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R E V I E W A R T I C L E

A Clinical Assessment of Sodium Imbalance Induced Delirium in Critical Care Units in A Tertiary Care Hospital

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A B S T R A C T

Delirium is very common within the intensive care unit (ICU), particularly amongst mechanically ventilated patients. The medical practitioner ought to take into account delirium, or acute central nervous system pathology, as the brain's type of "organ pathology." The third leading cause is known to increase the mortality rate in intensive care units. The study design implemented is a prospective observational cohort study, to assess the risk of developing delirium in sodium and fluid imbalance patients. The study population included 200 critically ill patients admitted to the various departments of critical care. The study was conducted for six months at Gleneagles Aware Global Hospital, with prior ethical committee permission. The assessment for delirium was done using the scales RASS, CAM-ICU, and NEECHAM. Data regarding serum sodium and delirium specificity was correlated to assess the epidemiology. Statistics were calculated using SPSS version and Microsoft Excel version 2016 16.0.6741.2048. The correlation between delirium and sodium imbalance was found to be clinically significant with P-value 0.05. The sensitivity was found to be 0.57 and specificity 0.48 for delirium induced due to sodium imbalance. The assessment of delirium is crucial in critical care as it not only increases the duration of hospitalization, decreases response to therapy but also increases mortality.

Keywords: Delirium, Pathology, Patient, Sodium imbalance

A R T I C L E I N F O

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C O N T E N T S

1. Introduction

A disturbance of consciousness specifies delirium with concomitant modification in cognition. Delirium generally manifests as a constellation of symptoms with an acute onset and an unsteady course. Delirium is very common within the intensive care unit (ICU), particularly amongst mechanically ventilated patients. The medical practitioner

ought to take into account delirium, or acute central nervous system pathology, as the brain's type of "organ pathology."

Environmental causes:

Sensory deprivation – The sensory impairment will be observed when a patient is kept isolated in a closed room with no windows.

Sleep deprivation – The continuous noises and disturbance with hospital staff round the clock to check vital signs, give medications may cause inadequate sleep to the patient.

Stress – In most scenarios ICU patients will be in a condition of no hope on life.

Continuous lights – Continuous disturbance of normal biorhythms with lights switched on round the clock in the ICU, i.e., no reference to day or night.

Lack of orientation – Patient's loss of knowledge about time and date.

Medical causes:

- Uncontrollable pain in the ICU experienced by the patients.
- Critical illness – The severity of illness, pathophysiology of disease or traumatic incident, the amount of stress a patient experiences during an illness/disease can cause a wide variety of psychological symptoms.
- Infection-related fever and toxins in the body.
- Metabolic disturbances – electrolyte imbalances – specially altered serum sodium levels, elevated metabolic enzymes and hypoxia.
- Heart failure (inadequate cardiac output).
- Drug reaction or side effects – Various new medications typically administered to the patient's in the hospital or ICU.
- Dehydration.
- Post-operative outcomes.
- Glucose deficiency in the body.
- Alcohol withdrawal delirium – delirium tremens.
- Structural problems in the brain.
- Severe vitamin deficiencies.
- Liver, kidney or thyroid failure

Medication-related:

- ✓ Sedatives
- ✓ Laxatives
- ✓ Opioids
- ✓ Anticholinergic agents such as atropine.
- ✓ Steroids
- ✓ Anti-allergic medications
- ✓ Substance abuse such as alcohol, tobacco, cannabis, heroin.

Pathophysiology:

Disturbances of sodium and fluid balance are a significant cause of confusion among geriatric critically ill patients, accompanying infections and drug effects. Delirium is closely linked to fluid imbalance, which is a multifactorial problem that includes physiological changes of senescence. Such changes can also cause hyponatremic dehydration, which is not at all rare in the elderly. In the literature, sodium imbalance is cited among the more common causes of delirium in the elderly.

Assessment:

The psychological evaluation and management of critically ill patients are considered as a part of the patient care plan. The potential adverse effects of delirium include increased hospital stay, decreased level of functioning - usually in elderly, stress response syndrome after hospitalization and increased mortality. Often, the clinical features of delirium vary from patient to patients such as increased or decreased psychomotor activity, impaired attention and memory, hallucinations and delusions. ICU syndrome is not different from delirium and is dangerous because it hinders the standard research and may reduce the surveillance needed to investigate and reverse the medical causes of the delirium thoroughly.

