

The LACE Index: A Predictor of Mortality and Readmission in Cardiovascular Diseases

Lutфу Askin^a, Yahya Urkmez^b, Okan Tanriverdi^c

^a Department of Cardiology, Gaziantep Islamic Science and Technology University, Gaziantep, Turkey

^b Department of Internal Medicine, Gaziantep City Hospital, Gaziantep, Turkey

^c Department of Cardiology, Adiyaman Education and Research Hospital, Adiyaman, Turkey

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SOUHRN

Index LACE je predikční nástroj používaný ve zdravotnictví pro odhad rizika opětovné hospitalizace pacientů po jejich propuštění z nemocnice. Zkratka LACE vznikla spojením slov (v angličtině) délka pobytu v nemocnici (length of stay), oprávněnost příjmu (acuity of admission), zátěž komorbiditami (comorbidity burden) a počet návštěv oddělení akutního příjmu (emergency department [ED] visits). Jedná se o jednoduchý skórovací systém, ve kterém se přidělují body za každý z uvedených čtyř faktorů podle jejich přítomnosti/nepřítomnosti a závažnosti; sečtením bodů vznikne skóre indexu LACE. Index LACE často používají poskytovatelé zdravotních služeb pro vyhledávání pacientů s potenciálně vyšší pravděpodobností opětovného příjmu do nemocnice po jejich propuštění. Identifikací pacientů s vyšším skóre LACE umožňuje poskytovatelům zdravotních služeb reagovat a poskytovat dodatečnou podporu nebo finanční prostředky, které by pomohly snižovat počty opětovných hospitalizací. Index LACE může být užitečný při změnách v léčbě a poskytování péče a při plánování propuštění pacienta; lze jej začlenit do rozhodovacích procesů v klinické praxi s cílem optimalizovat výsledný stav pacientů. Celkové skóre indexu LACE lze využít ke stratifikaci pacientů do různých kategorií rizika, například nízkého, středně vysokého a vysokého rizika opětovného příjmu do nemocnice. Tyto informace mohou pomoci poskytovatelům zdravotní péče při stanovování priorit v intervencích a při účinném přidělování finančních prostředků s cílem snižovat počty opětovných hospitalizací a zlepšovat péči o pacienty. Nicméně je nutno poznamenat, že index LACE je pouze jedním z mnoha podobných nástrojů a při rozhodování v této oblasti je třeba použít i klinický úsudek a provést individuální vyšetření pacienta s kardiovaskulárním onemocněním.

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ABSTRACT

The LACE index is a predictive tool used in healthcare to estimate the risk of hospital readmission for patients who have been discharged from the hospital. LACE stands for length of stay, acuity of admission, comorbidity burden, and emergency department (ED) visits. It is a simple scoring system that assigns points to each of these four factors based on their presence and severity and then sums up the points to calculate the LACE index score. The LACE index is often used by healthcare providers to identify patients who may be at higher risk of being readmitted to the hospital after discharge. By identifying patients with higher LACE scores, healthcare providers can potentially intervene and provide additional support or resources to help prevent readmission. The LACE index can be useful in guiding care transitions and discharge planning and can be incorporated into clinical decision-making processes to optimise patient outcomes. The total score calculated from the LACE index can be used to stratify patients into different risk categories, such as low, moderate, or high risk of hospital readmission. This information can help healthcare providers prioritise interventions and allocate resources effectively to prevent hospital readmissions and improve patient care. However, it's important to note that the LACE index is just one tool among many, and clinical judgement and individualised assessment of cardiovascular patients should also be considered in making care decisions.

Keywords:

Comorbidity burden

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Address: Lutфу Askin, M.D., Gaziantep Islamic Science and Technology University, 2700 Gaziantep, Turkey, e-mail: lutfuaskin23@gmail.com

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Introduction

Canada, Australia, and the UK employ the US-created readmission rate figure for quality and cost reduction. The Affordable Care Act's (ACA's) Hospital Readmission Reduction Programme (HRRP) penalises 30-day readmission rates over the US average. Local healthcare quality improvement may lower readmission rates and save money, benefiting the global economy. More advanced methods are needed to predict readmission risk before discharge.^{1,2} Unexpected hospital readmissions are costly. 30-day unplanned readmission shows the initial method failed. The Centers for Medicare and Medicaid Services (CMS) reports \$17 billion in hospital readmissions. CMS included chronic disorders with high hospitalisation rates in the 2010 Hospital Readmission Reduction Programme (HRRP).³

