Analysis on the Utilization Rate of Hospital Resources

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Abstract. In the current social environment where the population is increasing and the aging of the population is intensifying, and against the backdrop of continuously growing medical demands and relatively limited medical resources. In some hospitals, medical resources still exhibit inappropriate medical resource utilization behaviors. Such behaviors not only lead to the waste of medical resources but also cause medical staff to be overworked, which in turn reduces patient satisfaction and may even result in conflicts between doctors and patients. Improving the utilization rate of hospital resources is not only a way to enhance the efficiency of medical services, but also a means to ensure the quality of patients' medical care and mitigate doctor-patient conflicts. This study analyzed the impact of Bed utilization rate: Equipment utilization rate; Human resource utilization rate; Turnover rate of drugs and consumables; and Turnover rate of outpatients and inpatients on hospital resource utilization rate. And corresponding suggestions were also put forward for relevant aspects.

Keywords: Hospital Resources, Bed utilization rate, Equipment utilization rate, Human resource utilization rate, Turnover rate of drugs and consumables.

1. Introduction

At present, population growth and the intensification of aging are reshaping the supply and demand pattern of medical services. Data shows that the proportion of people aged 60 and above in China has been increasing year by year, and the medical needs of the elderly group are significantly higher than those of the middle-aged and young groups. Paradoxically, the supply of medical resources is relatively limited - hospital beds, high-end equipment configuration and the training of professional medical staff are all difficult to meet the urgent medical needs of the people. Against this backdrop, enhancing the utilization rate of hospital resources has become the core for improving the efficiency of medical services, ensuring the quality of patients' medical treatment, and alleviating doctor-patient conflicts.

The utilization efficiency of core resources in hospitals directly affects the operational quality of the medical system. As a basic resource, the turnover efficiency of beds determines the waiting time for patients to be admitted to the hospital. Large-scale imaging equipment such as computed tomography (CT) and magnetic resonance imaging (MRI) has problems of short average daily operating times and high idle rates in some hospitals, while in others, excessive use leads to frequent malfunctions and a sharp increase in maintenance costs. The scheduling of medical staff is more complex: Unreasonable scheduling may cause some departments to be overworked while others have idle manpower, which not only reduces service quality but also sown the seeds of doctor-patient conflicts.

The problem of uneven distribution of medical resources is widespread, with the gap between urban and rural areas being particularly prominent. High-quality equipment and professional medical staff are mostly concentrated in large urban hospitals, while primary medical institutions are confronted with the predicament of outdated equipment and insufficient personnel. This has led to many patients flocking to urban hospitals, further intensifying the resource shortage in large hospitals. Even within the same hospital, the allocation of resources among different departments is often unbalanced, which not only leads to waste of resources but also results in insufficient communication time for diagnosis and treatment due to the overwork of medical staff. Eventually, this reduces service quality and patient satisfaction and increases the incidence of doctor-patient conflicts.

It is of great significance to study the utilization rate of hospital resources. From an operational perspective, optimizing bed turnover, equipment utilization and human resource arrangement can significantly reduce hospital operating costs and enhance efficiency. From the perspective of service quality, the rational allocation of resources can shorten the waiting time for patients to seek medical treatment and improve their medical experience. For medical staff, scientific shift scheduling can relieve work pressure and reduce the rate of diagnosis and treatment errors.

With the development of internet of things (IOT) and artificial intelligence (AI) technologies, dynamic monitoring and precise management of hospital resources have become possible. Relying on these advanced technologies, this study constructs a quantitative analysis model to accurately measure key indicators such as bed utilization rate, equipment utilization rate, and the work efficiency of medical staff, deeply analyzes the factors influencing resource utilization rate, and proposes targeted improvement plans. Through this research, it is expected to provide a scientific and systematic solution for hospital resource management, promote the refinement and intelligence of medical resource management, and ultimately achieve the goals of improving medical service efficiency, reducing operating costs, enhancing service quality, alleviating doctor-patient conflicts, and promoting the healthy development of the medical system.

