AI-Based Prediction of Hospital Readmission Risk

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Abstract

In the bustling corridors of Dhaka Medical College, the National Institute of Cardiovascular Diseases (NICVD), and other tertiary hospitals across Bangladesh, the moment a patient is discharged is often treated as a triumph. Yet, for a significant proportion of Bangladeshi patients, that victory is short-lived. Within 30 days, many find themselves back in a hospital bed—a phenomenon known as the "revolving door" of healthcare. This cycle is not merely a medical frustration; in 2026, it is increasingly recognized as a critical systemic and economic issue.

High readmission rates strain hospital resources, compromise patient outcomes, and impose substantial financial burdens on families and the national healthcare system. Through advances in Machine Learning (ML) and Predictive Analytics, hospitals are beginning to identify high-risk patients before discharge, enabling proactive interventions and more efficient resource allocation.

Hospital readmission within 30 days is widely used as a global benchmark for the quality of care. However, in Bangladesh's resource-constrained healthcare environment, the stakes are uniquely high. Internationally, 30-day readmission rates typically range between 12% and 15%, but for Bangladeshi patients with chronic conditions such as Congestive Heart Failure (CHF) or Chronic Obstructive Pulmonary Disease (COPD), these rates can be significantly higher. The factors driving this include fragmented post-discharge care, inconsistent follow-up, and gaps in patient education about self-management. For low-income families—earning below USD 103.55 per month—a single readmission often translates to catastrophic expenditure. Studies suggest that nearly 41% of readmissions in comparable developing contexts are avoidable, resulting from preventable lapses such as inadequate discharge planning, medication non-adherence, or insufficient follow-up arrangements. At the hospital level, readmissions exacerbate systemic pressures: bed occupancy rates in Dhaka frequently exceed 100%, meaning that each avoidable readmission directly prevents another patient from accessing timely care.

The primary objective of AI-based hospital readmission prediction is to assign a "Readmission Risk Score"

to each patient at the point of discharge. These scores enable clinicians and hospital managers to focus attention on patients most likely to return, tailoring interventions that can reduce unnecessary readmissions. Multiple machine learning approaches have been evaluated to identify the most suitable model for Bangladesh's clinical and operational landscape. Logistic Regression serves as a baseline, valued for interpretability, achieving an Area Under Curve (AUC) of approximately 0.71. Random Forest (RF) models demonstrate superior handling of noisy and imbalanced electronic health records, frequently achieving AUC values around 0.85. XGBoost has emerged as the gold standard in 2026, combining predictive accuracy with operational speed and the ability to capture non-linear interactions that traditional models often miss—for instance, the complex interaction between diuretics usage and patient age that significantly influences readmission risk.

Beyond identifying high-risk patients, it is crucial to understand the underlying factors contributing to readmission. By employing SHapley Additive exPlanations (SHAP), AI models reveal the "predictive DNA" of readmission. Comorbidity density is a dominant predictor: patients with three or more chronic conditions—such as Diabetes, Hypertension, and Renal Dysfunction—face the highest risk. Length of Stay (LOS) is also significant, with both unusually short stays, indicative of premature discharge, and extended stays, reflective of clinical complexity, increasing the probability of readmission. Geographical factors play a role as well; patients residing more than 35 kilometers from the hospital exhibit higher readmission rates, reflecting challenges in attending follow-up visits, accessing medications, and maintaining continuity of care. By quantifying these risk factors, predictive models provide actionable insights that clinicians and hospital administrators can use to tailor post-discharge support.

Equity considerations are central to the responsible application of AI in Bangladesh. In a society characterized by pronounced income disparities, models must avoid privileging the insured and urban populations over vulnerable groups. Fairness adjustments are therefore integrated into predictive algorithms. For example, models trained exclusively on private hospital data could mistakenly equate the absence of insurance with medical risk. By applying fairness constraints, AI ensures that recall and sensitivity metrics are balanced across socio-economic strata, enabling accurate identification of high-risk patients in urban slums as well as middle-class communities. Similarly, age-sensitive modeling ensures that elderly patients—those over 65, who are inherently at higher risk—receive appropriate post-discharge support without reinforcing ageist assumptions that could marginalize them. These fairness interventions are critical for ensuring that AI-driven interventions do not unintentionally exacerbate existing healthcare inequities.

The predictive insights gained from AI are most impactful when translated into concrete interventions. Integration with Hospital Management Systems (HMS) allows for risk scores to inform discharge planning and follow-up care. High-risk patients are provided with specialized discharge plans that include medication reconciliation, nutritional counseling, and telehealth check-ins within 72 hours of discharge. Hospital

administrators can also use aggregated risk forecasts to optimize bed allocation, ensuring preparedness for seasonal surges of chronic patients. Moreover, predictive models facilitate stronger integration with community health services. Automated alerts can notify local Community Health Workers about high-risk patients, creating a bridge between tertiary care facilities and patients' homes, and enabling early intervention that may prevent readmission altogether.

The economic and societal benefits of AI-driven readmission prediction are considerable. By reducing avoidable readmissions, hospitals can free up limited bed space, improve patient throughput, and enhance overall quality of care. Families avoid the catastrophic costs associated with repeat admissions, reducing the risk of financial hardship. At a national level, improving post-discharge outcomes alleviates systemic stress, allowing the health system to allocate resources more efficiently, particularly in regions with high population density and limited hospital capacity. Importantly, these gains are achieved without sacrificing equity; fairness-aware AI ensures that interventions are directed to those most in need, rather than those most represented in historical datasets.

Implementation in Bangladesh also requires attention to operational realities. Electronic health record systems are often incomplete, and patient data may be fragmented across multiple facilities. Models must therefore be robust to missing data, imbalanced populations, and variable data quality. Furthermore, clinician engagement is essential: AI should serve as a supportive tool rather than a replacement for clinical judgment. Explainable AI allows physicians to understand the rationale behind risk scores, ensuring that interventions are contextually appropriate and aligned with patient-specific considerations. Continuous feedback loops enable models to adapt over time, incorporating new clinical patterns and local epidemiological trends.

Finally, AI-driven readmission prediction emphasizes the human dimension of healthcare. Technology does not replace the interpersonal aspects of care; it augments them. Patients identified as high-risk are not merely flagged; they receive coordinated support from nurses, physicians, and community health workers. This collaborative model enhances patient trust, encourages adherence to treatment regimens, and strengthens the overall patient experience. By combining predictive analytics with human-centered care, Bangladesh is moving toward a healthcare system that is both efficient and compassionate.

In conclusion, hospital readmission represents a critical "leak" in the healthcare system that cannot be ignored. By 2026, AI-based prediction of readmission risk transforms the approach from reactive to proactive, enabling hospitals to anticipate challenges and intervene before complications arise. Predictive modeling, fairness adjustments, and human-in-the-loop integration together create a system that is accurate, equitable, and clinically actionable. In the context of Bangladesh, where hospital capacity is constrained and families are financially vulnerable, such interventions are not optional—they are essential. The ultimate measure of success in a Smart Bangladesh healthcare system will no longer be simply the number of

patients discharged, but the number who remain healthy and out of the hospital, demonstrating the tangible benefits of prediction-driven prevention.