Cardiometabolic risk factors for admission to the intensive care unit

Factores de riesgo cardiometabólicos para el ingreso en la unidad de cuidados intensivos

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Received: 07/20/2025 Accepted: 09/19/2025 Published: 11/12/2025 DOI: http://doi.org/10.5281/zenodo.17616828

Abstract

The increasing prevalence of cardiometabolic conditions like hypertension, diabetes mellitus, and obesity is a major public health concern. These conditions are linked to several complications and comorbidities associated with hospital admission, longer length of stay, and higher healthcare costs. It has been proven that cardiometabolic risk factors (CMRF) are tightly linked to poorer clinical outcomes and higher mortality rates. However, assessing whether their impact on intensive care unit (ICU) admission is significant is a matter of debate. Although the prevalence of CMRF in the ICU is indeed significantly higher than that of the general population, no studies have been able to establish them as independent risk factors for ICU admission outside the context of COVID-19 cases. On the other hand, CMRF increase the prevalence of life-threatening conditions like congestive heart failure, chronic kidney disease, acute myocardial infarction, stroke, and many other entities that are indeed correlated with ICU admission. Nonetheless, the attributable risk for ICU admission in these cases may lie in the complications, and not the underlying CMRF properly. This review aims to analyze the evidence regarding the impact of CMRF on the rates of ICU admission to assess their utility as predictive factors for ICU hospitalization.

Keywords: Cardiometabolic risk factors, cardiovascular disease, intensive care unit, critical care, predictive factors.

Resumen

El aumento de la prevalencia de las afecciones cardiometabólicas, como la hipertensión, la diabetes mellitus y la obesidad, representa un importante problema de salud pública. Estas condiciones se asocian con múltiples complicaciones y comorbilidades relacionadas con la hospitalización, una mayor duración de la estancia y un incremento en los costos sanitarios. Se ha demostrado que los factores de riesgo cardiometabólicos (FRCM) están estrechamente vinculados con peores resultados clínicos y mayores tasas de mortalidad. Sin embargo, aún existe debate sobre si su impacto en el ingreso a la unidad de cuidados intensivos (UCI) es realmente significativo. Aunque la prevalencia de los FRCM en la UCI es considerablemente mayor que en la población general, ningún estudio ha logrado establecerlos como factores de riesgo independientes para el ingreso en UCI fuera del contexto de los casos de COVID-19. Por otro lado, los FRCM aumentan la prevalencia de enfermedades potencialmente mortales como la insuficiencia cardíaca congestiva, la enfermedad renal crónica, el infarto agudo de miocardio, el accidente cerebrovascular y muchas otras entidades que sí se correlacionan con el ingreso en UCI. No obstante, el riesgo atribuible de ingreso en UCI en estos casos podría deberse a las complicaciones derivadas y no propiamente a los FRCM subyacentes. Esta revisión tiene como objetivo analizar la evidencia disponible sobre el impacto de los FRCM en las tasas de ingreso en

UCI, con el fin de evaluar su utilidad como factores predictivos de hospitalización en cuidados intensivos.

Palabras clave: factores de riesgo cardiometabólicos, enfermedad cardiovascular, unidad de cuidados intensivos, cuidados críticos, factores predictivos.

Introduction

During the last century, the leading causes of death have significantly evolved. Infectious diseases went from being the leading cause of death to one of the most preventable causes. Instead, chronic noncommunicable diseases have occupied their place[1]. Conditions like cancer, diabetes mellitus (DM), hypertension (HT), heart failure, chronic pulmonary disease, chronic kidney disease (CKD), and many others have replaced infectious diseases as the most relevant causes of death worldwide[2]. Among these conditions, cardiovascular diseases (CVD) are the leading cause of global mortality and the major contributor to disability[3]. The prevalence of CVD has nearly doubled from 271 million in 1990 to 523 million in 2019. Likewise, CVD-attributable deaths have steadily risen from 12 million to 18.6 million in the same period[4].