A various number of instruments are available to assess delirium in critically ill patients. There is evidence that to report delirium, physicians in the ICU recognize less than one-third of delirious critically ill patients without using any instruments. Around six validated instruments to assess delirium in ICU patients that were identified in a standardised review that was done in 2007 are Confusion Assessment Method for the Intensive Care Unit (CAM-ICU), Intensive Care Delirium Screening Checklist (ICDSC), Neelon and Champagne Confusion Scale (NEECHAM), Delirium Detection Score, Abbreviated Cognitive Test for Delirium, Cognitive Test for Delirium and Nursing Delirium Detection score.

The most widely used scale for assessing delirium in critically ill patients is CAM-ICU which can be used at beside in nonverbal mechanically ventilated patients.

Four main features that are important for assessing delirium in CAM -ICU are:

Feature-1: Acute Onset or Fluctuating Course

Feature-2: Inattention

Feature-3: Altered level of Consciousness

Feature-4: Disorganized Thinking.

When bedside nurses without any psychiatric training utilized CAM -ICU scale, it showed high accuracy and reliability in a single-center study. In another study, it was being used by trained bedside nurses in the ICU. The harmony between the assessment of delirium by bedside nurses and research staff rater was low at the beginning but was very high during the training period. In recent studies, it was found that the sensitivity of the CAM-ICU scale ranged from 64% to 81% and specificity ranged from 88% to 98 %. However, in a more recent study, CAM-ICU had high specificity and low sensitivity. The difference between the previous research and others may originate from different implementation methods, such as different approaches to educating and training the providers/staff using the worksheet.

Many studies compared different instruments for assessing delirium in critically ill patients. In one study, the accuracy of CAM-ICU, Delirium Detection Score and Nursing Delirium Screening Scale were examined prospectively in 156 patients. The results showed that sensitivities of CAM-ICU and Nursing Delirium Screening Scale were almost similar (CAM-ICU: 83%; Nursing Delirium Screening Scale: 83%) whereas the sensitivity of Delirium Detection Score was 30%. The specificities of CAM -ICU and

Delirium Detection Scores were found to be 96% and 91% respectively. The above-indicated instruments are our best tools for early assessment of delirium in the ICU, but they have some limitations. Few studies indicate different sensitivities for the same device, specifically CAM-ICU. This difference in sensitivities can be illustrated by a wide range of heterogeneity seen in the patients included in the study but mainly by a different level of training and experience among the assessors involved in the reviews. Thus, it is difficult to demonstrate with what efficacy these instruments work without adequate preparation, but it is sensible to state that a considerable proportion of critically ill patients with delirium remain undiagnosed if these instruments are applied without proper training to the health care providers. In recent times, two systematic reviews evaluated the accuracy of CAM -ICU and concluded that it is an accurate instrument for the diagnosis of delirium in critically ill patients. However, in the only study which was conducted in a non-research setting, most of the delirious patients were not detected by CAM-ICU.

The RASS (Richmond Agitation Sedation Scale) contains two levels, each denoting a state of response that is voice (score -1 to -3) and touch (score -4 & -5). The ratings are allotted based on the condition of the patient that is +4 combative, +3 very agitated, +2 agitated, +1 restless, zero alert and calm, -1 drowsy, -2 light sedation, -3 moderate sedation, -4 deep sedation, and -5 unarousable (unconscious). The scale can be rated within 1-2 minutes from observation. The score zero indicates the patient is healthy, any count greater than or equal to 3 points to proceed to the CAM -ICU scale.

CAM-ICU Worksheet

Feature 1: Acute Onset or Fluctuating Course	Score	Check here if Present
Is the patient different than his/her baseline mental status? OR Has the patient had any fluctuation in mental status in the past 24 hours as evidenced by fluctuation on a sedation/level of consciousness scale (i.e., RASS/SAS), GCS, or previous delirium assessment?	Either question Yes →	☐
Feature 2: Inattention		
Letters Attention Test (See training manual for alternate Pictures) Directions: Say to the patient, *"I am going to read you a series of 10 letters. Whenever you hear the letter 'A,' indicate by squeezing my hand."* Read letters from the following letter list in a normal tone 3 seconds apart. S A V E A H A A R T or C A S A B L A N C A or A B A D B A D A A Y Errors are counted when patient fails to squeeze on the letter "A" and when the patient squeezes on any letter other than "A."	Number of Errors ≥2 →	☐
Feature 3: Altered Level of Consciousness		
Present if the Actual RASS score is anything other than alert and calm (zero)	RASS anything other than zero →	☐
Feature 4: Disorganized Thinking		
Yes/No Questions (See training manual for alternate set of questions) 1. Will a stone float on water? 2. Are there fish in the sea? 3. Does one pound weigh more than two pounds? 4. Can you use a hammer to pound a nail? Errors are counted when the patient incorrectly answers a question. **Command** Say to patient: "Hold up this many fingers" (Hold 2 fingers in front of patient) "Now do the same thing with the other hand" (Do not repeat number of fingers) *If the patient is unable to move both arms, for 2nd part of command ask patient to "Add one more finger" An error is counted if patient is unable to complete the entire command.	Combined number of errors ≥1→	☐
Overall CAM-ICU Feature 1 plus 2 and either 3 or 4 present = CAM-ICU positive	Criteria Met →	☐ CAM-ICU Positive (Delirium Present)
	Criteria Not Met →	☐ CAM-ICU Negative (No Delirium)