Several methods predict readmissions.^{3,4} The US and Canada use LACE extensively. The LACE score predicts 30-day readmission or death for medical and surgical patients. Administrative data confirmed the model. Acuity, duration, comorbidities, and six-month Emergency Department (ED) visits are included. 30-day readmission risk is 0–19 and 10+.³ High scores predict rehospitalization. Straightforward, therapeutically helpful.^{5–9} 30-day unplanned readmissions assessed acute care quality. UK hospitals needed emergency readmission 28 days following discharge.¹⁰ The Western Australian Ministry of Health judged quality by unplanned 30-day surgical and all-cause hospital readmissions.¹¹ Its application to diverse populations and locations is unknown.

South Korea's healthcare system is shown in the unplanned 30-day readmission after hospital discharge.¹² Nonetheless, mortality and administrative statistics can be used to calculate the readmission rate. As a result, the use of the LACE index has increased. Quality and cost depend on the 30-day hospital readmission risk prediction. In our opinion, we have not previously found a review of all cardiovascular diseases in the literature. Therefore, we addressed the value of the LACE score in determining mortality and readmissions in all cardiovascular diseases with this review.

Heart failure (HF)

Readmission plagues American hospitals. Medicare and Medicaid increasingly prioritise readmission rates, treatment quality, and cost. 15% of Medicare-covered hospital patients are readmitted within 30 days, costing \$15 billion, according to the Agency for Healthcare Research and Quality. Addressing and predicting HF readmission, a primary cause of over 65 hospital admissions, reduces cost, morbidity, and death.^{13,14}

Hospital Score, LACE index, and LACE+ index are validated readmission prediction measures; however, little research has explored their usage in HF patients. Yazdan-Ashoori et al. found higher LACE index scores predicted 30-day HF readmission when the threshold was increased to 13. Australian researchers developed a 30-day readmission prediction model for HF with preserved ejection fraction (HFpEF) and HF with reduced EF (HFrEF) patients.

Clinical, administrative, sociodemographic, and mental health data were modelled.^{15,16}

Van Walraven et al.³ created and verified LACE. The Ontario population-based LACE+ index was more discriminating than the LACE index (C-statistic 0.771, 95% CI 0.767–0.775). The LACE+ score did not predict brain tumour patients' 30-day readmissions. Brain tumour patients with the LACE+ score had limited specificity for 30-day readmission (C-statistic = 0.58). HFpEF and brain tumour patients reported similar results. Certain groupings may not be predicted by LACE+.^{17,18}

ED visits predicted readmissions. ED visits may increase readmissions. They may have greater chronic illnesses. Chronic disease increases ED visits, hospital admissions, and hospitalisations. Extreme age may cause it. Age, Charlson Comorbidity Index (CCI) score, and hospital stay did not impact readmission. Myocardial infarction (MI) and peripheral vascular disease (PVD) patients reported more hospital readmissions due to chronic illnesses. Medicare data suggests diabetes, MI, PVD, and stroke may predict congestive HF (CHF) readmissions. MI and CHF increased readmissions. Both chronic disorders typically co-exist.^{19–23} Wang et al.²⁴ observed that the LACE score may not properly predict 30-day CHF readmissions. High-risk CHF readmissions may be associated with frequent ED visits, MI, or PVD.

Acute myocardial infarction (AMI)

Acute coronary syndrome (6.4%) was the most common index diagnosis in the initial LACE investigation, and the 30-day all-cause unplanned readmission and mortality rate was 6.0%. The most common index procedure was angioplasty or coronary artery bypass graft surgery (4.6% prevalence), with a 4.6% 30-day all-cause unplanned readmission and mortality rate. Rates may vary according to stable angiography patients. So, this apparently healthier group may explain the lower AMI readmission rate.^{3,25}

Duration of stay and number of ED visits in the preceding 6 months drove the logistic regression analysis of LACE index factors. These findings confirm recent studies suggesting that a few fundamental factors may predict complex outcomes like readmission after nonemergent noncardiac surgery. Prediction models may not work in homogenous populations with comorbidities like the Charlson Index. In the prior experiment (with a more heterogeneous cohort), dementia and acquired immunodeficiency syndrome (AIDS) were more common, while this research found few cases. The Charlson Comorbidity Index may have been better.²⁵

