The European Journal of Biomedical and Life Sciences 2026, No 1
ISSN 2310-5674

PREMIER Publishing
ppublishing.org

Section 2. Life Sciences

DOI:10.29013/EJBLS-26-1-11-14

PATIENT ROUTING SYSTEM AS A TOOL FOR MANAGING HOSPITAL RESILIENCE DURING THE COVID-19 PANDEMIC

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Cite: *Khusanov A.M., Alimova H.P. (2026). Patient Routing System as a Tool For Managing Hospital Resilience During the Covid-19 Pandemic. The European Journal of Biomedical and Life Sciences 2026, No 1* https://doi.org/10.29013/EJBLS-26-1-11-14

Abstract

During the COVID-19 pandemic, patient routing became a key mechanism for maintaining hospital resilience. This study evaluated a multi-level dynamic routing model implemented at the Republican Specialized Hospital "Zangiota No. 1" for managing hospitalization flows. A retrospective–prospective analysis of admission and discharge data (2020–2025) assessed disease severity distribution, ICU transfer rates, and bed management efficiency. Formalized admission criteria, multi-stage triage, and regular clinical reassessment reduced inappropriate hospitalizations, optimized resource use, and improved timely access to intensive care. Predictive flow management helped prevent critical overload during peak epidemiological periods. The model demonstrated high adaptability, controllability, and scalability, supporting its use as an effective crisis-management tool and a foundation for sustainable multidisciplinary hospital operations.

Keywords: *patient routing, hospital resilience, flow management, COVID-19, organizational management, crisis response*

Introduction

The COVID-19 pandemic exposed structural limitations in healthcare systems and emphasized the need for adaptive organizational mechanisms to maintain hospital resilience under surge conditions (Zhong L., Pei S., et al., 2024). Patient routing became a key crisis-management tool, enabling optimization of hospitalization flows, resource redistribution, and reduction of institutional overload, replacing traditional linear referral models with flexible, multi-level flow management systems (Litvak E., Keshavjee S., et al., 2021). Evidence indicates that effective routing improves resilience through better coordination, optimized admissions, and more efficient resource use (Adelaja I., Sayma M., et al., 2020). Digital routing tools and flexible planning approaches further supported rapid decision-making during epidemiological surges (Carrié A., Penmasta V., et al., 2024). However, large-scale

implementation remains limited by infrastructural disparities, variable digitalization, and inconsistent triage standards, highlighting the need to integrate routing systems into unified organizational management frameworks (Knight E., 2021).

Materials and Methods

This retrospective–prospective analytical study at RSH "Zangiota No. 1" (Tashkent, Uzbekistan) evaluated the patient routing system implemented during the COVID-19 pandemic (2020–2025). The analysis included admission and discharge data, bed capacity dynamics, disease severity, hospitalization flows, and ICU transfer rates, assessed annually to identify epidemiological peaks and workload. The methodology combined organizational and clinical-statistical analysis with comparative evaluation of routing effectiveness, including admission criteria, multi-stage triage, intra-hospital redistribution, and de-escalation mechanisms. Key outcomes were bed management efficiency, timeliness of ICU transfer, and admission-to-discharge balance as indicators of institutional stability.

Results

At the RSH "Zangiota-1," patient routing was organized as a continuous and controlled process covering pre-hospital triage, admission, intra-hospital distribution, and subsequent de-escalation of care, consistent with contemporary hospital flow management concepts. A key managerial decision was strengthening the pre-hospital stage as a filtering mechanism to reduce inappropriate admissions and prevent hospital overload. Hospitalization was based on clearly defined organizational and clinical criteria considering disease severity, required level of care, and treatment priority. These criteria enabled rational patient routing, reduced pressure on the admission department and ICU, and improved bed management efficiency during peak epidemiological periods (Table 1).

