External Validation of the HOSPITAL Score for 30-Day Readmission in Internal Medicine Departments of a Tertiary Center in Israel

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Abstract

Introduction Hospital readmissions are a global concern, costly to healthcare systems, and negatively impacting patient outcomes. The HOSPITAL score was developed to identify adults at risk of 30-day readmission using seven readily available clinical variables. This tool has been validated in large academic hospitals and several other settings; however, its performance in different populations remains under investigation. **Objective** To comprehensively evaluate the HOSPITAL score's performance

and generalizability within a large, single-center internal medicine cohort in Israel, elucidating its potential for targeted readmission prevention strategies. **Methods** In this retrospective study, we analyzed 77,625 adult discharges from Sheba Medical Center's internal medicine service (2018–2023), excluding short-stay admissions. We calculated the HOSPITAL score (0 to 13+) using laboratory values, admission characteristics, and historical patient data. Comprehensive performance assessment included discrimination metrics (AUROC, precision-recall), calibration tests (Hosmer-Lemeshow, Pearson χ^2), and overall predictive performance (Brier score).

Results Of 77,625 discharges, 17,963 (23%) experienced 30-day readmissions. The HOSPITAL score demonstrated moderate discriminative capacity (AUROC: 0.635, 95% CI: 0.631–0.639) with an average precision of 0.320. The Brier score of 0.163 revealed moderate probabilistic alignment. Calibration tests revealed significant miscalibration (Hosmer-Lemeshow: $\chi^2 = 6254.097$, $p = 0.000$; Pearson $\chi^2 = 5410.160$, $p = 0.000$). Despite this, the score effectively stratified pateints by risk: readmission rates progressively increased from 18.1% (low-risk), 32.7% (med-risk) to 44.8% (high-risk). **Conclusion** Our single-center study confirms the potential utility of the HOSPITAL score in identifying adults at elevated risk for 30-day readmissions. While the discriminative ability (AUROC 0.635) was lower than some prior validations (e.g., 0.77 reported by Robinson in a moderate-sized US hospital), the score retained **meaningful stratification** power across risk categories. Differences in local practice, cohort size, and the relative weighting of oncology admissions may partly explain performance deviations. Future refinements or the addition of further predictive features could enhance accuracy. Nonetheless, our findings support the use of the HOSPITAL score as part of a broader interventional strategy to reduce readmissions.

1 Introduction

Reducing hospital readmissions within 30 days post-discharge remains a big challenge for hospitals worldwide. In the US alone, nearly 20% of patients are readmitted within 30 days of discharge, resulting in an estimated total annual cost of $17 to $26 billion [Lahijanian and Alvarado(2021)]. Beyond the financial implications, readmissions are associated with increased patient morbidity and mortality [Shaw et al.(2020)Shaw, Stiliannoudakis, Qaiser, Layman, Sima, and Ali], as well as heightened burdens on healthcare facilities, including potential penalties under programs like the Hospital Readmissions Reduction Program [Kocher and Adashi(2011), Centers for Medicare & Medicaid Services(2025)].

Predictive tools have been developed to proactively identify patients at elevated risk for readmission, with the HOSPITAL score being among the most recognized [Mathys et al.(2024)Mathys, Büti

This scoring system incorporates seven variables: hemoglobin level at discharge, discharge from an oncology service, serum sodium level at discharge, any procedure during the index admission, type of admission (urgent or elective), number of hospital admissions in the past year, and length of stay. While the HOSPITAL score has demonstrated reasonable predictive capability, variations in healthcare delivery, patient demographics, clinical practices, and local health system characteristics can substantially impact a model's performance. Moreover, the original score relies on proprietary software to define potentially avoidable readmissions, which may not be available to any hospital Ref -

This study aims to externally validate the HOSPITAL score within internal medicine departments of a tertiary academic medical center in Israel. By assessing its predictive accuracy and applicability in this specific setting, we seek to determine its utility for early identification of patients at risk for 30-day readmission, thereby informing potential interventions to reduce such occurrences.

2 Materials and Methods

2.1 Study Design and Population

We conducted a single-center, retrospective validation study at Sheba Medical Center. Our initial cohort included all adult discharges ($\geq$18 years) from the internal medicine service from 2018 through 2023. A total of 113,312 discharges were initially screened. Patients with a hospitalization length of stay of $\leq$ 24 hours (n = 35,687) were excluded, resulting in a final cohort of 77,625 discharges. Among these discharged patients, 17,963 (23.1%) experienced a 30-day readmission, while 59,662 (76.7%) did not. Notably, this cohort is substantially larger than that of the original HOSPITAL score derivation study (N=9,212).