2. Related work

2.1. Bed utilization rate

Bed management is an effective method for large hospitals to improve their accommodation efficiency and is also an important indicator reflecting the quality of hospital work and management benefits [1]. Bed utilization rate is a core indicator for measuring the available bed capacity of a hospital. Specifically, it refers to the percentage of beds occupied by patients to the total available beds of the hospital within a specific time [2].

In previous studies, the bed utilization rate was mainly inquired through the following methods. First, refer to the hospital's statistical annual report. The hospital compiles a statistical annual report every year, which includes key data such as the bed utilization rate. These statistical annual reports are usually distributed to the hospital's internal management personnel and relevant government departments and are archived in the hospital's archives room for subsequent inquiries and references by the hospital. Second, review the hospital's manual ledgers and reports. Each department of the hospital will have dedicated personnel responsible for recording the daily bed usage, including the patient's admission time, discharge time, bed number and other information. Through these manually recorded data, the bed utilization rate can be regularly summarized and calculated. Third, check the bed usage report of the hospital's statistics department. Based on the data reported by each department, the hospital's statistics department will compile a report on the usage of hospital beds for the hospital's management to understand the status of bed usage.

2.2. Equipment utilization rate

Regarding equipment utilization, hospitals usually have dedicated personnel or specialized departments in charge. For equipment with a fixed hourly output or an easy-to-calculate output, analyze based on the production report and calculate through formula (1).

$$A = B/C \times 100\% \tag{1}$$

In formula (1), A represents equipment utilization rate, B represents actual output per hour, and C represents theoretical output per hour.

For cases where the output is variable or the equipment is small, formula (2) is adopted.

$$A = D/E \times 100\% \tag{2}$$

In formula (2), D represents the actual power-on time for each shift, and E represents the power-on time for each shift or formula (3) for statistics.

$$A = F/G \tag{3}$$

In formula (3), F represents the number of units turned on at a certain sampling moment, and G represents the total number of devices [3].

The hospital will also assign dedicated personnel to collect and organize the working hours data of its employees. Calculate the utilization rate of human resources according to formula (4).

$$H = (I/K) \times 100\% \tag{4}$$

In formula (4), H represents the utilization rate of human resources, I represent the actual working hours of employees, and K represents the available working hours.

In addition, for some work that is charged by project, the billable working hours of employees are counted and calculated through formula (5).

$$H = (M/N) \times 100\% \tag{5}$$

In formula (5), M represents the billable working hours, and N represents the total working hours.

Hospitals usually also regularly prepare reports on human resources. People can obtain relevant information about human resources by consulting these reports. In addition, the archives management department of an enterprise may also keep employees' work records, performance appraisal records, etc. By reviewing these archives, it is possible to understand the work situation of employees and thereby estimate the utilization rate of human resources.

2.3. The turnover rate of drugs and consumables

In terms of the turnover rate of drugs and consumables, the financial statements of enterprises play a significant role. For instance, the annual and quarterly reports of enterprises usually include relevant data on drugs and consumables. The turnover rate of drugs and consumables can be calculated through the inventory items in the balance sheet and the cost of sales in the income statement. Inventory ledgers record detailed information such as the entry, exit, and inventory levels of drugs and consumables. Through these data, the average inventory level can be calculated, thereby providing a basis for the calculation of turnover rate.

In addition, by analyzing the sales records of drugs and consumables, one can understand their sales speed and volume, and then calculate the turnover rate. Some hospitals may be equipped with logistics management software. By using data such as the total amount of drugs and consumables dispatched, the average initial inventory amount, and the ending inventory amount stored in the software database, the turnover rate of drugs and consumables can be calculated. The turnover rate can be calculated according to the following formula (6).

$$O = P/Q \tag{6}$$

In formula (6), O represents the turnover rate of drugs and consumables, P represents the initial inventory, and Q represents the average sales volume [4].

2.4. Turnover rate of outpatients and inpatients

In terms of the turnover rate of outpatients and inpatients, by using the internal statistical reports regularly compiled by the hospital, one can find information such as the number of outpatients visiting, the number of inpatients discharged, and the usage of hospital beds. Through these data, the turnover rate of outpatients and inpatients can be calculated.

The outpatient patient turnover rate can be calculated by formula (7).

$$X = Y/Z \tag{7}$$

In formula (7), X represents the patient turnover rate, Y represents the number of inpatients and discharges, and Z represents the average number of open beds.

