

Clinical utility of the Therapeutic Intervention Scoring System (TISS-28) as a predictor of mortality in critically ill patients: A retrospective study in an Intensive Care Unit in Montería, Colombia

Utilidad clínica del Sistema de Puntuación de Intervenciones Terapéuticas (TISS-28) como predictor de mortalidad en pacientes críticos: estudio retrospectivo en una Unidad de Cuidados Intensivos de Montería, Colombia

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SUMMARY

Introduction: The care of critically ill patients represents multiple clinical and organizational challenges. Mortality in the Intensive Care Unit (ICU), influenced by patient severity and interventions performed, is a key indicator of hospital performance. **Objective:** This study aimed to evaluate the clinical utility of the Therapeutic Intervention Scoring System (TISS-28) as a predictor of mortality in a tertiary ICU in Montería, during the period 2019-2023. **Methods:** A descriptive, retrospective study with a quantitative approach. Patients with complete TISS-

28 score records were included in the analysis. **Results:** A total of 3 822 patients were analyzed. Cumulative mortality was 10.04 % in the TISS IV group, 6.39 % in the TISS III group, and 3.23 % in the TISS II group. The use of the TISS-28 score was correlated with clinical severity and patient prognosis. The most frequent diagnoses were of respiratory origin, such as severe Pneumonia and respiratory distress syndrome. There was a decrease in admissions classified as TISS IV (from 465 in 2019 to 243 in 2023), a sustained increase in TISS II (from 171 to 267), and a slight recovery in TISS III cases. **Conclusion:** The TISS-28 scoring system proved to be a helpful tool for predicting mortality in critically ill patients and facilitating human resource planning in the ICU.

Keywords: TISS-28, APACHE II, Therapeutic intervention, Intensive Care Unit, severity of illness.

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RESUMEN

Introducción: El cuidado de pacientes críticos representa múltiples desafíos tanto clínicos como organizativos. La mortalidad en la Unidad de Cuidados Intensivos (UCI) influida por la gravedad del paciente y las intervenciones realizadas es un indicador clave del desempeño hospitalario. **Objetivo:** Este estudio tuvo como objetivo evaluar la utilidad clínica del Sistema de Puntuación de Intervenciones Terapéuticas (TISS-28) como predictor de mortalidad en una UCI de tercer nivel en Montería, durante el período 2019-2023. **Métodos:** Estudio descriptivo, retrospectivo, con enfoque cuantitativo. Se incluyeron pacientes que contaban con registros completos del puntaje TISS-28. **Resultados:** Se analizaron 3 822 pacientes. La mortalidad acumulada fue de 10,04 % en el grupo TISS IV, 6,39 % en TISS III, y de 3,23 % en TISS II. El uso del TISS-28 se correlacionó con la severidad clínica y el pronóstico del paciente. Los diagnósticos más frecuentes fueron de origen respiratorio, como neumonía grave y síndrome de distrés respiratorio. Se observó una disminución en los ingresos clasificados como TISS IV (de 465 en 2019 a 243 en 2023), un aumento sostenido en TISS II (de 171 a 267) y una leve recuperación en los casos TISS III. **Conclusión:** El sistema de puntuación TISS-28 demostró ser una herramienta útil para predecir la mortalidad en pacientes críticos y facilitar la planificación del recurso humano en la UCI.

Palabras clave: TISS-28, APACHE II, intervención terapéutica, unidad de cuidados intensivos, gravedad de la enfermedad.

INTRODUCTION

In the Intensive Care Unit (ICU), efficient management of nursing staff workload is essential to ensure optimal clinical outcomes. Several studies have shown that an inadequate nurse-to-patient ratio is associated with increased mortality (1,2), higher rates of complications and adverse events (3), missed care (4), and prolonged hospital stay (5). This situation is aggravated by the sustained increase in the number of critically ill patients admitted to the ICU (6), many of whom present with organ dysfunction and require highly complex interventions (7). Procedures such as extracorporeal membrane oxygenation or continuous renal replacement therapy place a significantly higher workload on nursing staff (8). At the same time, the average length of stay has

decreased, despite the increase in clinical severity, representing a challenge for resource planning and quality of care in critical care (9). Faced with this reality, the American Academy of Nursing has emphasized that adequate staffing is critical to both the quality of care and the well-being of nursing staff (10). However, only a few countries have established legal regulations on minimum nurse-to-patient ratios. California (USA) pioneered a minimum ratio of one nurse to two critically ill patients in 1977 (11), a measure later adopted by states such as Oregon and Massachusetts (10), as well as Victoria (Australia) (12). In Europe, Germany has established a 1:1 ratio exclusively in neonatal ICUs (13), while in France, legislation in 2002 initially set a ratio of 1 nurse to 2.5 ICU patients, updated in 2022 to 1:2.5 ICU beds and 1:4 in intermediate care units, although not based on scientific evidence (2).