The study was approved by the Institutional Review Board (IRB) of Sheba Medical Center. The requirement for informed consent was waived by the IRB due to the retrospective nature of the study and the use of de-identified data.

2.2 Dataset

Demographic, clinical, and laboratory data were extracted from Sheba's electronic health records using the MDclone platform. The following data were collected for each patient: hemoglobin in g/dL , sodium in mEq/L, procedure ICD codes, admission type (urgent or emergent as opposed to elective), previous admissions in the past year, and total length of stay (LOS)—variables critical for computing the HOSPITAL score. All laboratory tests

(Hemoglobin and Sodium levels), procedure codes, admission type and total LOS were collected on the day of discharge from the index admission. The predictor "previous admissions during the past year" was collected on the first day of the index admission. As all discharges were from internal medicine departments, the O" (Oncology) component of the HOSPITAL score was zero unless explicitly coded otherwise.

The unit of analysis was the hospital discharge. In cases where multiple hospitalizations occurred within a 30-day period, a single admission could serve both as the index admission and as a subsequent readmission, depending on its position in the sequence . As a result, a single patient could contribute multiple hospitalizations to the cohort; in total, 77,625 admissions were included, representing approximately 48,449 unique patients.

2.3 Data Collection and Variables

Data were extracted from Sheba Medical Center's electronic health record platform, MDclone. These data underwent quality control by both the hospital's IT team and the MDclone implementation team, ensuring high validity and reliability (primarily limited by the quality of medical documentation). Collected information included demographics, clinical characteristics, laboratory results, and indices of comorbidity.

2.4 Outcome Definition

We defined our primary outcome as all-cause 30-day readmission to Sheba Medical Center. Patients who died during index admission were not included in the original cohort, and patient who had a length of stay of $\leq$24 hours were excluded, to avoid observational stays. We could not reliably identify patients transferred to other facilities or those who left against medical advice, and thus their outcomes may be missing. These cases likely represent a small minority. We did not capture readmissions occurring at other hospitals.

In contrast to the original derivation of the HOSPITAL score by [Donzé et al.(2013)Donzé, Aujesky, Wil which focused exclusively on potentially avoidable readmissions (PARs) as identified by the proprietary SQLape algorithm, our study evaluates the score's performance on all unplanned 30-day readmissions. The use of SQLape in the original study, as well as in its external validation by the same authors ([Donzé et al.(2016)Donzé, Williams, Robinson, and Auerbach]), likely enhanced predictive performance by narrowing the outcome to readmissions that were more closely linked to modifiable in-hospital factors. In contrast, our analysis reflects a more pragmatic and generalizable assessment of the HOSPITAL score in real-world clinical practice, where such classification tools may not be available or routinely used. This key methodological difference should be considered when comparing performance metrics across

studies.

2.5 HOSPITAL Score Calculation

The HOSPITAL score ranges from 0 to a maximum of 13+ points, incorporating the following components (with the mnemonic HOSPITAL):

- **H**emoglobin: Low at discharge (defined as < 12 g/dL)
- **O**ncology: Discharge from an Oncology division
- **S**odium: Low serum sodium at discharge (defined as < 135 mEq/L)
- **P**rocedure: Presence of a procedure during the index hospitalization
- **I**ndex admission **T**ype: Elective vs. non-elective (emergent or urgent)
- **A**dmissions: Number of hospital admissions in the previous year. This number of admissions was grouped into three: 0, 1-5 and ¿5 admissions in the previous year, as grouped in the derivation study.
- **L**ength of stay: 5 or more days

Each criterion contributes a fixed number of points (1 or 2) to a total score that can range from 0 to 13 . These scores are not calculated on a continuous scale, but rather in discrete steps, meaning each patient's score corresponds to one of a limited number of predefined risk categories. For example, a patient with a score of 1 will be assigned a fixed estimated risk of 8% for readmission—regardless of whether their true underlying risk might be slightly higher or lower.

In this way, the HOSPITAL score groups patients into broad risk brackets based on combinations of specific clinical features. While this stepwise system is common in clinical scoring tools, it's important to understand that it may mask smaller differences in individual patient risk.