Fig 1: Confusion Assessment Method

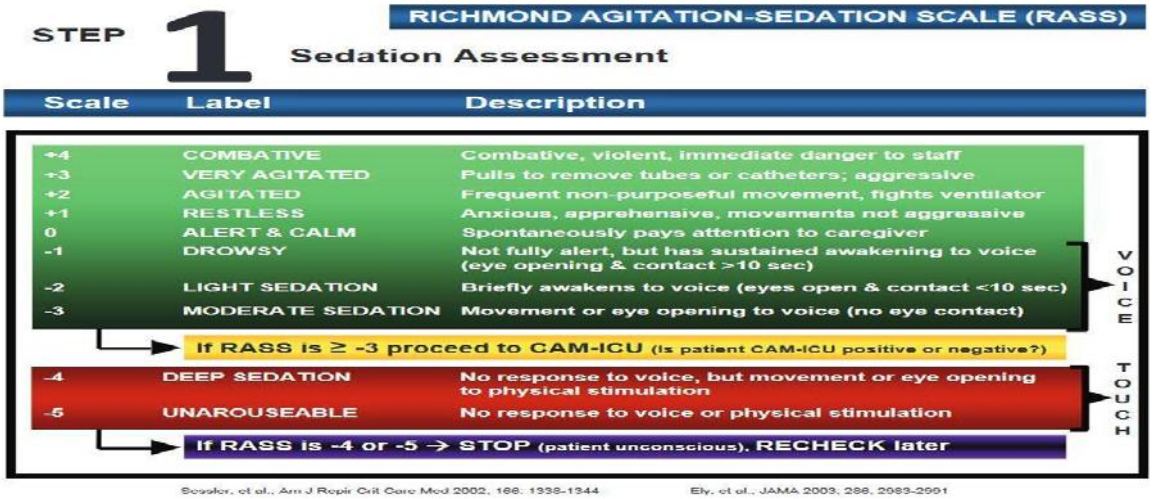

Fig 2:RASS worksheet

The NEECHAM (Neelon and Champagne) Confusion Scale contains nine scaled parameters divided into three levels. Each level provides three characteristic parameters. Level-I deals with information processing and orientation (score ranging from 0 – 14 points). It evaluates components of cognitive status: attention and alertness, verbal and motor response, and memory and orientation. Level-II deals with behavior (score ranging from 0 – 10 points). It evaluates behavior and performance ability: general appearance and posture, sensory-motor performance, and verbal responses. Level-III deals with physiological control (score ranging from 0 – 6points). It evaluates important function stability: vital signs, oxygen saturation stability and urinary continence control. The total NEECHAM scale score is the product sum of the scores on the three scales. The scale can be rated in 5-10 minutes from observations and measurements of vital signs. The ratings may range from 0-30 where zero indicates minimal function and 30 means normal function; the threshold point is 24. The score from 0–24 points indicates delirium as three types: mild, moderate and severe.

Table 1:NEECHAM scale

NEECHAM Confusion Scale	**Score**
Subscale I: Level of responsiveness-informationprocessing	
• Attention and alertness	(0 – 4 points)
• Verbal and motor response	(0 – 5 points)
• Memory and orientation	(0 – 5 points)
Subscale II: Level of behavior	
• General behavior and posture	(0 – 2 points)
• Sensory-motor performance	(0 – 4 points)
• Verbal responses	(0 – 4 points)
Subscale III : Vital functions	
• Vital signs	(0 – 2 points)
• Oxygen saturation level	(0 – 2 points)
• Urinary continence	(0 – 2 points)
Scores: 0 – 19 points- moderate to severe confusion	
20 – 24 points- mild or early development of delirium	
25 – 30 points- not confused or normal function	

Objectives:

Delirium is hospital-acquired comorbidity which results in increased risk of mortality in critically ill patients. As per prior discussion, many factors contribute to the development of delirium, among which sodium imbalance could be an essential criterion. The authors sought to assess the impact of developing delirium induced due to sodium imbalance (associated with a fluid imbalance in some patients) in critical care units.

