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ORIGINAL RESEARCH

Building a Hospital Pharmacist Workforce by a Diversified and Position-Oriented Learning System

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Background: The role of hospital pharmacists has shifted from primarily ensuring drug supply to providing comprehensive pharmaceutical care. To accommodate this shift, new positions are needed. The traditional training model for hospital pharmacists is no longer sufficient for the evolving demands of pharmaceutical care and these new roles. This study aimed to describe the development of a position-oriented learning system explicitly tailored for hospital pharmacists and to assess its impact on workforce development and pharmacy service.

Methods: The position-oriented learning system for hospital pharmacists, aimed at enhancing training and workforce development, was evaluated based on two critical criteria: the completion rate of learning modules and the subsequent improvement in pharmaceutical care at the hospital. The completion rate assessed the engagement and effectiveness of the training content. At the same time, the improvement in pharmaceutical care evaluated practical outcomes such as percentages of patients who received pharmaceutical care and percentages of inappropriate medication orders intercepted.

Results: In 2021, 218 employees participated in the learning system. The pharmacy department has identified 22 pharmacists for various positions through this system. The quantity and quality of pharmaceutical care have improved significantly.

Conclusion: The position-oriented diversified learning system achieves the perfect combination of department development direction and individual career planning of employees. The learning system can significantly improve the learning efficiency of pharmacists, enhance the quality of various pharmaceutical care, and promote the development of disciplines.

Keywords: learning system, position-oriented, clinical pharmacist, informatics pharmacist

Introduction

In recent years, hospitals have implemented policies to reform the health system and transform pharmaceutical care, notably by phasing out drug markups.[1–3] This policy shift has steered pharmaceutical care from a "drug-centered" approach to a "patient-centered" approach. As a result, the role of hospital pharmacies has transitioned from primarily providing "drug supply" to delivering "comprehensive pharmaceutical care". This new focus emphasizes professional technical services and active participation in clinical drug use.[4–6] Despite these changes, the core functions of most hospital pharmacies, including procurement, warehousing, and dispensing, remain unchanged. However, pharmacists are increasingly expected to use their expertise and skills to optimize patient health outcomes and minimize medical expenses.[4,6–8] Many medical university-affiliated hospitals also function as premier teaching institutions, there is a pressing need for highly skilled pharmaceutical professionals capable of providing value-added care.[4,9] Hospitals face significant challenges in staffing and training pharmacists to meet these evolving demands.[6,10] Therefore, exploring innovative training models for hospital pharmacists is essential for advancing and refining the pharmaceutical discipline within medical institutions.

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Traditionally, newly recruited pharmacists in China underwent initial training, consisting of brief rotations in various sectors of the Pharmacy Department, followed by regular intensive professional skills courses. With its primary focus on initial drug security tasks such as warehousing and dispensing, this training regimen often do not target detailed classification of positions, which can restrict new employees to interactions within the Pharmacy Department and limit their integration into multidisciplinary teams.[11] It therefore needed to be revised as modes of pharmaceutical care and personnel structures evolved. Managers should constantly evaluate training effectiveness and identify suitable candidates for specific roles.

In response to these limitations, some hospitals have experimented with new training models, including problem-based learning[12] and case-based learning.[13,14] However, these methods are primarily utilized by pharmaceutical students and clinical pharmacists and are tailored to address specific issues in pharmaceutical practice. Although these models offer advancements in certain areas, they still need to fully meet the comprehensive training needs of multi-specialty pharmacists.

This study aimed to describe the development of a position-oriented learning system tailored explicitly for hospital pharmacists and to assess its impact on workforce development and pharmacy service.

Ethics Approval

The data presented in this study were obtained from Pharmacy Department management monitoring, and did not involve any participant medical data or privacy. The study was pre-evaluated and considered no need for ethical review by the Ethics Committee of The Second Affiliated Hospital Zhejiang University School of Medicine (SAHZU).

Method

Setting and Creation of Pharmacist Positions

This study was conducted at The Second Affiliated Hospital Zhejiang University School of Medicine (SAHZU), a tertiary academic hospital in China with four campuses and 4154 beds, which integrates medical treatment, teaching, and research. In 2022, Pharmacy Department provided pharmaceutical care to approximately 10.27 million outpatients, 0.47 million emergency patients, and 0.29 million inpatients.

