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Analysis of the Design and Functions of the Intelligent Management Platform for Hysteroscopy Centers

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SUMMARY: *In order to support the continuous organization of multi-source and multi-link diagnosis and treatment process in hysteroscopy center, this paper constructed an intelligent management platform based on Browser/Server three-tier architecture, enterprise service bus and MySQL core engine to realize clinical business collaboration and department management linkage. The platform connects HIS, LIS, PACS and EMR through ESB, and integrates emergency, outpatient and inpatient day patients into the unified case object, covering patient access, information retrieval, surgical scheduling, intraoperative image acquisition, graphic and text report generation, qualification review, authority control and file management. Relying on nearly 7,000 hysteroscopic surgery scenarios per year in the center, the platform has included 600 patients since it was officially put into clinical practice in December 2025. Application results show that the system can stably complete cross-system data exchange, intraoperative information synchronous call and multi-module collaborative processing, and support workload statistics, quality collection and visual analysis, which provides stable support for fine management, data accumulation and subsequent expansion of the specialist center. And reserved space for teaching broadcast, scientific research utilization and subsequent expansion.*

KEYWORDS: *Hysteroscopy center; Intelligent management platform; Multi-source data collaboration; Layered architecture design*

1 Introduction

In the process of the evolution of specialty medicine to digitalization, platform and collaboration, building a computable intelligent platform around the operation process, data organization and fine management has become an important technical path to improve the operation efficiency and service quality of specialty. Gortz et al. constructed a software-defined platform framework for surgical scenarios, indicating that cross-system connection, modular deployment and process reengineering can provide a unified digital base for surgical management [1]. Leung et al. combined artificial intelligence and terminal tools into the scheduling system and proved the practical support value of computational methods in resource allocation and personnel collaboration [2]. Curchoe et al. evaluated the operation performance of the digital personnel management platform in the assisted reproduction laboratory, indicating that the specialized platform not only assumes the business carrying function, but also supports quality supervision and process tracking [3]. Chen et al. proposed an intelligent recognition algorithm for hysteroscopic diagnosis and treatment, showing that the gynecological endoscopic scene has a realistic basis for embedding computational models

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into clinical processes [4]. Demir et al. reviewed stage identification and step identification in surgical process analysis, and pointed out that structured process representation has become an important direction for intelligent surgical systems [5]. Choksi et al. used edge computing for real-time surgical stage identification, indicating that the instant processing ability of intraoperative data is becoming a core component of the digital surgical space [6]. Samad et al. released a public operating room event database, which provided standardized data support for perioperative data integration, state modeling and application verification [7]. Cheikh Youssef et al. analyzed the evolution position of video technology in the digital operating room, further indicating that image acquisition, transmission and call have shifted from a single recording tool to a surgical collaboration infrastructure [8]. Bottani et al. combined the Internet of things tracking technology with the operating room scheduling model and demonstrated the integrated implementation of patient circulation management, timing coordination and resource scheduling [9]. Ellis et al. conducted an evaluation study on gynecological digital informed consent, indicating that digital interaction has been extended to patient communication and service management [10].

In this context, the intelligent construction of hysteroscopy center should not stay at the superposition level of a single point system, but need to establish a unified platform structure around the link of specialized diagnosis and treatment. The hysteroscopy center is responsible for the reception and surgical arrangement of patients from different sources such as emergency, outpatient and inpatient day. The business chain covers the links of preoperative admission verification, surgical appointment, intraoperative image acquisition, record generation, postoperative filing, follow-up management and statistical analysis. If appointments, history writing, image storage, and report generation still rely on separate information units, it is difficult to synchronize data access, process cohesion, and management feedback. The operation data of the center show that the annual operation volume of the center is close to 7000 cases. The center has been equipped with high-definition hysteroscopy, multi-modal imaging platform, online management platform and internal and external broadcasting system. On this basis, it has built an intelligent management platform that uses B/S three-tier architecture, MySQL as the core engine, and connects HIS, LIS, PACS and EMR through ESB. After the platform was put into clinical practice in December 2025, 600 patients have been included in the unified management, which has the application basis of patient access management, information retrieval, graphic and text reports, qualification review, authority control and file management. It also provides a unified data base for subsequent system expansion.

In summary, this paper focuses on the design and function of the intelligent management platform of hysteroscopy center. The specific objectives are as follows: (1) to construct a hierarchical system architecture and data organization model in line with the specialized diagnosis and treatment process; (2) Formed a core functional module collaboration mechanism covering preoperative, intraoperative, postoperative and management links; (3) The implementation effect of intelligent management combined with platform operation data analysis in process integration, data response and application support.

2 Related work

In terms of specialized data fusion and intelligent recognition, Li et al. constructed a multimodal learning system that fused electronic medical records and hysteroscopic images, and used it for reproductive outcome prediction and endometrial injury risk stratification, indicating that joint modeling of heterogeneous medical data has been able to serve

gynecological specialty decision-making [11]. Brandao et al. systematically reviewed the application progress of artificial intelligence in the field of gynecology, and pointed out that image analysis, auxiliary judgment and individual management are forming a continuous link from data acquisition to clinical application [19]. Patel et al. summarized the application forms of artificial intelligence in obstetrics and gynecology, and proposed that the algorithm model has been extended from a single recognition task to perioperative management, diagnosis and treatment collaboration and outcome support [20]. Levin et al. realized the automatic identification of the key steps of hysterectomy, indicating that the gynecological surgical process can be broken down into computable, labeled and traceable structural units [21]. These studies show that the data resources in the gynecological scene have the conditions to change from static recording to dynamic calculation, and lay a technical foundation for image calling, process recording and business linkage in the hysteroscopy center platform.