In this context, the objective assessment of nursing workload has become a priority for hospital management (14). Several tools have been developed for this purpose (15), among which the Nursing Activities Score (NAS) has been identified as one of the most suitable for estimating the care load in ICUs (16,17). This tool allows a standardized and objective measurement of the time and effort required per patient (18). However, a gap remains in the literature regarding studies that specifically analyze nursing workload in local contexts, which limits their applicability in certain regions.

In parallel, several clinical scoring systems have been developed to assess the severity of conditions in critically ill patients, support therapeutic decisions, and improve resource allocation (19). Among the most widely used are the APACHE II (Acute Physiology and Chronic Health Evaluation), which classifies patients according to their clinical severity (20); the SOFA (Sequential Organ Failure Assessment), helpful in assessing organ dysfunction and predicting outcomes (21); and the Child-Pugh and MELD (Model for End-Stage Liver Disease) systems, used to assess the prognosis in patients with advanced liver disease (22).

Although these tools have enabled greater standardization of critical care medicine, they have limitations in assessing nursing workload, a crucial component for staffing planning and ensuring the quality of care in the ICU. In this regard, the TISS-28 (Therapeutic Intervention Scoring System) is gaining relevance as a tool that quantifies the interventions

required per patient and establishes relationships between clinical severity, workload, and outcomes.

Given the increasing use of the TISS-28 in international settings and the scarcity of national and regional studies validating its usefulness in local contexts, this study aims to evaluate its predictive value as a mortality indicator in a tertiary ICU in Montería, Colombia, during the period 2019-2023. The findings could contribute to optimizing human resource planning, improving operational efficiency, and strengthening the quality of care for critically ill patients.

METHODOLOGY

An observational, descriptive, cross-sectional, and retrospective study with a quantitative approach was conducted in the multipurpose Intensive Care Unit (ICU) of a tertiary healthcare provider (IPS) located in Montería, Colombia. The analysis period ran from January 2019 to December 2023. The target population consisted of 3 822 patients admitted to the ICU during the study period.

The sample was selected using non-probability convenience sampling, including only those patients with complete medical records and documented use of the TISS-28 system. The data were organized in Microsoft Excel, tabulated, and processed using the Statistical Package for the Social Sciences (SPSS) software.

RESULTS

A study of 3 822 patients admitted to the Intensive Care Unit (ICU) in Montería, Colombia, between 2019 and 2023, revealed notable fluctuations in annual admissions, with no discernible linear trend. The highest number of admissions was recorded in 2019 with 827 patients (21.63 %), followed by a significant decrease in 2020 with 714 patients, possibly related to the COVID-19 pandemic and the restructuring of services. In 2021, with 787 patients and in 2022 with 779 patients, a relative recovery was observed, while in 2023, a slight decrease (715 patients) was observed, without reaching 2019 levels (Figure 1). This variability is important for contextualizing the TISS-28 analysis, as both the patient profile and ICU operating conditions may have changed over time.

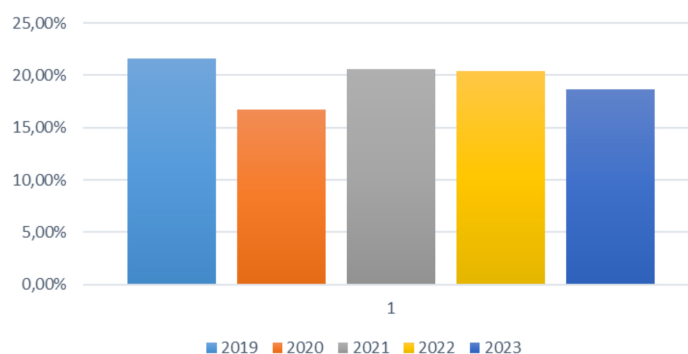


Figure 1. Distribution of patients by year.