Table 1. *Organizational Criteria for Patient Admission at the RSH"Zangiota-1" During the Pandemic*

Admission criterion	Severity level	Admission profile	Priority
Confirmed COVID-19-associated pneumonia without respiratory failure	Moderate	Infectious (therapeutic) ward	Planned
Pneumonia with progressive hypoxemia requiring oxygen support	Severe	Therapy unit with possible ICU transfer	High
Acute respiratory failure with hemodynamic instability	Critical	ICU	Emergency
Pneumonia in patients with impaired immune status (oncologic/hematologic disease, immunosuppression, HIV, etc.)	Moderate	Therapy / ICU	High
Pneumonia associated with hematologic pathology	Severe	Therapy with enhanced monitoring / ICU	High
Pregnant women with COVID-19-associated pneumonia	Moderate	Maternity complex ("Zangiota-1")	High
Acute kidney injury or decompensated CKD requiring renal replacement therapy	Severe	Hemodialysis unit / ICU	Emergency
Patients requiring emergency surgery with concurrent COVID-19	Severe / Critical	Surgical unit with ICU support	Emergency
Combined infectious and somatic pathology with high risk of deterioration	Moderate	Specialized ward with possible ICU transfer	High

Unlike traditional inpatient models, intra-hospital routing at "Zangiota-1" was dynamic, with patients managed as a continuously reassessed flow according to clinical evolution and current bed occupancy. The transition toward a 1,000-bed multidisciplinary republican center required integrated evaluation of manageability, development stages, and potential risks. Key challenges included staffing shortages, workforce burnout, dependence on stable infrastructure and resource supply, epidemiological uncertainty, and increased logistical complexity. However, centralized governance, modular bed structure, resource reserve systems, and prior crisis-management experience allowed these risks to be considered controllable. The transformation project was designed as a phased process, beginning with deployment of core specialized departments and workforce stabilization (Table 2).

Table 2. *Key Transformation Risks and Mitigation Strategies*

Risk group	Risk description	Mitigation mechanism
Human resources	Staff shortage, professional burnout	Rotation, training, staff reserve
Resource-related	Dependence on oxygen, energy, and medications	Backup capacity, centralized reserves
Epidemiological	Re-emergence of infectious threats	Modular re-profiling, dedicated infection units
Managerial	Scaling up to 1,000 beds	Centralized governance, digital monitoring

The mid-term phase is focused on expansion of high-technology services, development of dialysis and intensive care capacity, and implementation of digital tools for monitoring bed utilization and resource allocation.

Table 3. *Expected Social and Medical Outcomes*

Domain	Expected effect
Access to care	Reduction in inter-hospital transfers
Clinical outcomes	Decreased mortality and disability
Public health	Improved quality and continuity of care
Healthcare system	Development of a sustainable response model

The social and medical impact of the transformation is expected to include improved access to specialized care, reduced mortality and disability, fewer inter-hospital transfers, and strengthening of public health outcomes (Table 3).

Discussion

The data obtained confirm that patient routing systems and predictive capacity management tools play a central role in maintaining hospital resilience during epidemiological crises (Parker F., Ganjkhanloo F., et al., 2024). International experience demonstrates that mixed-integer linear programming approaches improve bed allocation and patient flow optimization, reducing the need for reserve capacity and enhancing resource efficiency (Karakra A., Lamine E., et al., 2020). Decision-support dashboards integrating real-time data with predictive analytics enable rapid managerial adjustments, increase process transparency, and support timely resource redistribution without compromising quality of care (Shi P., 2022). Further development is associated with digital twin technologies that allow real-time monitoring of patient pathways and departmental workload, strengthening operational stability under uncertainty (Parker F., Mart'inez D. A., et al., 2024). Hybrid simulation models for forecasting COVID-19 cases and optimizing bed capacity have shown significant potential in reducing mortality and preventing hospital overload (Lu Y., Guan Y., et al., 2021).

Conclusion

Implementation of a multi-level dynamic patient routing system at the Republican Specialized Hospital "Zangiota No. 1" demonstrated high organizational effectiveness during the COVID-19 pandemic. Formalized admission criteria strengthened pre-hospital triage, multi-stage sorting, and regular clinical reassessment improved bed utilization, reduced ICU overload, and minimized delays in specialized care. A systems-based approach to hospitalization flow management proved essential for maintaining hospital resilience during peak epidemiological periods.

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submitted 06.03.2026;
accepted for publication 20.03.2026;
published 31.03.2026

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