Labroschiano et al. discovered that the LACE score predicted post-AMI readmission in angiography patients. Length of stay and past 12-month ED encounters best predict 30-day all-cause unplanned readmission (and combined readmission and death). These two traits are simple to detect and may help doctors identify patients at greater risk of readmission and give extra care, treatments, and therapy to reduce readmissions and deaths, but larger samples are needed to see whether they consistently predict readmission.²⁵

Pulmonary embolism

The LACE index may be used as a tool to assess the risk of readmission or death within 30 days after discharge for patients who have been hospitalised for pulmonary embolism, along with other relevant clinical information. However, the LACE index should be used in conjunction with clinical judgement and other assessment tools to make appropriate healthcare decisions for individual patients. It is always important to consult with a qualified healthcare professional for an accurate assessment and management of patients with pulmonary embolism or any other medical condition.

Stroke

The LACE index is not typically used in the context of assessing patients with stroke. For stroke, there are other risk prediction tools that are more commonly used, such as the CHADS₂ and CHA₂DS₂-VASc scores, which are used to estimate the risk of stroke and guide anticoagulation therapy in patients with atrial fibrillation, a common risk factor for stroke. The LACE index, which stands for length of stay, acuity of admission, comorbidity, and emergency department visits, is specifically designed for patients with CHF and is not directly applicable for assessing the risk of stroke or stroke-related outcomes. Stroke risk assessment typically involves evaluating factors such as age, sex, hypertension, diabetes, smoking status, prior history of stroke or transient ischemic attack (TIA), and other relevant clinical information to determine the risk of stroke and guide appropriate management strategies.

Diabetes

The LACE index is not typically used in the context of assessing patients with diabetes. There are other risk prediction tools that are commonly used in the management of diabetes, such as the American Diabetes Association (ADA) Risk Calculator, which estimates the risk of developing diabetes in the next 5 years based on factors such as age, sex, body mass index (BMI), family history of diabetes, blood pressure, and others. In the management of diabetes, healthcare professionals also use various other tools, guidelines, and clinical judgment to assess and manage patients, including glycemic control, blood pressure management, lipid management, lifestyle modifications, and other relevant interventions based on individual patient characteristics and clinical considerations.

Peripheral vascular disease

It may not be directly applicable to assessing patients with vascular disease, as it is specifically designed for CHF. Vascular disease refers to a group of conditions that affect the blood vessels, including arteries and veins, throughout the body. This can include conditions such as PVD, carotid artery disease, aortic aneurysm, deep vein thrombosis (DVT), and others. In the management of vascular

disease, healthcare professionals may use other specific risk assessment tools and guidelines that are relevant to the specific condition being evaluated. For example, in the case of PAD, the Fontaine or Rutherford classification systems may be used to assess the severity of the disease and guide management decisions. In the case of carotid artery disease, the degree of stenosis (narrowing) of the carotid artery, as determined by imaging studies such as carotid ultrasound or angiography, is often used to determine the risk of stroke and guide management decisions.

Recent studies

LACE index values of 4 are related to higher COVID-19 hospital admissions and deaths, consistent with non-COVID-19 studies. COVID-19 patients have a greater risk. As it predicts mortality, the LACE score should identify high-risk COVID-19 patients.²⁶ Unplanned 30-day readmission after stroke was increased in high LACE+ index groups. This verifies the LACE+ stroke readmission prediction approach.²⁷ Cho et al.²⁸ showed that national cohort data may identify older people at high risk for all-cause mortality using the LACE score. These findings influence post-discharge patient management.

The HOSPITAL score and LACE index predicted 30-day and 1-year death in older multimorbid polypharmacy patients. These simple parameters may predict post-hospitalisation mortality in older multimorbid people.²⁹ Belouali et al.³⁰ identified social determinants of health variables that governments and healthcare systems might address to prevent readmissions. Sun et al.³¹ discovered that only specific comprehensive geriatric assessments, mobility disabilities, and gender components independently predicted readmission. LACE and HOSPITAL scores did not discriminate 30-day hospitalisation in all and subgroup participants. To predict 30-day readmissions, this patient sample requires additional identifiers.