To meet the evolving demands of pharmaceutical services, the Pharmacy Department of SAHZU gradually expanded its functions to include five new positions besides dispensing pharmacists (Figure 1).

Clinical pharmacists are experts in medication therapy. They actively participate in ward rounds, offering crucial medication evaluations and recommendations to patients and healthcare professionals. Management pharmacists handle specific administrative tasks under the guidance of the Pharmacy Department's director. Their responsibilities include formulating and enforcing daily management plans, including personnel, drugs, and teaching activities. Prescription

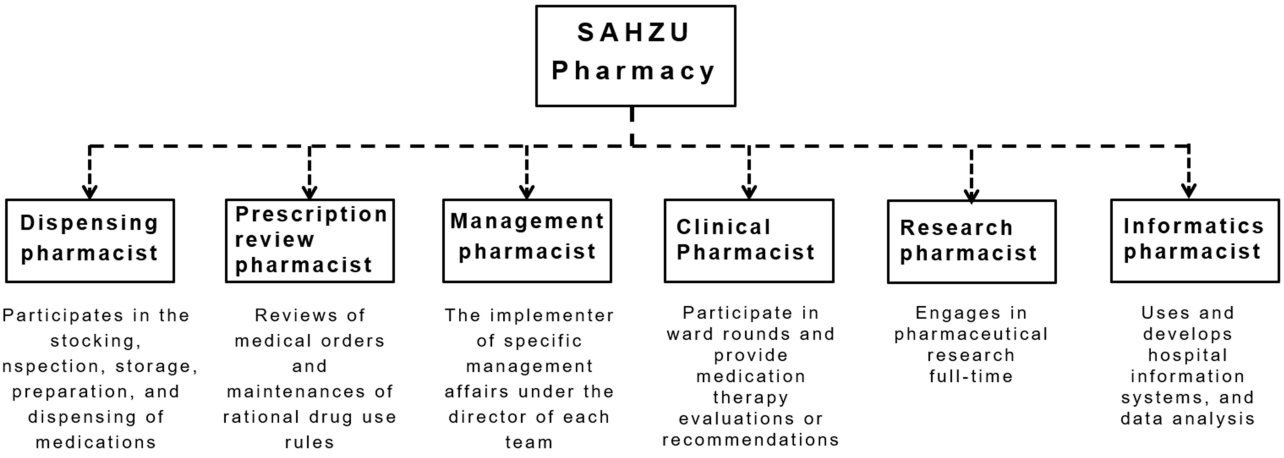

Figure 1 Pharmacist position classification and main responsibilities.
Abbreviation: SAHZU, The Second Affiliated Hospital Zhejiang University School of Medicine.

review pharmacists operate from a centralized prescription review center, where they oversee the review of medication orders across all campuses. They use the hospital information system's prescription review software to ensure adherence to its rules and regulations. The role of research pharmacists is increasingly essential, especially in large general hospitals, where the labor division is deepening. As a leading research and teaching hospital, the department has established this role to foster a robust research culture.

In response to government directives for better hospital informatization and intelligent construction,[15,16] the hospital has acknowledged the importance of informatics in healthcare.[17] Informatics pharmacists specialize in utilizing and developing hospital information systems and health-related software, aiming to optimize patient outcomes.[18] Although this role is still being standardized in Chinese hospitals and involves various responsibilities, the informatics pharmacist is pivotal in collaborating with information engineers to ensure that pharmaceutical informatics needs are effectively addressed.

The Development of a Position-Oriented Learning System

During the past years, the Pharmacy Department has gradually explored and reformed the original traditional learning mode, and by 2020, a training mode dominated by a diversified position-oriented learning system was initially taking shape, as illustrated in Figure 2. Central to the management and operation of this system is the Training Management Team (TMT), which plays a critical role in organizing, planning, directing, and coordinating educational activities. Led by the Pharmacy Department Director, the TMT is responsible for outlining the training process, cultivating an organizational culture that aligns with strategic objectives, and inspiring team members to work toward these goals. Executive team members, including the Director's Assistant and leaders from each learning group, assist the Director in various managerial tasks.