Of course, these key indicators will also be included in the hospital's annual report for internal management and review and reference by higher authorities. The medical record room of a hospital

also keeps detailed information such as the patient's inpatient medical records. By reviewing the patient's medical records, information such as the patient's admission time and discharge time can be obtained, thereby accurately counting the number of discharged patients and further calculating the turnover rate of inpatients. For outpatients, the registration records in the medical record room can also be used to count the number of visits within a certain period, providing data support for calculating the turnover rate of outpatients. In addition, each department will assign a dedicated person to record the daily number of outpatients and the admission and discharge of inpatients. For instance, before leaving work every day, nurses will count the number of discharged patients and the number of beds occupied in their department for the day. At the end of the month, a summary will be made. Then, through manual recording and regular summary, the turnover rate of outpatients and inpatients for the current month can be calculated.

3. Existing problems

The various measurement indicators for the utilization rate of medical resources have significant differences in limitations and application scenarios. The specific analysis is as follows.

3.1. Bed utilization rate

The bed utilization rate indicator focuses on the saturation degree of bed resources. However, there are two significant limitations: First, it cannot reflect the quality of effective utilization of beds. High usage rates can mask some problems. For instance, some hospitals, in pursuit of high utilization rates, admit many patients with mild symptoms, or falsely claim high utilization rates due to patients' long postoperative recovery periods and their inability to leave the hospital, which in turn reduces their capacity to admit critically ill patients. Secondly, the differences among departments were not considered. There are essential differences in the demand for beds among different departments. If a uniform standard for the number of beds is implemented throughout the hospital, it is likely to lead to an unbalanced situation where beds in some departments are idle while those in others are extremely tight. Despite the continuous expansion of hospital beds, the supply of beds has always been unable to keep up with the growing medical demands, resulting in many hospitals still generally facing the problem of bed shortage [5].

From the perspective of application scenarios, this indicator is mainly used for the overall planning of hospital bed resources and the allocation of beds among departments. It is suitable for medical institutions with beds as the core resource, such as general hospitals or specialized hospitals, especially for the assessment of beds in the inpatient department as a whole or in individual departments.

3.2. Equipment utilization rate

The equipment utilization rate indicator focuses on the degree to which equipment's production capacity is fully utilized. The limitation of this indicator lies in the calculation of "startup time" in formula (2), which includes a large amount of invalid startup time. For instance, if a CT machine has been turned on but is in an idle state waiting for patients, it will lead to an inflated equipment utilization rate calculated and fail to accurately reflect the actual utilization of the equipment.

From the perspective of application scenarios, the application scenarios of this indicator are the management of medical equipment in hospitals and the assessment of investment returns on medical equipment. For instance, calculate whether the "effective usage time" of a certain device meets the standard, and thereby determine whether the equipment purchase is reasonable. Its applicable objects are equipment with clear usage time requirements, such as imaging equipment and testing equipment in hospitals.

3.3. Human resource utilization rate

The human resource utilization rate indicator focuses on the efficiency of human time utilization. The limitations of this indicator are in four aspects: First, it is easy to confuse time input with work output. High utilization rate does not necessarily mean high output - there may be a phenomenon of procrastination in work, or excessive overtime leading to a decline in efficiency (for example, doctors' consultation speed slows down after consecutive shifts), which instead reduces the quality of medical services. Second, the impact of job differences on the definition of effective time was not considered. For instance, the effective time that clinicians consider to be the visiting time, but in formula (4), the actual working time will include non-effective times such as administrative meetings and training, resulting in the indicator failing to reflect the true utilization rate of human resources. Thirdly, it is prone to the risk of excessive exploitation of medical staff. For instance, increasing the on-duty hours of medical staff to enhance their utilization rate will lead to their fatigue. If this continues for a long time, it will not only undermine the stability of the team but also increase the conflicts between doctors and patients. The fourth issue is the lack of performance assessment and salary incentives. In some hospitals, salary incentives are relatively few. This makes it difficult to form effective incentives, which will cause positive employees to develop a negative work attitude and thereby affect work efficiency [5]. Also, due to the different certifications and characteristics of hospitals, people usually go to higher-level hospitals or specialized hospitals whenever they feel unwell [7]. Few people go to the community hospital. This will also increase the workload of medical staff in large hospitals.