Mathematically, the conversion can be represented as:

$$P(\text{readmission}) = \begin{cases} 0.05 & \text{if Score} = 0 \\ 0.08 & \text{if Score} = 1 \\ \vdots & \\ 0.80 & \text{if Score} = 13 \end{cases} \tag{1}$$

In our implementation, a score of **13** is capped at the maximum probability of 0.80, maintaining consistency with the original validation studies. Table 7 details this conversion:

2.6 Statistical Analysis

We summarized categorical variables as frequency (%) and analyzed them using Pearson's chi-square or Fisher's exact test, as appropriate. Continuous variables were compared using the Mann–Whitney U or Kruskal–Wallis tests when distributional assumptions were not met. Discrimination was measured via ROC curves (area under the curve, AUC) and precision-recall analysis (average precision). Calibration was evaluated via Observed versus predicted readmission rates, Hosmer–Lemeshow goodness-of-fit, and Pearson chi square test while overall performance was assessed by the Brier score. All analyses were conducted using Python (version 3.9) software. To account for patients with multiple index hospitalizations, we used generalized estimating equations (GEE) with clustering at the patient level.

3 Results

During 2018-2023, the internal medicine departments at Sheba Medical Center had 113,312 discharges. Of them, 35,687 (31.5%) were excluded due to a LOS of $\leq$24 hours. The final study cohort comprised 77,625 (68.5%) discharges, of whom 17,963 (23.4%) discharges resulted in a 30-day readmission (Figure 1).

Table 1 compares the characteristics of our cohort with the original derivation cohort. Discharges were comprised of 41,422 (53.4%) men, had a mean (SD) age of 70.6 (16.7) years, and had a median (IQR) length of stay of 2.5 (1.6-4.2) days. Tables 2 and 3 compare the baseline characteristics of the Sheba cohort stratified by readmission status to the derivation and the original external validation studies, respectively.

The median (IQR) for time to readmission was 10.0 days (5.0-18.0). Readmitted patients were more likely to experience longer index hospital stays (¿4 days) (32.6% vs 24.6%), low levels of hemoglobin (72.3% vs 54.9%) or sodium at discharge (13.3% vs. 9.1%), and higher probability of admissions in the previous year 65.6% vs. 44.5%), with all comparisons showing $p < 0.001$.

The Hosmer–Lemeshow test produced a chi-square of 6254.097 (1 df, p=0.000) and the Pearson chi-square test produced a chi-square of 54160.160 ($p = 0.000$). The ROC analysis demonstrated an AUC of 0.635 (95% CI: 0.631–0.639), indicating moderate discriminative ability. A precision-recall curve yielded an average precision of 0.317. The Brier score was 0.163.

Using conventional cutoff points (0–4, 5–6, and ≥7), the HOSPITAL score stratified patients into three risk categories. The low-risk group (scores 0–4) comprised 72.4% of discharges (56,218 discharges) and had a 30-day readmission rate of 18.1%. The intermediate-risk group (scores 5–6) accounted for 19.4% of discharges (15,087 discharges) and had a readmission rate of 32.7%. The high-risk group (scores ≥7) included 8.1% of discharges (6,320 discharges), with a readmission rate of 44.8%.

We compared our findings with the original derivation and validation studies of the HOSPITAL score by [Donzé et al.(2016)Donzé, Williams, Robinson, and Auerbach], as well as with a smaller validation study by [Robinson(2016)]. Table 3 presents both results.

As mentioned earlier, [Donzé et al.(2016)Donzé, Williams, Robinson, and Auerbach] restricted their primary outcome to *potentially avoidable* 30-day readmissions, identified using the proprietary SQLape algorithm. This tool excludes clinically foreseeable or non-modifiable readmissions, such as planned returns for chemotherapy, rehabilitation, or transplant procedures, as well as readmissions for new conditions unrelated to the index hospitalization. By narrowing the outcome to events more likely to reflect modifiable aspects of hospital care, this approach likely enhanced model performance.

In contrast, our study includes *all* unplanned 30-day readmissions to Sheba Medical Center, offering a more pragmatic and generalizable evaluation of the HOSPITAL score in settings where proprietary classification tools like SQLape are not routinely available. This key methodological difference should be considered when comparing performance metrics across studies.

4 Discussion

In this large, single-center, retrospective study, the HOSPITAL score demonstrated moderate capability (AUC=0.635) to identify adult patients at risk for 30-day readmission. Although our discrimination is somewhat lower than that observed by [Robinson(2016)], we found a consistent trend of increasing readmission rates across low-, intermediate-, and high-risk categories, underscoring the score's clinical utility in discharge planning.

Our study population differs from [Donzé et al.(2016)Donzé, Williams, Robinson, and Auerbach] international validation study of the HOSPITAL score in several important ways: First, our analysis is specifically focused on an internal medicine population, which differentiates our study from other implementations of the HOSPITAL score that include multiple specialties. Because our data consist solely of internal medicine discharges, the corresponding oncology-related score component is zero in most cases. Second, most (96%) of the admissions during this timeframe were classified as urgent or emergent. This adjustments may affect the dis-

tribution of scores compared with the original validation cohorts.