With the gradual clarification of the different pharmacist's positions, and through the blessing of online courses and learning platform, Pharmacy Department basically realized a learning system consisting of six position-oriented groups in 2020. The professional curriculum is primarily based on web-based online courses. After determining the course content, the TMT invites experts in the pharmaceutical and medical fields and university professors to conduct the lectures. These video courses, customized by each group leader, are then uploaded to the training modules on the learning platform. Participants can access these courses at their convenience using computers or mobile devices and review the material as often as necessary. The TMT closely monitors participant engagement, tracking user ID, name, sex, years of service, and other pertinent information. To enhance learning outcomes, some courses include quizzes and grading components.

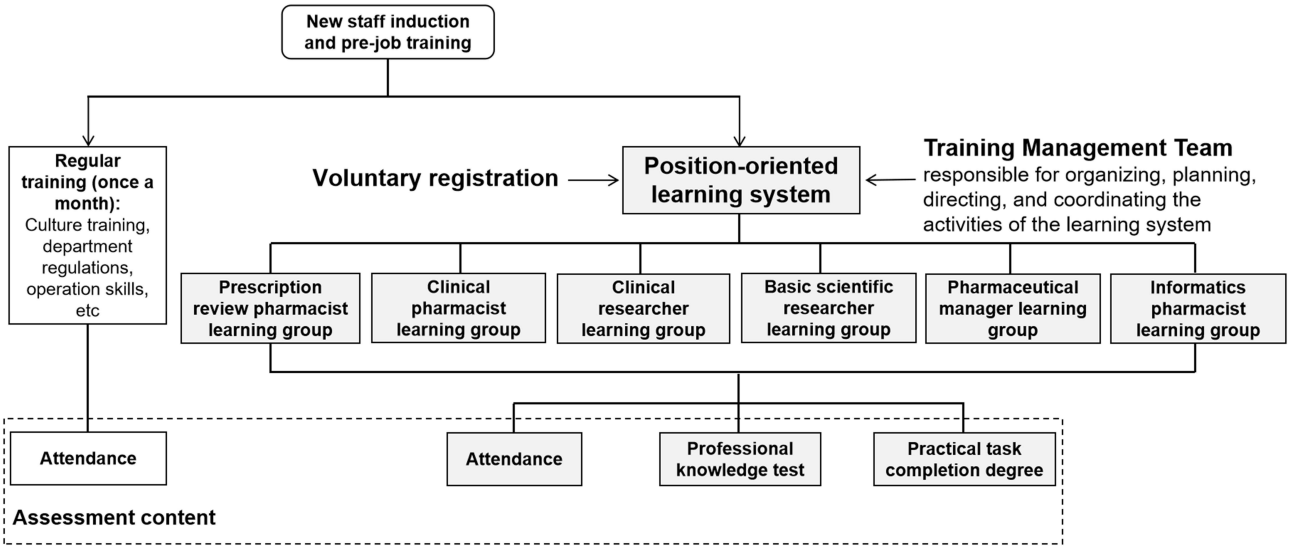

Figure 2 Overview of the pharmacist training based on diversified position-oriented learning system.

While the online modular learning approach offers flexibility, it may only partially capture the advantages of traditional, face-to-face interactive learning due to the inherent separation in space and time. To address this limitation, the learning system is augmented with practical tasks specifically designed to accommodate the unique requirements of each role. These tasks aim to bridge the gap between theoretical knowledge and practical application.

For example, prescription review pharmacists conduct real-life reviews and evaluations of medication orders, providing a practical context for their learning. Similarly, members of the pharmaceutical management group are involved in annual quality improvement projects within their respective departments, applying their learned skills in a tangible work setting. The learning environments and work modes vary significantly between the clinical research and basic scientific research groups. The former group mainly includes clinical pharmacists who work in hospitals, laboratories, and research institutions, focusing on applied research. In contrast, the latter group comprises full-time research pharmacists predominantly stationed in laboratory settings, engaging in fundamental scientific research.