From the perspective of application scenarios, this indicator is mainly used for optimizing the human resource scheduling of hospital departments (such as adjusting the duty roster based on the utilization rate of nurses), as well as internal conflicts and efficiency declines caused by overwork of some staff and idleness of others. Meanwhile, the efficiency of hospital staff is also used to determine whether the labor cost is reasonable, thereby controlling the hospital's labor cost and reducing the expenditure on idle labor.

3.4. Turnover rate of drugs and consumables

Medicines are special commodities with an expiration period. The conditions for their storage and preservation are relatively high. The more days of inventory turnover there are, the more likely it is for medicines to become ineffective, resulting in economic losses. As a result, it has become a crucial indicator of capital turnover rate in hospital operations. The procurement plan for drugs is easily influenced by multiple factors [8].

The indicator of the turnover rate of drugs and consumables focuses on the efficiency of inventory turnover. The limitation of this indicator lies in the fact that a high turnover rate may be accompanied by the risk of supply disruption. Some hospitals, in pursuit of a high turnover rate of drugs, may reduce the reserves of certain drugs. In the event of sudden demand, which leads to a sharp increase in the demand for drugs, it is easy to cause supply disruptions or even medical accidents, affecting normal diagnosis and treatment. Conversely, a low turnover rate is not necessarily a management issue. For instance, when hospitals stockpile drugs for treating rare diseases, even if the turnover is slow, they must ensure an adequate inventory to guarantee that patients' medication needs are met.

From the perspective of application scenarios, this indicator is mainly used for the management of hospital pharmacies and consumables warehouses. It can prevent overstocking or supply disruptions, reduce the loss of expired drugs, and assess whether the supply chain can match the hospital's consumables and drug consumption demands. Its application scope covers high-frequency consumption of medicines and consumables with clear expiration dates. Such as infusion sets, syringes or commonly used medicines, etc.

3.5. Outpatient and inpatient turnover rate

The outpatient and inpatient turnover rate indicators focus on the efficiency of patient turnover. This indicator has three limitations: First, it is prone to neglect the quality of diagnosis and treatment. Some hospitals, to increase the turnover rate of outpatient services, reduce the time doctors spend on

each consultation, which leads to an increased risk of misdiagnosis and missed diagnosis, a decline in patient satisfaction, and further intensifies the conflicts between doctors and patients. The second is that the differences in the severity of patients' conditions were not considered. In the same department, the hospitalization period for critically ill patients is naturally longer than that for those with mild symptoms. If a uniform turnover rate is used for calculation, it may induce departments to refuse to admit critically ill patients, which goes against the core tenet of the medical industry. Thirdly, it is vulnerable to interference from external factors. For instance, some patients are discharged from the hospital earlier due to medical insurance policies or personal reasons. This leads to the indicators being unable to fully, comprehensively and accurately reflect the true service capabilities of the hospital itself.

From the perspective of application scenarios, this indicator is mainly used to optimize the outpatient process in hospitals, such as alleviating the pressure on large hospital outpatient departments and reducing the situation where patients register for the wrong outpatient department, or for bed scheduling in inpatient departments to reduce patients' excessively long waiting times and long-term bed occupation. This indicator is applicable to the outpatient and inpatient departments of general hospitals and specialized hospitals, especially to hospitals with a large flow of patients, such as tertiary hospitals or key hospitals in big cities.

4. Suggestion

4.1. Bed utilization rate

In terms of bed utilization rate, the two core issues existing in the bed utilization rate indicator, namely the inability to reflect the quality of effective utilization and the failure to consider the differences among departments, can be addressed from dimensions such as optimizing the indicator system and refining management strategies. And put forward specific solutions and suggestions.

In addressing the issue of the inability to reflect the quality of effective bed utilization, the suggestion of this article is to add quality indicators based on the bed utilization rate index, shifting from quantity to quantity plus quality, to avoid the waste of resources caused by false high utilization rates.