As shown in Figure 2, an analysis of 3,822 patients admitted to the ICU in Montería, Colombia, between 2019 and 2023, revealed a nearly equal gender distribution, with an overall average of 51 % men and 49 % women. However, a higher number

of female admissions was recorded in the later years of the period. Regarding age, the over-60 age group predominated in both sexes, with a greater prevalence among men (76.2 % of male cases), while the age distribution was more balanced among women.

CLINICAL UTILITY OF THE THERAPEUTIC INTERVENTION SCORING SYSTEM (TISS-28)

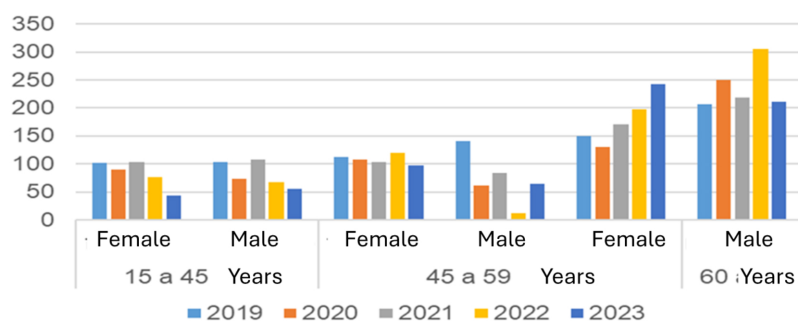


Figure 2. Sociodemographic data.

Diagnoses leading to ICU admission in Montería, Colombia, were respiratory conditions, with severe Pneumonia (13 %) and respiratory distress syndrome (11.95 %) being the most frequent. These were followed by glycemic crisis (8 %), ischemic and hemorrhagic cerebrovascular diseases (both 6 %), and acute coronary syndrome (6.64 %). Acute renal failure, septic shock, hypertensive emergency, hypovolemic shock, and cardiac arrest with successful resuscitation were also frequently identified, demonstrating a predominance of acute respiratory, metabolic, and cardiovascular diseases.

The average ICU stay remained relatively stable, ranging from 6 to 7 days, during the period from 2019 to 2022. In 2023, however, an increase was recorded,

reaching an annual average of 7 days, the highest in the five years.

On a monthly basis, the duration varied considerably, with peaks in May and July 2023 (8.52 and 8.22 days, respectively) and October 2021 (8.36 days). The lowest averages were observed in August 2023 (3.41 days) and April 2022 (3.95 days). These fluctuations could be related to clinical complexity, discharge policies, bed availability, or external factors such as the COVID-19 pandemic.

As shown in Figure 3, there was a decrease in admissions classified as TISS IV (from 465 in 2019 to 243 in 2023), a sustained increase in TISS II (from 171 to 267), and a slight recovery in TISS III cases.

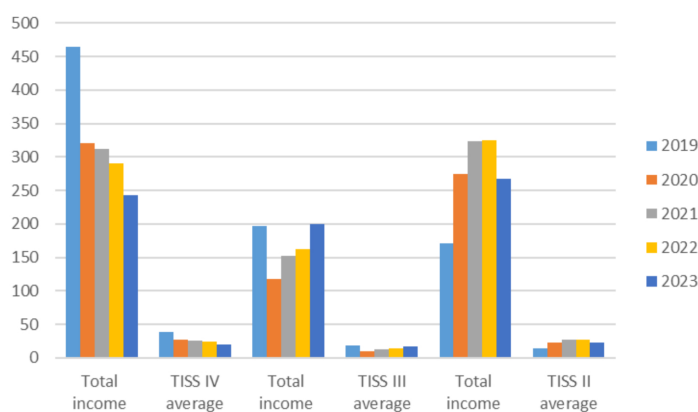


Figure 3. Patients treated in the ICU are classified as TISS IV, III, and II.

Between 2019 and 2023, the Intensive Care Unit (ICU) recorded a decrease in the number of discharges of patients with higher complexity (TISS IV), going from 465 in 2019 to 243 in 2023, the lowest rate of the period. Despite this reduction, the unit maintained a high survival rate, with 1 483 live discharges and 149 deaths, resulting in a cumulative

mortality rate of 10.04 %, which reflects favorable clinical management in highly critical cases (Table 1). This decrease suggests a lower care burden on ICU staff and resources. Although 2023 had the lowest number of discharges, monthly behavior was more stable in the first half of the year compared to previous periods.