The informatics pharmacist role, a relatively recent addition to Chinese hospitals, requires specialized training. These professionals often receive additional training to fully understand the informatics concepts applicable to healthcare.[18] Their responsibilities generally focus on managing information technology projects rather than direct involvement in system development.[19,20] To cater to these specific training needs, we have integrated an online course from the China Medical Education Association, tailored for informatics pharmacists. This course incorporates practical tasks midway through its duration, allowing participants to actively contribute to maintaining and enhancing the department's information system.

Evaluate the Impact of the Position-Oriented Learning System

The online format of the learning system allows the TMT to effectively track and monitor the completion of training courses by participants. The TMT regularly conducts spot checks and evaluations, focusing on two aspects: 1) the promoting impact of the system on pharmacist workforce development, and 2) the influence of the system on patient care quality. This comprehensive assessment approach gauges the participants' theoretical understanding and practical skills, learning capacities, and adherence to professional standards.[4]

Data Collection and Statistical Analysis

During the implementation of the position-oriented learning system, relevant data were gathered and analyzed by TMT. Descriptive statistics were used to present these data.

Results

Some Representative Data of Pharmacist Participation After Implementation of the Learning System

Given that the learning system was initially taking shape by 2020, 2021 was chosen as the statistical period. The Pharmacy Department had a total staff of around 400, of which 229 pharmacists registered for the learning program, which was organized into six groups. After reviewing the eligibility criteria, 218 registrants were qualified to participate in the program. To achieve a completion status, participants were required to maintain an attendance rate exceeding 60% and to pass a practical competency assessment successfully. At the end of the year, 146 participants met these completion criteria. Comprehensive statistical details on this program are presented in Table 1.

Impact of the Learning System on Pharmacist Workforce Development

Since 2019, all the pharmacists appointed in key positions were chosen from those who participated in the corresponding learning groups and successfully passed the necessary assessments, including 12 clinical pharmacists, 4 management pharmacists, 4 prescription review pharmacists and 2 informatics pharmacists (1 full-time and 1 part-time).

Table 1 Participation Details of Various Learning Groups

People Counting	Prescription Review Pharmacist	Clinical Pharmacist	Management Pharmacist	Clinical Research Pharmacist	Basic Science Research Pharmacist	Informatics Pharmacist
Applicants	89	59	27	38	10	6
Enrollment	86	57	27	34	10	4
Completed	55	47	21	13	8	2
Proportion of completion	64%	82%	78%	38%	80%	50%

Note: "Completed" means that the attendance rate was greater than 60% and passed the practical competency assessment.

Impact of the Learning System on the Coverage and Quality of Pharmaceutical Care

There have had clinical pharmacists in SAHZU since the early 2000s, but until 2019, there were only nine full-time clinical pharmacists, and by June 2023, that number had risen to 24, reflecting significant growth in this area. The increase in the number of hospital beds from 2020 to 2022 resulted in a decrease in the overall pharmacist-to-bed ratio, but the ratio of clinical pharmacists per 100 beds experienced a notable increase. The changes of clinical pharmacist workforce and bed capacity are shown in Table 2.

From 2020 to 2022, notable increases have been observed in several key performance indicators: the percentage of inpatients receiving pharmaceutical care, the frequency of outpatient visits to pharmacist clinics, the rate at which pharmacists' comment on outpatient and emergency prescriptions, and the rate of comments on inpatient orders. Alongside these improvements, there has been a corresponding decrease in the incidence of medication errors, as detailed in Table 3.

In 2021, the hospital introduced rational drug use software designed to streamline the inpatient order review process. This initiative involved prescription review pharmacists and clinical pharmacists working collaboratively in a centralized prescription review center. Their primary role at this center is to review and intercept prescription orders that are deemed

Table 2 The Change of Pharmacist Workforce

Staff allocation	2020	2021	2022
Number of clinical pharmacists per 100 beds	0.53	0.51	0.58
Number of pharmacists per 100 beds	6.99	7.05	6.48
Number of hospital beds	3218	3714	4154