The increased prevalence of CVD is partly explained by the parallel growth in cardiometabolic risk factors (CMRF). Obesity, DM, HT, dyslipidemia, metabolic syndrome, and other risk factors like smoking, physical inactivity and unhealthy dietary patterns have exponentially grown to pandemic proportions in the last decades[5]. Consequently, there is a growing concern in the medical community regarding the impact of these conditions on the quality of life and life expectancy in patients with CMRF[6]. These factors increase the risk of developing life-threatening conditions like acute myocardial infarction (AMI), stroke, pulmonary embolism, and sepsis[7,8]. In light of the severity of these conditions, it is expected that these patients may need admission to an intensive care unit (ICU)[9].

The rate of admission to the ICU varies according to the triggering condition. However, the risk of needing ICU admission increases as more risk factors are associated with the profile of the patients[10]. Variables like age, renal function, hematologic parameters, and prior history of chronic diseases increase the likelihood of needing critical care in specific situations. Moreover, most of these factors also increase the likelihood of in-hospital death[11,12]. Several scales, like the Sequential Organ Failure Assessment (SOFA), have long been used as screening tools to estimate the severity of patients' condition at a certain point in time, and thus estimate the need for ICU admission[13]. However, most available scales do not consider CMRF for their predictive accuracy. This review aims to analyze the evidence regarding the impact of CMRF on the rates of ICU admission to assess their utility as predictive factors for ICU hospitalization.

CARDIOMETABOLIC RISK FACTORS AND INTENSIVE CARE UNIT ADMISSION: FACT OR FICTION?

HT is the leading preventable risk factor for CVD and all-cause mortality worldwide. Nearly 1.4 billion people suffered from HT in 2010, with a tendency to rise in the near future[14]. As a result, HT is a frequent comorbidity in hospitalized patients. However, it is rarely the cause of hospital admission, and rather, it is most often a secondary diagnosis[15]. Although patients with hypertensive crises may need in-hospital management, these patients represent a small proportion of the hypertensive population, of less than 5 per 1000 patients with diagnosed HT[16]. Nevertheless, HT is known for significantly increasing the risk of AMI, stroke, and other conditions that require in-hospital management and, sometimes, ICU admission[17].

It has been demonstrated that HT increases the rate of hospital admission, the cost of hospitalization, and the length of stay, independently of the reason for hospitalization[18]. Recently, HT was labeled a risk factor for ICU admission due to the analyses regarding hospitalization in patients with Coronavirus Disease 2019 (COVID-19)[19]. A plethora of studies showed HT was strongly associated with critical cases of COVID-19 and, thus, ICU admission. For instance, Du et al.[20] analyzed 24 observational studies. They concluded that the risk of ICU admission in COVID-19 patients was significantly higher than that of the patients without HT (Odds ratio (OR): 1.82). The authors concluded HT was independently associated with developing critical COVID-19, ICU admission, and in-hospital mortality from COVID-19.

Several authors and meta-analyses have reported the same findings from different locations, further reassuring the impact of HT on ICU admission rates[21–26]. Nonetheless, other studies have failed to find an association between HT and ICU admission in the context of other diseases. Moreover, Nystrom et al.[27] reported that patients with high blood pressure (BP) at the time of admission to the ICU in patients with AMI had a better prognosis than those with lower BP values. This raises questions regarding the relationship between BP and mortality in a situation of acute stress[28]. Similarly, PROVE-IT-TIMI 22 trial proved that HT was independently associated with an increased risk of future cardiovascular events, but not with an increased need for intensive care[29].

Conversely, the INTERACT2 trial analyzed several variables associated with ICU admission in patients with acute cerebral hemorrhage. Analyses showed that younger age, large hemorrhage volume, and high systolic BP on admission were associated with an increased rate of admission to the ICU. Likewise, prior history of antihypertensive treatment, and therefore a history of HT, was associated with an increased risk of ICU admission and prolonged length of stay[30]. Likewise, Knight et al.[31] analyzed the risk factors associated with unexpected ICU admission in patients undergoing elective non-cardiac and non-transplant major surgical procedures. Although HT did not show an independent correlation with ICU admission, clinical surrogates did. Patients with CKD, valvular heart disease, peripheral vascular disease, and congestive heart failure (CHF) had a significantly greater risk of unexpected ICU admission[31]. However, more research is needed regarding the impact of HT as an independent factor for ICU admission in several different contexts to provide suitable conclusions.

