# Digital Patient Queue & Appointment Management System

**A Digital Patient Queue & Appointment Management System with Disease-Based Priority Classification for Government Hospitals in India**

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## 1.0 Abstract

The digital transformation of India's public healthcare system is a critical national priority, yet government hospitals continue to face systemic challenges related to patient management. Overcrowding, prolonged waiting times, and inefficiencies stemming from manual registration processes create significant barriers to timely and effective care, a problem explicitly identified within the Ayushman Bharat Digital Mission (ABDM) framework. This research articulates the architecture for a digital appointment and queue management system that utilizes a disease-based priority classification mechanism to address these critical gaps. The system's core innovation is the strategic shift from the traditional, chronological first-in-first-out (FIFO) model to a dynamic, clinical-need-based priority queue. By automatically triaging patients based on the severity of their condition, the system ensures that those with the most urgent needs receive attention first. This approach is expected to significantly reduce patient waiting times, optimize the utilization of limited hospital resources, enhance overall patient satisfaction, and create a more transparent and efficient service delivery model, thereby aligning with the foundational goals of digital governance in India's evolving healthcare ecosystem.

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## 2.0 Introduction

India's healthcare landscape is undergoing a strategic digital transformation, guided by national initiatives like the National Digital Health Blueprint (NDHB), which envisions a comprehensive and integrated digital health ecosystem to achieve universal health coverage. However, the public healthcare system, particularly government hospitals, is strained by significant operational challenges. The country faces an acute shortage of medical professionals, with a doctor-to-patient ratio lower than the World Health Organization's recommendation of 1 per 1000 people. This shortage is exacerbated by a pronounced urban-rural disparity, where approximately 70% of the nation's medical infrastructure is concentrated in urban centers that house only 35% of the population. These systemic issues are compounded by a reliance on manual administrative processes, which are prone to incorrect data entries and are often bottlenecked by insufficient staff at reception counters, leading to long and disorganized patient queues.

Traditional queue management, whether manual or based on a simple First-In-First-Out (FIFO) digital system, has inherent limitations in a clinical setting. These systems are fundamentally incapable of differentiating between patients requiring immediate, critical care and those presenting with routine or non-urgent conditions. This lack of clinical prioritization can lead to dangerous delays in treatment for high-acuity patients, while simultaneously creating inefficient workflows and suboptimal allocation of hospital resources. The current

paradigm fails to address the foundational principle of medical triage, where care is administered based on urgency and severity. These persistent inefficiencies in patient flow and clinical prioritization define the core operational problem that this research seeks to address through a targeted digital intervention.

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# 3.0 Problem Statement

The design of an effective HealthTech solution is predicated on a precise and comprehensive problem definition, as this clarity guides the system's architecture, functionalities, and ultimate objectives. In the context of India's government hospitals, the problem is multi-faceted and severe. These facilities are consistently plagued by overcrowding, leading to extended and unpredictable waiting times for patients seeking care. Inefficient manual appointment and registration systems further exacerbate this issue, creating significant barriers to accessing quality healthcare. The Ayushman Bharat Digital Mission (ABDM) playbook explicitly states that reducing patient waiting time is "crucial in helping citizens avail services in a hassle-free and time-bound manner," highlighting this as a central challenge to be solved through digital intervention.

However, simply digitizing the existing chronological queueing model is an insufficient solution. A digital version of a FIFO queue fails to address the core clinical problem: the failure to prioritize patients based on medical urgency. This is a foundational concept in established triage systems used in emergency medicine worldwide. The absence of a prioritization mechanism means that a patient with a minor ailment could be seen before someone with symptoms of a life-threatening condition, purely based on their arrival time. Therefore, the central problem this research aims to solve is the lack of an intelligent, automated, and scalable system that can dynamically manage patient queues in government hospitals by classifying and prioritizing patients according to the severity of their medical condition. To solve this, a set of specific, measurable system objectives must be established to guide the design and evaluate the success of the proposed solution.

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# 4.0 System Objectives

- **Reduce Patient Waiting Time:** Digitization of registration (ABDM "Scan & Share") to minimize administrative tasks and ensure waiting time is proportionate to clinical need.
- **Prioritize Critical Patients:** Automated identification and elevation of life-threatening conditions to the front of the queue.
- **Improve Hospital Efficiency:** Real-time dashboards and analytics to identify bottlenecks and optimize staff allocation.
- **Enable Digital Governance:** Establishing an accountable, auditable, and citizen-centric service delivery model.