Table 3 The Impact of the Learning System on Pharmaceutical Care

Pharmaceutical Care Metrics	2020	2021	2022
Percentage of inpatients received pharmaceutical care	9.33%	10.95%	11.66%
Number of outpatient who visited to pharmacist clinics	255	648	1081
Percentage of outpatient and emergency prescriptions that received comments from pharmacists	4.47%	4.19%	8.82%
Percentage of inpatient prescriptions that received comments from pharmacists	6.92%	7.10%	8.19%
Incidence of medication errors	104	132	48
Number of inappropriate prescriptions intercepted by pharmacists	7166	8634	5906
Number of inappropriate prescriptions intercepted by the prescription software	Not yet introduced	Outpatient 7646 Inpatient 40,493	Outpatient 3651 Inpatient 48,634
Intervention acceptance rate for potentially inappropriate prescriptions	0.12%	0.28%	1.50%

unreasonable. These intercepted orders are subsequently analyzed and converted into specific rules within the software to prevent similar occurrences in the future. As a result, a comprehensive set of 779 rules has been developed targeting the interception of unreasonable medical orders. The effects of this technological advancement and the training program's overall impact on the hospital's pharmaceutical program are detailed in Table 3.

The Impact of the Learning System on Quality Improvement

As practical tasks, the management pharmacist group worked together to accomplish ten significant quality improvement projects. Notable among these projects is the development of a multi-hospital prescription examination platform using the Quality Function Deployment and Failure Modes and Effects Analysis model. Additionally, the department implemented a Plan-Do-Check-Act (PDCA) cycle to reduce the incidence of inappropriate medication orders and another PDCA cycle focused on decreasing the wait time for outpatient drug collection.

The success of these improvements was recognized at the national level when the hospital received the Regional Excellence Award in the China Hospital Management Award. The China Management Science Society, a leading national academic organization under the Ministry of Science and Technology, sponsors this prestigious award. The award acknowledges the hospital's outstanding contributions to hospital management.[21]

Discussion

In China, medical institutions often exhibit low employee turnover rates, and numerous staff members remain at the same hospital throughout their careers. As these institutions evolve and transition toward a "patient-centered" model, the need arises for more complex pharmaceutical roles and the development of specialized professional skills. This shift makes the effective training of existing employees and identifying suitable candidates for new positions critical decision-making issues. Such challenges require thoughtful consideration to ensure that medical staff are equipped to meet the dynamic needs of patient care and adapt to the changing healthcare landscape.

Compared to developed countries, pharmacist training in China is still developing.[22] Many hospital pharmacists, even those with advanced degrees, such as a master's degree in pharmacy or a doctor of pharmacy, often find themselves inadequately prepared for the practical requirements of various pharmacy-related roles.[23,24] Therefore, pharmacists must develop professional skills and cultivate collaborative abilities tailored to their specific roles, enhancing their effectiveness in the workplace.[6] Position-oriented learning system significantly enhances their ability to meet the demands of diverse and complex positions.

Our learning system operates primarily as a position-based employee training program. However, due to its significant emphasis on individual preferences and the prospective development of employees, it more aptly aligns with an employee development system. Characterized by voluntary registration and an initial screening process, the system provided employees with a clear understanding of the department's future direction.

There were significant differences in participation and completion rates among different groups in the learning system, which confirmed that participants' career planning greatly affected their enthusiasm and initiative in receiving training. The prescription review pharmacist group received the highest number of applications but only ranked fourth in completion rate, at 64%. In contrast, the clinical pharmacist group achieved the highest completion rate, 82%. This variation in rates can likely be attributed to the characteristics of the applicants and their potential for career progression. Opportunities to transition from dispensing to prescription review pharmacists are relatively limited due to the fewer positions available in the prescription review center.

Consequently, even after completing the course, only a few individuals have the opportunity to change roles in the short term. In contrast, the number of positions for clinical pharmacists is on an upward trajectory, making it a more feasible target for a larger pool of candidates. The strict academic and professional prerequisites for becoming a clinical pharmacist tend to attract more selective and driven applicants, which could explain the higher rate of program completion observed in this group.