In terms of establishing an assessment of both quantity and quality, it no longer solely relies on the number of beds but combines other indicators for evaluation to reflect utilization efficiency and quality. The effective utilization rate of beds will exclude the utilization rate after invalid beds are occupied. Among them, ineffective bed occupancy days include patients staying in the ward for too long after the postoperative recovery period and not being discharged, patients with minor injuries occupying the bed for too long, etc. This indicator will enhance the authenticity and reliability of the usage rate. If the high usage rate of a certain department is accompanied by a proportion of minor injuries exceeding 60%, it will be determined as low-quality occupation, and the department needs to adjust the standards for admission and treatment. If the bed utilization rate is high, but the average length of hospital stay far exceeds the industry standard, and the cure rate and improvement rate are relatively low, this indicates that there are problems of bed overcrowding and low treatment efficiency in this department. The treatment process needs to be optimized.

In addressing the imbalance of resources caused by not considering the differences among departments, the suggestion of this article is to break the standard of uniform beds throughout the hospital, and each department should conduct dynamic management of beds on its own to avoid the average distribution of beds throughout the hospital. The number of beds should be flexibly adjusted according to the different medical needs and patient flow of each department.

Establish a management method for mobile beds. Based on the assessment results of medical data each quarter, the department calculates the reasonable range for bed opening, increases or decreases the number of beds for each sub-specialty group, and reserves 10 to 20 mobile beds, which are uniformly managed by the department. And formulate a management system for mobile beds [1].

In addition, technical tools can be utilized to enhance management efficiency. For instance, an intelligent bed management system can be employed, which can automatically calculate indicators such as the effective utilization rate of beds and the matching degree of disease structure, providing data support for dynamic adjustments. In addition, isolation wards should be set up in infectious departments to reduce the spread of the virus within the hospital [9].

4.2. Equipment utilization rate

In terms of equipment utilization rate, to address the issue of inflated data due to the inclusion of invalid startup times in the equipment utilization rate indicator, we need to make improvements in multiple aspects and accurately distinguish between effective and invalid boot-ups to ensure that the indicator can reflect a more accurate equipment utilization rate.

This study suggests clarifying the definitions and standards of effective usage time and ineffective startup time. Take CT machines and other imaging equipment as examples. The effective usage time refers to the period when the equipment is performing diagnostic and therapeutic tasks, which includes the entire process from operation preparation, core testing to result processing. Invalid startup time refers to the period when the equipment has been powered on and started up but has not yet performed diagnostic and therapeutic tasks. It also includes non-diagnostic and therapeutic time, as well as the time used for equipment maintenance, calibration, component replacement, etc., to ensure the normal operation of the equipment. In addition, the standards used for the same equipment in different departments may not be the same, and the determined standards should also be adjusted according to the differences among departments [3].

Based on the above content, it is suggested that the startup time in formula (2) be changed to the actual available time, and at the same time, the effective usage time should be taken as the core component to ensure the authenticity of the indicators. After modifying formula (2), some specific operations need to be carried out to ensure that the effective usage time can be accurately counted, while reducing the ineffective startup time and improving the equipment utilization efficiency from the source. By leveraging technical tools to achieve automatic time statistics, omissions and errors caused by human mistakes can be avoided. Relying on the linkage between the equipment system and the hospital information platform, automatic data capture is achieved. The device has added an operation log function to mark invalid startup times. This way, problems can be identified from the data and the time of invalid boot-up can be reduced.

4.3. Human resource utilization rate

In terms of the utilization rate of human resources, in response to the problems existing in the human resource utilization rate indicators such as confusing time with output, ignoring job differences, and over-exploiting medical staff, some suggestions can be put forward from aspects such as process optimization and mechanism guarantee.

The shift schedule can be adjusted according to different positions. For instance, due to factors such as the high frequency of childcare, difficult communication, and inconvenient care, the work efficiency and complexity of pediatric nurses within a unit of time are higher than those of ordinary internal medicine nurses. Therefore, the working hours of pediatric nurses can be appropriately reduced to avoid excessive fatigue caused by the same working hours.