On the other hand, type 2 DM (DM2) is another chronic noncommunicable condition known for its multiple comorbidities. Moreover, DM2 significantly increases the risk of life-threatening conditions like AMI, stroke, diabetic ketoacidosis (DKA), CKD, CHF, and many others[32,33]. As a result, studies have shown that ICU admissions are more prevalent in patients with DM2 than in those without (5% vs. 3.3%, $P< 0.001$)[34]. Similar to HT, observational studies from COVID-19 populations concluded that diabetic status, independent of the type, was tightly correlated with critical COVID-19, ICU admission, and in-hospital mortality[35]. Diabetic patients had nearly triple the risk of needing ICU admission compared to non-diabetic individuals (OR: 2.79, 95% CI; 1.85-4.22)[36]. Likewise, other studies reported that glycated hemoglobin (HbA1c) greater than 7% was significantly associated with ICU admission in COVID-19 patients[37].

However, there is scarce evidence regarding DM2 as an independent risk factor for ICU admission after adjusting for DM complications and comorbidities[38]. Conversely, evidence has shown that hyperglycemia at the moment of admission is significantly associated with ICU admission rates and mortality prognosis[39–42]. Since hyperglycemia is part of the normal acute stress response, it is often difficult to distinguish pure stress hyperglycemia from decompensated diabetic status or a combination of both. Calculating stress hyperglycemia parameters like stress hyperglycemia ratio (SHR) offer an alternative to distinguish between these entities[43,44]. Other glycemic parameters like glycemic gap, SHR, and glycemic variability have also been linked to increased ICU admission and poorer outcomes[45]. More importantly, stress hyperglycemia has more evidence regarding increased ICU admission and worse outcome than DM[46–49]. As a result, more research is needed to establish the independent role of DM in ICU admission.

Regarding obesity, increasing evidence has shown that the prevalence of obesity inside ICU facilities has increased in the past decades. Obesity prevalence inside the ICU has been reported to be between 28.2% and 36%, similar to the prevalence of the general population[50]. However, there is still debate regarding the impact of obesity on hospitalization outcomes. In hospitalized ICU patients with obesity and chronic illnesses, overweight and moderate obesity have a protective effect against mortality compared to normal body mass index (BMI) and severe obesity, a phenomenon termed the obesity paradox[51]. However, despite the protection against mortality, morbidity is adversely affected by obesity, with a linear correlation between BMI and in-hospital complications[52]. Although an important correlation between obesity and critical COVID-19 has been demonstrated, as with the previous risk factors, it has not been possible to reproduce those results outside the context of COVID-19[53–55].

Conclusions

The increasing prevalence of cardiometabolic conditions like HT, DM, and obesity is a major public health concern. These conditions are linked to several complications and comorbidities associated with hospital admission, longer length of stay, and higher healthcare costs. It has been proven that CMRF are tightly linked to poorer clinical outcomes and higher mortality rates. However, assessing whether their impact on ICU admission is significant is a matter of debate. Although the prevalence of CMRF in the ICU is indeed significantly higher than that of the general population, no studies have been able to establish them as independent risk factors for ICU admission outside the context of COVID-19 cases. On the other hand, CMRF increase the prevalence of life-threatening conditions like CHF, CKD, AMI, stroke, and many other entities that are indeed correlated with ICU admission. Nonetheless, the attributable risk for ICU admission in these cases lies in the complications, not the underlying CMRF. Multivariate analyses adjusting for confounders and complications are needed to establish the independent role of CMRF as predictors of ICU admission. Given the lack of evidence, at present, CMRF may not increase the accuracy of ICU admission criteria.

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