The data also reveals a notable disparity between the two research-focused groups. The clinical research group recorded a completion rate of 38%, in contrast to the basic researcher group, which achieved a rate of 80%. This significant difference could be attributed to the different roles within the department. Members of the basic research

group are primarily research pharmacists engaged full-time in pharmaceutical research, a requirement for their participation in the group. On the other hand, the clinical research group typically consists of clinical pharmacists or highly educated dispensing pharmacists who engage in research driven by personal interest or as a means of career advancement. Clinical research activities are often secondary to these individuals' primary professional responsibilities.

Departing from conventional centralized training Methods and intensive sessions, our learning system is specifically tailored to accommodate the unpredictable schedules of front-line pharmacists. It features online courses that allow learners to engage with the material on their terms at varying times, locations, and speeds. This level of customization facilitates usage of fragmented time to transition from passive to active learning for future target positions, reducing the Pharmacy Department's time and human resources consumption. Since exploring the learning system, we have appointed a total of 22 pharmacists in 4 types of positions from participants who have completed the training, among which the Informatics Pharmacist was a completely new position. The training provided by these learning groups had instrumental in ensuring that these participants were well prepared before they entered the positions, enabling them to quickly adapt to their assigned roles and begin their professional duties effectively.

Consistent research findings indicate that employees' perception of their job role profoundly impacts their performance.[25] At our hospital, employees who recognize that position-oriented learning is crucial to their career progression are more likely to engage willingly, driven by intrinsic motivation. This positive attitude towards learning frequently Results in improved educational outcomes. Additionally, having access to proper guidance is essential for employee success, not only within the organization but also in their broader professional development.[26]

Practical tasks in learning system served to evaluate the participants' understanding of theoretical concepts, skills, and overall proficiency and pinpoint areas requiring further improvement. This dual functionality is crucial for both individual self-improvement and curriculum enhancement. Through systematic coursework and practical tasks, the pharmacy department efficiently identifies and selects individuals who exhibit a vital initiative for self-learning and a strong drive, essential qualities necessary to meet the demands of their roles. After the system was formed, 12 new full-time clinical pharmacists were appointed in just 4 years. The ratio of clinical pharmacists per 100 beds experienced a notable increase. The learning system improved work efficiency and patient medication safety by optimizing the staff structure of hospital pharmacists.

Role ambiguity, insufficient training and understaffing of pharmacists are considered to have a negative impact on pharmaceutical services in China.[8] Our position-oriented learning system seemed to be able to compensate for this shortcoming. The strengthening of the pharmacy team at the hospital had significant improved various pharmaceutical care metrics of SAHZU. These pharmaceutical cares, such as pharmacist clinics, checking prescriptions, making treatment plans, medication guidance and pharmaceutical monitoring, are recognized as beneficial for patients' medicine therapy. Similarly, the quality improvement projects completed by the participants in the practical tasks also substantially remedied process deficiencies within the pharmacy department, thereby enhancing service standards across its various units.

This system empowered the TMT to monitor the engagement and progression of the participants effectively through the training modules. This capability was vital for assessing and analyzing the overall effectiveness of the learning process. Furthermore, the flexibility inherent in this predominantly online learning mode enabled participants to balance their educational pursuits, professional responsibilities, and personal lives better, making the learning experience more manageable and productive.

Another significant benefit of this approach is its impact on mentorship within training environments. Research has shown that mentorship not only aids in the learning process for mentees but also contributes to the improvement of mentor skills.[26] Mentors acquire new insights from their trainees, improving their abilities and becoming more adept at guiding others. Our position-oriented learning system asks senior pharmacists involved in teaching and practical tasks to reassess their roles continually. This ongoing process of self-evaluation deepens their understanding of their responsibilities and fosters enhancements in the quality of their work.

This study has limitations. First, this is a single-center experience. Second, we did not conduct the participants' questionnaires and interviews about this learning system.

Conclusion

The position-oriented learning system effectively aligns employee career goals with the department's development, enhancing personnel selection for roles, including new positions like informatics pharmacist, especially during rapid hospital expansion. This efficient and focused system benefits both the department and its staff. It increases pharmacists' learning efficiency, improves the quality of pharmaceutical care, and promotes professional growth. Tailoring learning experiences to specific job roles and individual development, the system represents a versatile, thorough approach to professional and organizational advancement.

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Disclosure

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