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# 5.0 Literature Review

A review of existing Indian initiatives reveals a strong foundation but functional gaps:

- **eHospital (NIC):** A web-based HMIS compliant with ABDM standards used in 1000+ facilities.
- **Online Registration System (ORS):** Citizen-centric online appointment scheduling.
- **ABDM "Scan & Share":** QR-based registration using Ayushman Bharat Health Account (ABHA).

**The Gap:** While these systems digitize the process, they maintain a FIFO (First-In-First-Out) model. They do not reorder the queue based on clinical urgency, leaving the core problem of delayed critical care unaddressed.

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# 6.0 Proposed System Architecture

The system follows the federated, multi-layered structure of the NDHB.

| Layer | Component | Function |
|---|---|---|
| **Local** | HIS Integration | Interface with eHospital/HMIS for data sync. |
| **Distributed** | Queue Engine | Regional queue management and data aggregation. |
| **National** | Directories | Adherence to FHIR standards and provider directories. |

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# 7.0 Disease Severity Classification

The system utilizes a three-tier automated triage mechanism:

1. **Very Serious (Highest Priority):** Life-threatening conditions (e.g., Chest pain, severe trauma, stroke symptoms).
2. **Medium (Moderate Priority):** Significant but stable conditions (e.g., High fever, fractures, acute infections).
3. **Daily Check (Standard Priority):** Routine or minor conditions (e.g., Follow-ups, medication refills, mild colds).

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# 8.0 Algorithm and Data Structures

1. **Priority Queue:** A data structure where patients are processed based on severity classification rather than just arrival time.
2. **Dynamic Reordering:** High-priority patients are automatically inserted ahead of lower-priority categories.

3. **Ageing Technique:** To prevent "starvation" of low-priority patients, the system gradually increases the priority of patients waiting over a certain threshold to ensure they are eventually seen.

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# 9.0 Key Features of the Application

- **Online Appointment Booking:** Mobile-first interface for self-assessment and booking.
- **Real-Time Queue Status:** Live updates on position and estimated wait time to reduce anxiety.
- **Emergency Override:** Manual override capability for clinical staff to bypass automation for unforeseen crises.
- **Doctor Dashboard:** Color-coded schedules for quick clinical assessment.
- **Admin Control Panel:** Analytics for departmental demand and flow optimization.

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# 10.0 Innovations

- **Dynamic Prioritization:** Replaces static FIFO with clinical-need-based hierarchy.
- **Smart Triage:** Digital "front door" that standardizes initial assessments.
- **Proactive Alerts:** Automated notifications to manage patient arrival and reduce waiting room crowding.
- **Integration:** Full compatibility with the ABHA ecosystem for zero-error data retrieval.

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# 11.0 Usability and User Experience (UX) Design

- **Simple UI:** Designed for low digital literacy using universal icons.
- **Multi-Language:** Support for major Indian languages to ensure equitable access.
- **Visual Cues:** Red/Yellow/Green color-coding for severity on staff dashboards.

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# 12.0 Technology Stack

- **Interoperability:** HL7 FHIR (National Standard).
- **Backend:** Java (HAPI FHIR) or .NET (Firely).
- **Frontend:** JavaScript (FHIR.js) for responsive mobile/web.
- **Real-Time:** MQTT Protocol for low-latency notifications.
- **Security:** AES-256 Encryption, JWT Validation (ABDM Certification standards).

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# 13.0 Use Case Scenarios

- **Emergency:** A trauma patient is manually elevated to "Very Serious," instantly notifying the cardiac/trauma team.
- **OPD:** A patient with high fever monitors their live queue position from home, arriving only when their turn is near.

- **Routine:** An elderly patient for a refill is placed in "Daily Check," but the "ageing" algorithm ensures they are seen after a fair wait despite newer arrivals.

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# 14.0 Expected Outcomes and Impact

- **Waiting Time Reduction:** Substantial reduction for high-acuity patients.
- **Satisfaction:** Increased transparency leads to a perceived sense of fairness.
- **Efficiency:** Data-driven staff allocation based on real-time departmental load.

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# 15.0 Conclusion and Future Scope

This paper proposes a shift from chronological to clinical queue management. By aligning with India's NDHB, this system addresses overcrowding and service delays.

**Future Scope:**

- **AI Symptom Detection:** Enhancing accuracy of the digital triage.
- **IoMT Integration:** Using wearable data (heart rate/glucose) to automatically trigger priority updates.
- **National Scaling:** Inter-hospital load balancing during pandemics or emergencies.