Despite these methodological variations, both the current findings and earlier validations highlight the HOSPITAL score's strengths. The tool relies on simple variables, making it attractive for routine clinical workflows. Nonetheless, the score showed limitations in overall accuracy (Brier=0.163) and had many false negatives, suggesting room for refinement. Incorporating additional data (e.g., comorbidity severity, medication reconciliation details) or advanced predictive models might enhance performance.

Key observations from our analysis highlight the stratification performance of the HOSPITAL score. The majority of admissions (72.4%) fell into the low-risk category, with an observed readmission rate of 18.1%, compared to a predicted rate of 16%. The high-risk group, comprising only 8.1% of admissions, exhibited a markedly elevated readmission rate of 44.8%. Overall, the progressive increase in readmission rates across the low-, intermediate-, and high-risk categories (18.1%, 32.7%, and 44.8%, respectively) supports the score's capacity to effectively discriminate between different levels of readmission risk. However, calibration analyses revealed significant miscalibration, with predicted readmission risks differing notably from observed rates (Hosmer-Lemeshow $\chi^2 = 6254.097$, $p < 0.001$; Pearson $\chi^2 = 5410.160$, $p < 0.001$). This suggests that while the HOSPITAL score can rank patients by risk, it may not accurately estimate absolute readmission probabilities in this external population.

4.1 Limitations

This study has several limitations. First, our study focuses exclusively on patients discharged from internal medicine departments and does not include patients discharged from oncology departement. While this focus was intentional, as the study was designed to address this specific clinical setting, it may limit the generalizability of our findings compared with the broader patient population in the original derivation study. Furthermore, the oncology discharge item in the HOSPITAL score was set to "no" in most cases, resulting in a deviation from the original score calculation. This modification may have affected the model's calibration and discrimination and should be acknowledged as a potential source of bias. Second, unlike the original derivation and validation studies, we did not use the SQLape algorithm to identify and exclude potentially avoidable readmissions, which may affect the comparability of our results. Third, all data were extracted automatically from the electronic medical record; therefore, some clinical events or procedures may have been underreported if they were not coded in the system. Finally, our dataset did not capture deaths or readmissions to other hospitals, which may have led to incomplete follow-up information.

While the HOSPITAL score provides useful risk stratification, it may benefit from additional predictive features or more sophisticated modeling approaches. Despite these limitations, the score demonstrates a meaningful stratification of readmission risk across different patient groups.

The progressive increase in readmission rates across risk categories validates the fundamental premise of the HOSPITAL score, that readily available clinical variables can provide meaningful insight into readmission risk.

5 Conclusions

Our retrospective validation of the HOSPITAL score in a large internal medicine cohort (N = 77,625) at Sheba Medical Center confirms a moderate level of discriminative ability (AUC = 0.635) and showes evidence of miscalibration, likely influenced by the large sample size, but still demonstrated a clear risk gradient across score categories . Although the score performed somewhat less favorably than in other settings (e.g., Robinson et al.'s US hospital cohort [Robinson(2016)]), it effectively segregates risk categories and could inform targeted interventions for high-risk patients.

Future research might include multi-center cohorts, prospective deployments, or score adjustments (e.g., weighting the oncology item differently or adding variables such as albumin and comorbidity severity). These efforts could help refine and enhance the current risk stratification approach. These efforts could help refine and enhance the current risk stratification approach. Until then, we conclude that the HOSPITAL score remains a valuable, easy-to-use tool for hospital readmission risk stratification, even if local adaptations may improve its accuracy.

6 Additional Information

- **Funding:** This study was supported by a research grant from Sheba Tel Hashomer Medical Center.

- **Conflicts of Interest:** The authors declare no conflicts of interest or financial disclosures.

- **Study Registration:** This study was not prospectively registered.

- **Data Sharing:** Due to the sensitive and identifiable nature of the electronic health record data, individual-level data cannot be shared. Aggregated data may be available

from the authors upon reasonable request and subject to institutional approval.

- **Code Availability:** The code used for analysis is not publicly available.
- **Patient and Public Involvement:** No patients or members of the public were involved in the design, conduct, reporting, or dissemination of this research.

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Figures and Tables

- **Figure 1**: Flow chart showing exclusion criteria and final patient selection.
- **Figure 2**: Receiver Operating Characteristic (ROC) curve for the HOSPITAL score.
- **Table 1**: Characteristics of the entire cohort – Sheba versus Donzé derivation cohort.
- **Table 2**: Characteristics comparing the Donzé derivation versus the Sheba external validation cohort.