Table 1. Status at discharge TISS IV.

Months	2019	2020	2021	2022	2023	Live Discharges	Deceased
January	39	22	35	19	20	127	8
February	38	23	24	18	27	121	9
March	40	19	16	16	26	105	12
April	40	21	28	20	18	119	8
May	45	22	26	24	12	110	19
June	34	28	29	28	18	120	17
July	44	27	24	21	25	123	18
August	41	25	20	29	26	129	12
September	36	35	24	26	10	122	9
October	37	34	33	27	16	132	15
November	26	31	29	36	22	134	10
December	45	34	24	27	23	141	12
Total/ year	465	321	312	291	243	1483	149

Between 2019 and 2023, patients classified as TISS III (medium-high complexity) had a mortality rate of 6.39 %, which is lower than that recorded in TISS IV patients (10.04 %), indicating a more favorable prognosis (Table 2). The number of discharges in this category varied, with a drop in 2020 (118) likely associated with the impact of the COVID-19 pandemic, which may have influenced admission criteria, length of stay, or clinical classification. Beginning in 2021, a progressive recovery was observed (151), with a notable increase in 2023 (200), indicating an improvement in the ability to manage cases of this level of complexity or greater. Unlike the downward trend observed in TISS IV

discharges, TISS III patients experienced a sustained recovery, possibly reflecting changes in epidemiology, admission policies, or the operational capabilities of the unit (Table 2).

TISS II, which corresponds to patients with less complex ICU conditions, showed a significant increase in the number of annual discharges between 2019 (171) and 2021 (323), with a high level remaining in 2022 (325) and a decrease in 2023 (267) (Table 3). Despite these fluctuations, the cumulative mortality rate was only 3.23 %, the lowest among all TISS levels, suggesting effective management of less severe cases that nevertheless require intensive care.

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Table 2. Status upon discharge from TISS III.

Months	2019	2020	2021	2022	2023	Live Discharges	Deceased
January	18	12	6	13	10	59	3
February	16	9	5	10	8	48	4
March	10	6	14	14	17	61	3
April	17	8	14	14	10	63	3
May	17	7	11	15	21	71	6
June	18	9	23	11	23	84	5
July	19	12	14	13	27	85	6
August	18	14	13	16	37	98	6
September	13	11	11	14	10	59	5
October	14	7	10	13	9	53	3
November	17	9	17	18	10	71	4
December	20	14	14	11	18	77	5
Total/year	197	118	152	162	200	829	53

Table 3. Status upon discharge from TISSII.

Months	2019	2020	2021	2022	2023	Live Discharges	Deceased
January	26	29	24	30	38	147	5
February	10	27	21	37	41	136	4
March	15	33	30	36	34	148	3
April	12	28	31	31	10	112	5
May	12	25	26	29	13	105	4
June	12	21	27	23	10	93	3
July	13	24	22	23	7	89	2
August	13	22	35	24	16	110	4
September	12	8	39	27	26	112	5
October	12	15	12	23	32	94	2
November	13	23	20	20	24	100	3
December	21	20	36	22	16	115	4
Total/year	171	275	323	325	267	1361	44

Comparative summary by TISS level

TISS IV (High complexity): Decreasing trend in annual discharges, from 465 in 2019 to 243 in 2023.

The cumulative mortality rate of 10.04 %, the highest in the group, is consistent with clinical severity. TISS III (Medium-High Complexity): Decrease in 2020 (118 discharges) followed by a recovery, with 200

discharges in 2023, exceeding 2019 levels. Mortality rate of 6.39 %. TISS II (Moderate Complexity): Progressive increase until 2022 (325), with a slight decrease in 2023 (267). A mortality rate of 3.23 %, the lowest in the group, is in line with the lower severity of the cases.

DISCUSSION

Assessing nursing workload in intensive care units using scales such as the TISS and NAS is essential for proper staff allocation. A study by Rivera et al. (23) analyzed 362 records from three ICUs and found that 64.64 % of cases were from a single center, with a predominance of male patients (62.01 %) and a mean age of 64.5 years. Circulatory disorders were the most common (41.99 %), with a median hospital stay of three days. In comparison, the present study reported a higher proportion of men (76.2 %) and a predominance of adults over 60 years of age, which emphasizes the importance of adapting resource planning to the characteristics of each unit.

