosis, or poor alveolar perfusion. Since ETCO2 levels are extremely low in cardiac arrest and may be affected by RR, the current study only included spontaneously breathing patients presenting to ED triage.





Conclusion :

- In this large prospective study of an undifferentiated ED patient population, end-tidal carbon dioxide levels measured at triage were able to predict in-hospital mortality and intensive care unit admission. Furthermore, when compared to conventional vital signs at ED triage, end-tidal carbon dioxide provided the highest predictive measure for mortality and intensive care unit admission. End-tidal carbon dioxide was also associated with measures of metabolic acidosis. These results suggest that incorporating end-tidal carbon dioxide into initial patient assessments at triage may provide early and important information for ED clinicians and has implications for medical decision making, including the need for higher levels of care.

Thank you for your attention