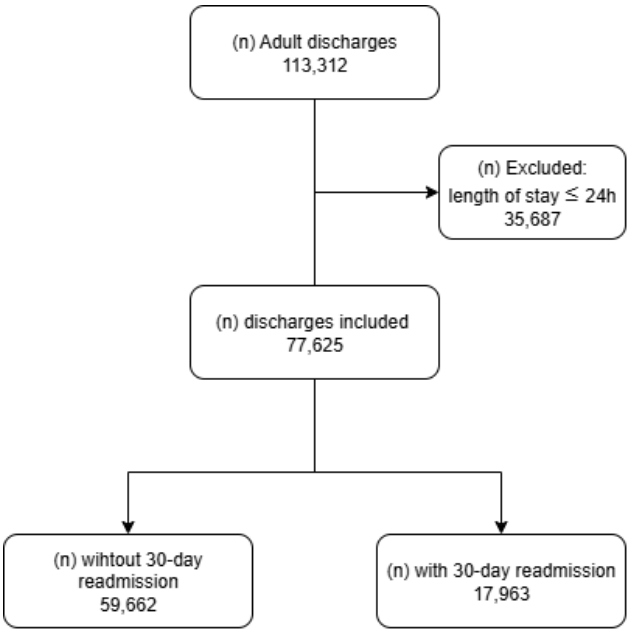

Figure 1: Flow chart of patient selection. Exclusion criteria: Hospitalization with length of stay $\leq$ 24 hours. The final cohort comprises 77,625 discharges with 17,963 readmissions.

- **Table 3**: Characteristics comparing Donzé's external validation cohort versus the Sheba external validation cohort.
- **Table 4**: Observed versus predicted 30-day readmission rates across risk categories.

Supplements

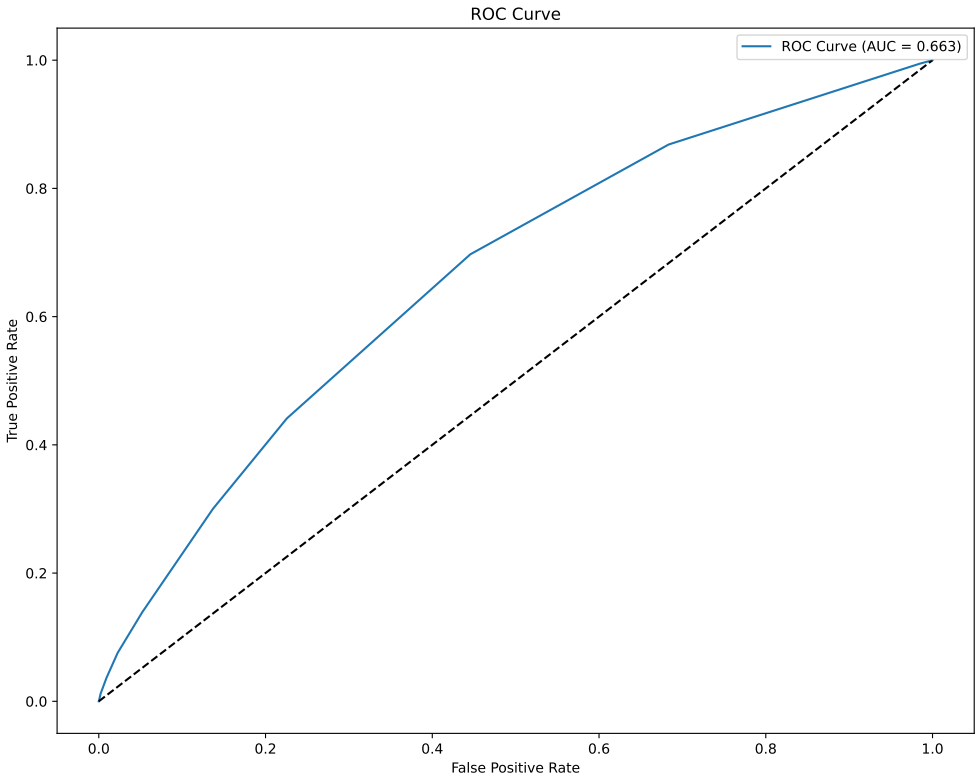

Figure 2: Receiver Operating Characteristic (ROC) curve for the HOSPITAL score in the Sheba dataset.