LACE and HOSPITAL readmission risk-prediction algorithms performed comparably in a diverse patient cohort at two university medical centres in Houston, Texas. These readmission risk factors may help identify in-house patients at high risk for readmission, so early intervention resources may reduce unplanned readmission.³² Regmi et al.³³ discovered that the HOSPITAL score and the RAHF scale predicted 30-day readmissions differentially in HF patients by race and gender, while the LACE index did not. Borja et al.³⁴ discovered the LACE+ score may predict 30- and 90-day readmissions after single-level lumbar fusion.

The LACE score predicts recurrent hospitalisations and short- and medium-term mortality after hospital discharge, particularly in younger adults.³⁵ LACE scores indicate hospital readmission-prone youth. LACE index scores above 4 reduce readmissions.³⁶ The upgraded LACE-Cranial model predicts short-term postdischarge mortality and readmissions better than the unmodified LACE index.³⁷ Lin et al. recommended giving non-linear classification algorithms greater attention since they produce large risk score discrepancies.³⁸ The EQ-5D-3L mobility, self-care, and total sum scores improve the LACE index 30-day readmission prediction and are associated with readmissions

Table 1 – The main topic points of recent studies

Reference no.	Authors	Subjects	Main theme
[26]	Fluck et al.	COVID-19 patients	LACE index values of 4 are related to higher COVID-19 hospital admissions and deaths, consistent with non-COVID-19 studies. As it predicts mortality, the LACE score should identify high-risk COVID-19 patients.
[27]	Jun et al.	Stroke patients	Unplanned 30-day readmission after stroke was increased in high LACE+ index groups. This verifies the LACE+ stroke readmission prediction approach.
[28]	Cho et al.	A nationwide population-based study	National cohort data may identify older people at high risk for all-cause mortality using the LACE score. These findings influence post-discharge patient management.
[29]	Aubert et al.	Older patients	The HOSPITAL score and LACE index predicted 30-day and 1-year death in older multimorbid polypharmacy patients. These simple parameters may predict post-hospitalisation mortality in older multimorbid people
[30]	Belouali et al.	Patients	Social determinants of health variables that governments and health systems might address to prevent readmissions.
[31]	Sun et al.	Older Adults	LACE and HOSPITAL scores did not discriminate 30-day hospitalisation in all and subgroup participants. To predict 30-day readmissions, this patient sample requires additional identifiers.
[32]	Jones et al.	Patients	LACE and HOSPITAL readmission risk-prediction algorithms performed comparably in a diverse patient cohort at two university medical centres in Houston, Texas. These readmission risk factors may help identify in-house patients at high risk for readmission, so early intervention resources may reduce unplanned readmission.
[33]	Regmi et al.	Heart failure patients	The HOSPITAL score and the RAHF scale predicted 30-day readmissions differentially in HF patients by race and gender, while the LACE index did not.
[34]	Borja et al.	Patients with complete information who underwent single-level, posterior-only lumbar fusion	The LACE+ score may predict 30- and 90-day readmissions after single-level lumbar fusion.
[35]	Heppleston et al.	Patients	The LACE score predicts recurrent hospitalisations and short- and medium-term mortality after hospital discharge, particularly in younger adults.
[36]	Han et al.	Children	LACE scores indicate hospital readmission-prone youth. LACE index scores above 4 reduce readmissions.
[37]	Jin et al.	Patients undergoing cranial neurosurgery	The upgraded LACE-Cranial model predicts short-term postdischarge mortality and readmissions better than the unmodified LACE index.
[38]	Lin et al.	Taiwan population	Non-linear classification algorithms greater attention since they produce large risk score discrepancies.

and death.³⁹ The primary care provider's (PCP's) judgement outperforms the LACE score in identifying high-risk readmission patients. This score may help PCPs identify discharged patients who require more intensive follow-up.⁴⁰ The main topic points of recent studies were shown in **Table 1**.

Conclusion

Many models predict hospital readmissions. The easy-to-use LACE index discriminates effectively. Therefore, we carried out an updated review of the use of the LACE score to predict mortality and readmission in cardiovascular diseases. Our review addressed firstly the value of the LACE score in determining mortality and readmissions in all cardiovascular diseases. Value-based medical care hos-

pitals may employ the LACE index. This study will help healthcare workers avoid 30-day readmissions by revealing the most effective strategies.

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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Ethical statement

The work was conducted in accordance with Helsinki declaration.

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