Frailty is a relevant factor associated with adverse outcomes in the ICU. López Cuenca et al. (24) identified frailty in 34.9 % of admitted patients, with an overall mortality rate of 13 %. Although there were no significant differences in age between groups, variations were observed in the use of mechanical ventilation and in sex distribution. In this study, it was estimated that 31 % of patients over 65 years of age were frail, with mortality rates of 6.39 % in TISS III and 10.06 % in TISS IV. Although the values are slightly lower, the differences could be explained by methodological or population factors.

Regarding early mortality in the ICU, a study by Rosa et al. (25) reported rates of 7.9 % (early) and 22.3 % (late), attributing the leading causes to infections. The study also indicated that age ≥ 65 years and a history of physical dependence were risk factors. The present analysis identified an early mortality of 10.06 % in TISS IV patients, with 31.16 % over 65 years of age, and predominant diagnoses such as severe Pneumonia (13 %) and respiratory distress syndrome (11.95 %). Although it was not possible to evaluate previous physical dependence, both studies agree on the role of age as a relevant prognostic factor.

Despite variations in length of stay, the daily cost per patient in the ICU remained relatively constant, which may be attributed to adequate staffing. Lindemark

et al. (26) reported short average stays, especially in patients with lower levels of complexity. In line with these findings, the present study demonstrated that patients with TISS II and TISS III had shorter hospital stays without compromising clinical outcomes.

Cardiopulmonary arrest remains a major cause of admission in older patients. In this cohort, 24 % of patients successfully resuscitated after arrest had prolonged stays, which is consistent with the findings of Holmström et al. (27), who analyzed treatment intensity, 12-month neurological outcome, mortality and healthcare-associated costs for patients aged over 75 years treated for cardiac arrest (CA) in an intensive care unit of a tertiary hospital. The study included a total of 1 285 patients, of whom 212 (16 %) were 75 years of age. Treatment intensity was lower for the elderly compared to the younger group, with median TISS scores of 116 and 147, respectively. They concluded that the elderly ICU-treated CA patients in this study had worse neurological outcomes, higher mortality, and lower cost-effectiveness than younger patients. The elderly received less intense treatment.

Although seasonal variations in case severity have been suggested, Galvão et al. (28) concluded that severity at admission does not significantly change according to age, presence of chronic diseases, or scores such as TISS. This observation is consistent with the data from the present study, where the clinical profile of TISS IV patients remained stable over the years.

The application of the TISS-28 is crucial for objectively estimating nursing workload. In the study by Plate et al. (30), the average score was 20.19 (95 % CI: 18.05–22.33), which is equivalent to 3.57 hours of direct work per patient per shift. In the present analysis, the average values observed for TISS II (22), TISS III (20), and TISS IV (27.2) reinforce this correlation with care demand.

The implementation of intermediate care units (IMCUs) has proven to be an effective strategy for reducing costs and improving the allocation of human resources. In a university hospital in the Netherlands, the use of the TISS-28 as a triage tool enabled patients with less complex conditions to be redirected to the IMCU, resulting in an estimated annual savings of over €1.5 million (31). This approach also aligns with the findings of the present study, which reinforce the usefulness of the TISS-28 as a clinical-administrative criterion for optimizing system efficiency without compromising the quality of care.

CONCLUSIONS

During the five-year study period, the ICU population in Montería, Colombia (3 822 patients) exhibited a slight male predominance (51.3 % men vs. 48.6 % women). A relevant demographic statistic is the high proportion of older adults, representing 63.9 % of women and 76.2 % of men. The most frequent diagnoses in critically ill patients were Acute Respiratory Distress Syndrome (ARDS) (91.4 %), Pneumonia (96 %), Diabetes Mellitus and its complications (59.8 %), Circulatory Shock (53.4 %), and Acute Coronary Syndrome (50.8 %).

Analysis of mortality by TISS (Therapeutic Intervention Scoring System) level revealed a clear correlation with complexity. TISS II patients (lower complexity) had a survival rate of 96.9 % (mortality between 2 % and 4.4 %). In TISS III (medium complexity), survival was 93.6 % (mortality 6.39 %). The most critical patients, TISS IV, recorded a survival rate of 90 % (mortality 10 %). These results highlight the epidemiological profile, the high proportion of older adults, the distribution of case complexity, and the differential survival rates based on the intensity of therapeutic interventions.

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