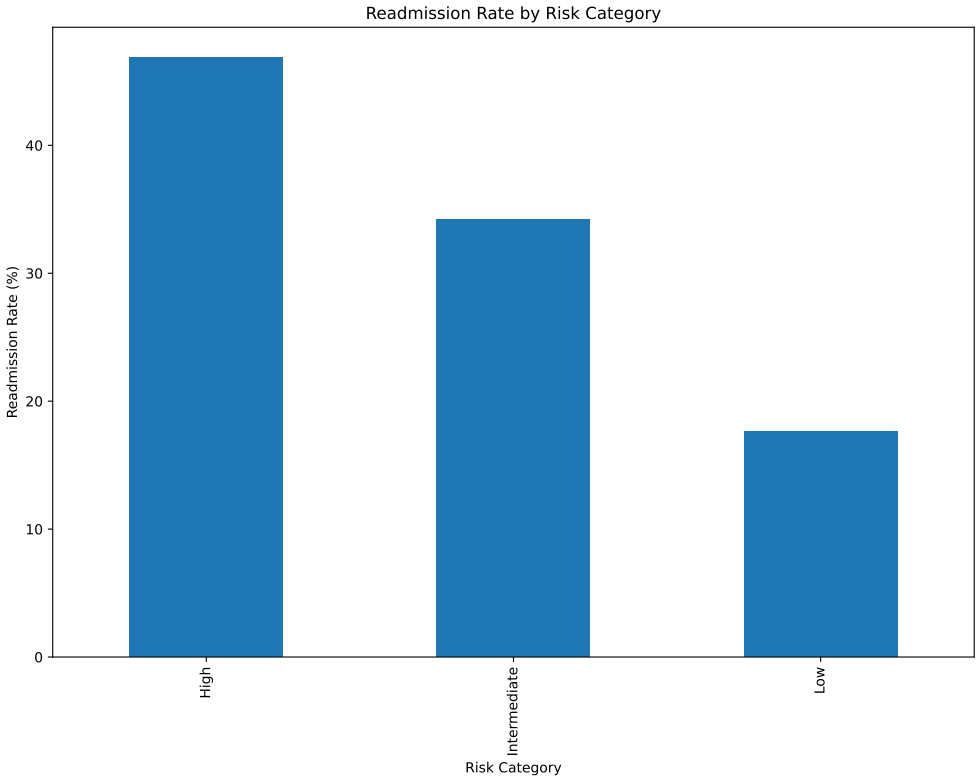

Figure 3: Readmission rates by HOSPITAL score risk category.

Table 1: Baseline Characteristics of the Entire Cohort: Sheba entire cohort (N = 77,625) vs. Donzé entire Cohort (N = 9,212). (Total data: 594)

Characteristic	**Entire Cohort Sheba**	**Entire Cohort Donzé**
Age > 75 y	35,138 (43.3%)	2,051 (22.3%)
Male sex	41,442(53.4%)	4,476 (48.6%)
Ethnicity: Non-Hispanic white	–	6,655 (72.2%)
Ethnicity: Non-Hispanic black	–	1,498 (16.3%)
Ethnicity: Hispanic	–	773 (8.4%)
Ethnicity: Other	–	286 (3.1%)
First language: English	–	8,376 (90.9%)
First language: Spanish	–	482 (5.2%)
First language: Other	–	354 (3.8%)
Source of index admission: Emergency department	75,042 (96.7%)	4,902 (53.2%)
Type of index admission: Elective	–	1,188 (12.9%)
Type of index admission: Non-elective	–	8,021 (87.1%)
Division of index admimssion: Oncology	–	2,292 (23.8)
Division of index admimssion: Other medical service	77,625 (100%)	7,020 (76.2)
Length of stay (days): 1-4	57,081 (73.5%)	5,181 (56.2%)
Length of stay (days): >4	20,544 (26.5%)	4,031 (43.8%)
No. of hospital admissions in past year: 0	55,012 (70.9%)	4,321 (46.9%)
No. of hospital admissions in past year: 1–5	21,942 (23.8%)	4,456 (48.4%)
No. of hospital admissions in past year: >5	671 (0.9%)	435 (4.7%)
Hemoglobin levels at discharge <12.0 g/dL**	45,737 (58.9%)	5,326 (61.1%)
Hemoglobin levels at discharge ≥ 12.0 g/dL**	31,888 (41.1%)	3,586 (38.9)
Serum sodium levels at discharge <135 mEq/L***	7814 (10.1%)	1,454 (15.8%)
Serum sodium levels at discharge ≥ 135 mEq/L***	69,811 (89.9%)	7,758 (84.2)
GFR* at discharge, mL/min ¡30	8,535 (11.0%)	892 (9.7)
GFR at discharge, mL/min 30-59	18,288 (23.6%)	1,977 (21.5)
GFR at discharge, mL/min ≥ 60	50,127 (64.6%)	6,343 (68.8)
Comorbidity: Diabetes Mellitus	23,871 (30.8%)	2,312 (25.1)
Comorbidity: Ischemic Heart Disease	14,302 (18.4%)	2,497 (27.1)
Comorbidity: Heart Failure	4,924 (6.3%)	2,029 (22.0)
Comorbidity: Atrial Fibrillation	–	1,633 (17.7)
Comorbidity: COPD	5,163 (6.7%)	936 (10.2)
Comorbidity: Malignant neoplasm	6,376 (8.2%)	3,250 (35.3)