In addressing the issue of excessive exploitation of medical staff, this article suggests setting a red line for human resource utilization and restricting excessive overtime. In accordance with the "Labor Law of the People's Republic of China" and medical industry norms, a uniform upper limit for the utilization rate of human resources throughout the hospital is clearly defined: for instance, the cumulative working hours of clinical doctors in a single week should be no more than 60 hours, and the working hours of nurses in a single shift should be no more than 10 hours, with a continuous on-duty interval of no less than 12 hours. This will further reduce the phenomenon of medical staff working too long hours.

4.4. Turnover rate of drugs and consumables

In terms of the turnover rate of drugs and consumables, based on the two issues of "high turnover rate is accompanied by the risk of supply disruption" and "low turnover rate is not necessarily a management problem", this article provides the following several solutions.

Classify according to the demand characteristics and drug attributes to avoid applying a uniform turnover rate assessment target to all drugs and consumables. Conventional high-frequency items such as infusion sets, syringes, cold and fever-reducing medicines, antihypertensive drugs, etc. These medicines and tools take "high turnover rate" as the core goal and adopt a replenishment model of "small batch and frequent". Emergency reserve types include flu-specific drugs, antibiotics, emergency consumables, and drugs related to public health emergencies. The assessment of turnover rate for these drugs and tools should be weakened, with priority given to ensuring supply stability. These drugs and tools should meet the 30-day sudden demand, and the inventory expiration dates should be regularly checked. For special demand categories (such as drugs for rare diseases, targeted drugs for tumors, and special-specification consumables), the turnover rate should not be used as an assessment indicator for these drugs and tools. There should be a dosage sufficient for one to two patients for one course of treatment, and at the same time, an emergency response mechanism for suppliers should be established to avoid a reduction in necessary reserves due to low turnover.

To achieve the informatization of pharmaceuticals and optimize the logistics system. Further optimize the drug information management system. The information-based pharmaceutical logistics system (EPS) is integrated with the hospital information system (HIS) and the pharmaceutical procurement platform and strengthens the management of drugs in the warehouse. This operation can accurately count the accumulated drugs in the drug warehouse, improve the drug turnover rate, avoid waste and reduce the occupation of hospital funds [10].

4.5. Outpatient and inpatient turnover rate

In terms of the turnover rate of outpatients and inpatients, this study provides several solutions and suggestions for the problems of neglecting the quality of diagnosis and treatment, not considering the differences in conditions, and being disturbed by external factors.

Firstly, this study takes medical quality as a prerequisite for the turnover rate. Through indicator binding and process supervision, ensure that the increase in turnover rate does not come at the expense of medical safety. Secondly, it is suggested that medical procedures be standardized to prevent hospitals from compressing treatment steps in pursuit of efficiency. Finally, it is suggested to enhance coordination with the medical insurance department to reduce the impact of policies and individual factors.

5. Summary

Today, where the population is increasing, the aging of the population is intensifying, medical demands are continuously growing and medical resources are relatively limited, improving the utilization rate of hospital resources not only helps to enhance the efficiency of medical services, but also ensures the quality of medical treatment for patients and alleviates doctor-patient conflicts. The resource utilization rate of a hospital, such as the number of hospital beds, hospital equipment, working hours of medical staff, the rationality of task arrangement and work efficiency, etc., has a direct impact on the hospital's operating costs, the time patients spend in the hospital, and the fatigue level of medical staff. These problems are widespread in all kinds of hospitals. Such behavior may lead to the waste of medical resources, overwork of medical staff, and subsequently a decline in patient satisfaction and the emergence of doctor-patient conflicts. The significance of studying the utilization rate of hospital resources lies in not only enhancing operational efficiency and improving service quality, but also alleviating the pressure on medical staff, reducing patients' visiting time, and thereby easing doctor-patient conflicts. With the development of the Internet of Things and artificial intelligence predictive models, dynamic monitoring and precise management of hospital resources

have become possible. This study aims to quantitatively analyze the utilization rate of resources, explore its influencing factors and improvement methods, provide theoretical support and improvement plans for hospital management decisions, and promote the better development of the medical system. In the future, it is suggested that more in-depth research be conducted on enhancing the work efficiency of medical staff and the utilization rate of medical equipment.

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