2. Methodology

This is a prospective observational cohort study designed to assess the epidemiology of delirium in intensive care units, developed due to sodium imbalance. The study was conducted with the prior permission from the Institutional Ethical Committee, and the Informed consent was taken from HOD of the critical care department. The study enrolled 200 patients admitted into the wards of Medical ICU, Respiratory ICU, and High Dependency Unit for six months at Gleneagles Aware Global Hospitals, L.B Nagar. Pediatric, pregnant and lactating women, and psychiatric patients were excluded from the study. Delirium was assessed utilizing the RASS (Richmond Agitation-Sedation Scale), CAM-ICU (Confusion Assessment Method) and NEECHAM scale (Neelon Champagne Confusion Scale). Sodium imbalance data (less than 130mmol/L) was collected from the daily patient reports and laboratory findings. Data was evaluated, analyzed and statistical calculations regarding sensitivity, specificity & likelihood correlation were done using SPSS version 25, Microsoft Excel version 2016 16.0.6741.2048.

3. Results and Discussion

Out of 200 patients enrolled for the study 123 patients (61.5%) were assessed as to develop delirium according to the scales and 77 patients (38.5%) were evaluated to be non-delirious (Table 2). Among these 200 patients, 14 patients (7%) were found to be hypernatremic, 90 patients (45%) were hyponatremic, and 96 patients (48%) were with normal serum sodium levels (Table 3, Figure 3). The sensitivity was calculated as 0.57 and the specificity as 0.48. The sodium imbalance was correlated with the sensitivity and specificity of delirium, using probability significance. From the P-value 0.05, sodium imbalance and delirium are significantly associated (Table 3).

Discussion:

From Figure 1, the correlation between sodium imbalance and delirious sensitivity and specificity is significantly probable. In this study, the prevalence and association of delirium in critically ill patients is significantly observed:

- ✓ Out of 14 patients with hypernatremia (>145mmol/ L) 3 patients developed mild, one developed moderate and 8 developed severe type of delirium.
- ✓ Out of 90 patients with hyponatremia (<130mmol/L) 15 patients developed mild, 13 patients developed

moderate, and 20 patients developed a severe type of delirium.

- ✓ The risk ratio to develop delirium in sodium imbalance is estimated to be 0.87.

In the above study, the authors were able to rule out significant contradictory variables attributable to comparisons. This supports the hypothesis that sodium imbalance, even less evident, could also be considered a relevant cofactor for the development of delirium. Factors that cause cognitive deterioration may additionally facilitate electrolyte imbalance.

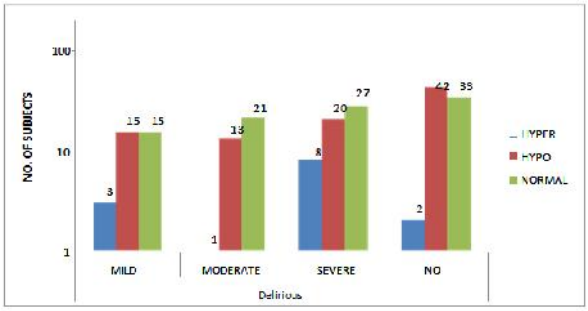

Fig 3: Correlation of sodium imbalance with delirium

Table 2: Distribution of patients based on Serum Sodium levels

Sodium	No. of subjects	% of subjects
HYPER	14	7.00
HYPO	90	45.00
NORMAL	96	48.00
TOTAL	200	100.00

Table 3: Correlation of sodium imbalance with delirium

		Delirious				Total	P-Value
		Mild	Moderate	Severe	No		
Sodium	Hyper	3	1	8	2	14	0.05
	Hypo	15	13	20	42	90	
	Normal	15	21	27	33	96	
Total		33	35	55	77	200	

4. Conclusion

Implementation of delirium assessment as regular healthcare management especially in the critically ill patients should be practiced daily. According to its higher prevalence of delirium in intensive care units, diagnostic evaluation of sodium imbalance plays a crucial role in assessment and management. It is the responsibility of the healthcare professionals in critical care departments, to implement such observational assessment practices as the therapeutic grid is too narrow in these patients, and any little deviation could lead to adverse consequences (hospital-acquired comorbidities and mortality).

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