Abbreviations: COPD, chronic obstructive pulmonary disease; GFR, glomerular filtration rate. *GFR was estimated using the Modification of Diet in Renal Disease (MDRD) study equation, considering gender, age, race, and serum creatinine. **Missing: 634. ***Missing: 611 The values were imputed as normal when missing (ie, no points attributed for the missing variable). Two separate analyses (supplement) were made: one analysis excluded all discharges with missing data: overall 565 (0.73%) out of 77,625 discharges included in the final cohort, and a second analysis, where missing values were treated as being below the noral range.

Table 2: Comparison of Baseline Characteristics in Univariable Analysis: Sheba External Validation (n= 77,625) vs. Donzé Derivation Set (n=6,141)

Characteristic	Sheba		Donzé Derivation	
	No Readmission (n=59,662)	**Readmission** (n=17,963)	**No Readmission** (n=5,553)	**PAR** (n=588)
	No. (%)			
Age > 75 y	26,613 (44.6%)	8,525 (47.5%)	1,277 (23.0%)	119 (20.2%)
Male sex	31,644 (53.0%)	9,778 (54.4%)	2,652 (47.8%)	282 (48.0%)
Ethnicity: Non-Hispanic white	–	–	3,989 (71.8%)	427 (72.6%)
Ethnicity: Non-Hispanic black	–	–	911 (16.4%)	99 (16.8%)
Ethnicity: Hispanic	–	–	467 (8.4%)	53 (9.0%)
Ethnicity: Other	–	–	186 (3.3%)	9 (1.5%)
Source of index admission: Emergency department	57,673 (96.7%)	17,369 (96.7%)	2,938 (52.9%)	315 (53.6%)
Type of index admission: Elective	–	–	736 (13.3%)	64 (10.9%)
Type of index admission: Non-elective	–	–	4,817 (86.7%)	524 (89.1%)
Length of stay of index admission: 1-4 days	44,972 (75.4%)	12,109 (67.4%)	3,252 (58.6%)	259 (44.0%)
Length of stay of index admission: >4 days	14,690 (24.6%)	5,854 (32.6%)	2,301 (41.4%)	329 (56.0%)
No. of hospital admissions in past year: 0	33,116 (55.5%)	6,183 (34.4%)	2,698 (48.6%)	178 (30.3%)
No. of hospital admissions in past year: 1–5	25,063 (42.0%)	10,157 (56.5%)	2,629 (47.3%)	344 (58.5%)
No. of hospital admissions in past year: >5	858 (1.5%)	1,623 (9.0%)	226 (4.1%)	66 (11.2%)
Hemoglobin levels at discharge <12.0 g/dL	32,747 (54.9%)	12,990 (72.3%)	3,761 (67.7%)	481 (81.8%)
Hemoglobin levels at discharge ≥ 12.0 g/dL	26,915 (45.1%)	4,973 (27.7%)	1,792 (32.3%)	107 (18.2%)
Serum sodium levels at discharge <135 mEq/L	5,426 (9.1%)	2,388 (13.3%)	832 (15.0%)	137 (23.3%)
Serum sodium levels at discharge ≥ 135 mEq/L	54,236 (90.9%)	15,575 (86.7%)	4,721 (85.0)	451 (76.7)
GFR* at discharge, mL/min ¡30	5,687 (9.5%)	2,848 (15.9%)	527 (9.5)	76 (12.9)
GFR at discharge, mL/min 30-59	13,590 (22.8%)	4,698 (26.2%)	1,178 (21.2)	119 (20.2)
GFR at discharge, mL/min ≥ 60	39,834 (66.8%)	10,293 (57.3%)	3,848 (69.3)	393 (66.8)
Comorbidity: Diabetes Mellitus	17,624 (29.5%)	6,247 (34.8%)	1,379 (24.8)	164 (27.9)
Comorbidity: Ischemic Heart Disease	10,624 (17.8%)	3,678 (20.5%)	1,508 (27.2)	139 (23.6)
Comorbidity: Heart Failure	3,430 (5.7%)	1,494 (8.3%)	1,221 (22.0)	142 (24.1)
Comorbidity: Atrial Fibrillation	–	–	1000 (18.0)	89 (15.1)
Comorbidity: COPD	3,777 (6.3%)	1,386 (7.7%)	567 (10.2)	61 (10.4)
Malignant Neoplasm	4,404 (7.4%)	1,972 (11.0%)	1,840 (33.1)	300 (51.0)

