SYNOPSIS

KEY POINT SUMMARY

OBJECTIVES

The study investigates the capabilities of four typical spatial layouts in existing hospitals to determine the potential for each to respond effectively to emergency scenarios.

Responsiveness and adaptability of healthcare facilities in emergency scenarios: COVID-19 experience

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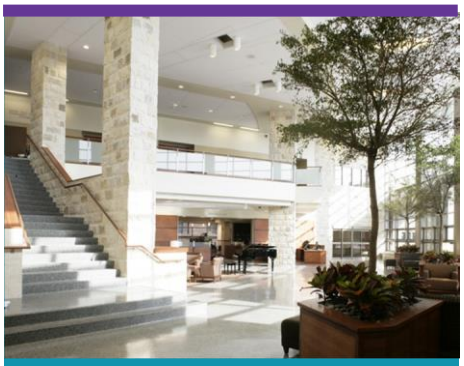
Key Concepts/Context

COVID-19 exposed shortcomings in hospitals' abilities to accommodate emergency scenarios with efficiency and preparedness. Prior research evaluates strategies for resilient hospitals, such as the use of architectural methods to reduce bacterial infection. The authors of this study reveal the significance of design in emergency response outcomes by comparing the operation of different hospital layouts under normal versus various emergency circumstances.

Methods

The authors examine the flexibility of existing hospital layouts, identifying models with the greatest potential to adapt, convert, and re-scale during a medical emergency. The hospital layouts analyzed in the study include comparable hospital examples in Krakow, Poland, which were selected by the Polish Ministry of Health in 2020 to handle the COVID outbreak. The study was performed with the general adaptability assessment tool (GAAT). GAAT was employed by the authors to assess parameters pertaining to the Evidence-Based Design (EBD) approach and the Design-for-all approach. The Design-for-all approach considers the user experience to be an important qualitative factor in a research study. In this context, EBD and Design-for-all relied on the perceptions of providers and patients within their environments. The efficiency of four existing hospital layouts was rated in relation to nine parameters, in three different scenarios: an everyday situation, an emergency situation requiring the separation of patient groups (due to infection transmission), and an emergency scenario that required a large surge of patients to be admitted rapidly (due to a medical emergency or a terrorist attack). The four spatial layouts included hospital prototypes: (1) the cluster/campus layout, (2) the comb/finger plan layout, (3) the tower-on-a-podium layout, and (4) the atrial layout. These layouts are defined in part by their circulation and their relationships with their larger environments. The cluster layout is characterized by separated units,



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while the comb layout links each ward to a shared street. The tower-on-a-podium layout features a vertical core, and the atrial layout often includes multiple internal courtyards. The nine parameters in the GAAT include (1) flow of patients, (2) flow of personnel, (3) flow of resources, (4) flow of air, (5) modifiability, (6) convertibility, (7) scalability, (8) comfort, and (9) view & surroundings. A 3-point scale was used by the authors to rate each layout for the purpose of achieving a general rather than detailed comparison. Values were given to each level of effectiveness (as performance relating to efficiency, flexibility, safety): effective (1), non-effective (1), and anti-effective (-1), where the anti-effective value (-1) represents a condition of active risk. The study referenced existing procedures, precedents in Polish hospital design prior to COVID-19, and the authors' own research.

Findings

In the everyday operation scenario, the tower-on-a-podium layout has the highest potential for effectiveness (as performance relating to efficiency, flexibility, safety), while the cluster/campus layout has the lowest potential for effectiveness. The centralized circulation shafts, airflow capabilities, and viewing conditions in the vertical structure of the tower-on-a-podium layout provide efficient flow of resources, passage, and natural lighting. The decentralized circulation paths and need for multiple entrances and support facilities in the cluster/campus layout decrease the capacity for efficiency in this scenario.

In the emergency scenario that requires the separation of patient groups, the cluster/campus layout is ideal. The quarantining capabilities inherent in the separated blocks design allow for emergency function to be separated from the maintenance of everyday operation. The open spaces between blocks yield options for temporary support modules. The tower-on-a-podium layout is the least efficient model in this scenario. The centralized circulation and airflow shafts act as routes for infection transmission. While the comb layout allows for the separation of wards, the connecting core is a potential transmission thoroughfare. The crossing movements of the patients and personnel in the contained inner courtyard of the atrial layout increase the chances of contamination.

In the emergency scenario that requires a large surge of patients to be admitted rapidly, the cluster/campus and comb layouts afford the highest efficiency. The replicated support facilities and decentralized layouts of each offer adaptability to triage conditions and proximity to separated specialist units.

The GAAT (general adaptability assessment tool) used in this study may be applied to the evaluation of healthcare institutions and can determine whether an existing facility must be remodeled, expanded, or closed, in order to meet the determined standards of functionality in an emergency scenario.

Limitations

Within the nine parameters in the GAAT, versatility is considered a category of adaptability. Versatility is evaluated in the context of a specific facility, and so it could not be included in this study that was an analysis of general layout typologies. It would be helpful to bring attention to the possibility of a specific facility to be anomalously effective (as performance relating to efficiency, flexibility, safety) due to its versatility, whose layout may have been determined to be ineffective in the general study. The authors do not explore possibilities for initial expansion measures in tower-on-a-podium layout (one of the most prevalent models) when determining the layout's feasibility for emergency scenarios.

Design Implications

The cluster/campus layout was deemed the most resilient system during an emergency scenario. The authors propose to optimize this layout with the inclusion of isolation wards, a detached ED facility that fluctuates between regular and epidemic use, emergency circulation paths, and the utilization of open areas in cooperation with temporary structures. New models can be assessed with the GAAT evaluation to advance solutions essential to the adaptation of new threats. Among these solutions are hybrid ventilation systems, multiple entrances, and touchless fixtures.

And Also...

Readers will find the diagrams helpful in visualizing the four hospital layouts. These diagrams show a simplified representation of each system, including an outline of the minimum area that must be dedicated to the infectious disease section.