Abbreviations: PAR= Potentially Avoidable Readmission

Table 3: Comparison of Baseline Characteristics: Sheba External Validation vs. Donzé External Validation

Characteristic	Sheba External Validation Patients, No (%) Not readmitted / Readmitted	**Donzé External Validation** , No (%) Not readmitted / readmitted
Patients, No. (%)	59,662 (76.9%) / 17,963 (23.1%)	112,418 (%) / 11,794 (%)
Age, mean (SD)	70.2 (Not Readmitted) / 72.1 (Readmitted)	60.8 (18.3) / 61.3 (18.0)
Male	31,664 (53.0%) / 9,778 (54.4%)	53,679 (51.0%) / 5,988 (53.0%)
Urgent/Emergent index admission	57,673 (96.7%) / 17,369 (96.7%)	78,708 (74%) / 9,369 (83%)
Length of stay ≥ 5 days	10,586 (17.7%) / 4,386 (24.4%)	45,655 (43%) / 6,058 (54%)
No. of hospital admissions in past year: ≤1	45,879 (76.9%) / 10,131 (56.4%)	79,197 (72%) / 4,826 (43%)
No. of hospital admissions in past year: 2–5	12,300 (20.6%) / 6,209 (34.6%)	25,109 (24%) / 4,464 (40%)
No. of hospital admissions in past year: >5	1,483 (2.5%) / 1,623 (9.0%)	4,453 (4%) / 2,017 (18%)
≥ 1 Procedure during index hospitalization	4,063 (6.8%) / 1,096 (6.1%)	78,818 (75%) / 8,781 (78%)
Low Hemoglobin levels at discharge (¡ 12 g/dL)	32,747 (54.9%) / 12,990 (72.3%)	59,381 (56%) / 8,005 (71%)
Low sodium levels at discharge (¡ 135 mEq/L)	5,426 (9.1%) / 2,388 (13.3%)	13,520 (13%) / 2,038 (18%)

Table 4: Observed vs. Predicted 30-Day Readmission Rates by HOSPITAL Score Risk Category

Points	**Risk Category**	**Patients, No. (%)**	**Observed Readmission (%)**	**Predicted Readmission (%)**
0–4	Low	56,218 (72.4)	18.1	16.0
5–6	Intermediate	15,087 (19.4)	32.7	26.0
≥7	High	6,320 (8.1)	44.8	54.3

Table 5: Performance metrics and characteristics across validation and derivation cohorts.

	Machado Validation	**Donzé Derivation**	**Donzé External Validation**	**Robinson Validation**
No. of admissions (cohort)	77,625	9,212	117,065	931
Experienced Readmission (%)	17,963 (23%)	2,396 (22.3%) all-cause; 879 (8.5%) PAR*	16,992 (14.5%) all-cause; 11,307 (9.7%) PAR	109 (12%)
Discrimination (AUC)	0.635	0.69 (Derivation); 0.71 (Validation); 0.67 (Complete cohort before exclusion of unavoidable readmission)	0.72 (Israel dataset: 0.68)	0.77
Calibration: HL test / Pearson χ^2	HL test: $\chi^2 = 6254.097$, $p = 0.000$; Pearson $\chi^2 = 5410.160$, $p = 0.000$	HL test: 0.28 (Derivation); 0.15 (Validation)	Pearson χ^2: $p = 0.89$	HL test: $\chi^2 = 1.63$, $p = 0.20$
Overall performance: Brier score	0.163	–	0.08	0.10
Primary outcome	All-cause 30-day hospital readmission	Potentially avoidable 30-day readmissions (PAR) using SQLape**; unavoidable readmissions excluded from final cohort/main analysis		All-cause 30-day hospital readmission
Discharges from Oncology service	No	Yes		No***

* PAR = Potentially avoidable readmissions.

** SQLape is a validated computerized algorithm based on administrative data commonly used in Switzerland.

*** Patients with oncology-related diagnosis-related group (DRG) codes were classified as discharged from an oncology service.

Table 7: HOSPITAL Score to Readmission Probability Mapping

HOSPITAL Score	**Estimated Readmission Probability**
0	0.05 (5%)
1	0.08 (8%)
2	0.10 (10%)
3	0.13 (13%)
4	0.16 (16%)
5	0.21 (21%)
6	0.26 (26%)
7	0.31 (31%)
8	0.38 (38%)
9	0.45 (45%)
10	0.53 (53%)
11	0.62 (62%)
12	0.71 (71%)
13	0.80 (80%)