In terms of surgical process calculation and operation collaboration, Bellini et al. summarized the application of artificial intelligence in operating room management, and pointed out that scheduling optimization, resource matching and operation monitoring constitute an important realization direction of digital surgery space [12]. Laterza et al. reviewed the intelligent operating room and proposed that data connectivity, image collaboration, equipment fusion and management cockpit together constitute the basic framework of intelligent surgical scene [13]. Cramer et al. carried out requirement analysis on the augmented reality assistant system for surgical instruments, indicating that the platform design should simultaneously meet multiple constraints such as data interface, interaction logic and scene adaptation [14]. Azriel et al. proposed a multi-task feature selection method for operation duration prediction, which proved that perioperative data can be directly used for service scheduling and resource allocation after computational modeling [16]. Kang et al. used the machine learning model to predict the operation duration, which further showed that the operation process data could be transformed into the basis for operation decision-making [17]. This part of the study shows that surgical activities themselves can not only be described, but also quantified, predicted and scheduled, thus providing more refined computational support for scheduling appointments, surgical articulation and resource scheduling in specialist centers.

In terms of hospital management decision-making and platform integration, Alves et al. discussed the supporting role of artificial intelligence tools in hospital management decision-making, indicating that the management platform has shifted from information aggregation tools to computing systems with analysis capabilities [15]. Lin et al. reviewed the artificial intelligence-enhanced clinical decision support system, and proposed that multi-source clinical information integration, rule linkage and auxiliary suggestion are the critical path to realize the usability of the medical platform [18]. This kind of research pushes the platform construction from the simple system development to the level of rule organization, management analysis and auxiliary decision-making, so that the smart medical platform has an extension space for operation and governance. For hysteroscopy centers, this research path is highly consistent with the actual needs of specialized centers for patient access management, information retrieval, graphic and textual report generation, authority control and statistical analysis.

To facilitate the comparison of the technical focus, data objects, and application boundaries of different studies, the relevant results are organized in Table 1. It can be seen from the table that the existing research has formed a relatively clear technology spectrum in the aspects of algorithm modeling, process recognition, decision support and digital surgery space construction, but the points of different results are not exactly the same.

Table 1: Summary of related studies on intelligent management platform of hysteroscopy center

Study	Technical Content	Data Object	Main Performance	Applicability Boundary
[11]	Multimodal learning	Electronic medical records and hysteroscopic images	Supports prediction and risk stratification	More oriented toward diagnostic and therapeutic inference
[12]	AI for operating room management	Perioperative operational data	Supports scheduling and resource management	Specialty process granularity is relatively coarse
[13]	Smart operating room framework	Multi-source surgical scenario data	Provides a system construction pathway	Implementation details are relatively limited
[14]	AR-assisted surgical system	Instrument and scenario requirement data	Emphasizes interface and interaction design	Coverage of management links is limited
[15]	Hospital management decision support	Hospital operational data	Supports management analysis	Coupling with the surgical site is insufficient
[16]	Surgery duration prediction	Perioperative feature data	Improves scheduling reference capability	Focuses on single-task modeling
[17]	Machine learning for surgical time	Surgical time-series data	Enhances operational estimation	Does not cover full-process management
[18]	Clinical decision support	Multiple types of clinical information	Supports rule linkage and alerts	Representation of specialty platforms is insufficient
[19]	Review of AI in gynecology	Multimodal gynecological data	Summarizes intelligent development pathways in gynecology	Architectural expansion is limited
[20]	AI applications in obstetrics and gynecology	Clinical and management data	Extends to collaborative management	Description of specialty centers is relatively limited

As can be seen from Table 1, the existing research has covered multiple directions such as gynecological multimodal data analysis, surgical process identification, duration prediction, management analysis and clinical support, and the technical chain is relatively complete. However, in the specialized environment of hysteroscopy center, The unified platform for patient admission verification, appointment scheduling, intraoperative image acquisition, report generation, qualification review, authority control, file management and multidimensional statistical analysis is still not centralized enough. Combined with the construction data of the center, the annual operation volume of the center is close to 7,000 cases. The center has been equipped with high-definition hysteroscopy, multimodal image management platform, online management platform and internal and external broadcasting

system. The platform adopts B/S three-tier architecture, MySQL as the core storage engine, and connects HIS, LIS, PACS and EMR through ESB. Since December 2025, 600 patients have been included in the unified management. Such a construction scenario determines that the platform research can not only stay in a single algorithm or a single process level, but also need to integrate data access, business organization, function collaboration and management analysis into the same computing framework. Based on the above research basis, this paper further integrates the specialized process, system architecture and intelligent management functions into a unified platform to form a design expression and application analysis that is more suitable for the operation characteristics of hysteroscopy center.

3 Research Methods

3.1 System architecture design of intelligent management platform for hysteroscopy Center

The intelligent management platform of hysteroscope center adopts a three-tier architecture based on B/S mode, and the overall framework is composed of hardware facility layer, business data layer and scene application layer. The data connection between HIS, LIS, PACS, EMR and central business units is completed through ESB. The structure is not a parallel splicing of the existing systems in the hospital, but reorganizes the request transmission path, data processing relationship and function call sequence around the links of patient admission, appointment arrangement, intraoperative acquisition, image retrieval, report generation, qualification review, authority control and file collection, so that the originally scattered specialist business is included in the unified computing space. The system architecture design must simultaneously meet the multiple requirements of continuous access, cross-system callback, role coordination and result writeback. Therefore, this section not only discusses the structure composition, but also explains the adaptation logic of the layered architecture in the specialized environment.

In order to accurately describe the complete delay composition of platform request from identity authentication, service routing, business processing, database interaction to result transmission, and to provide a unified structural expression for bottleneck location in subsequent performance analysis, the end-to-end response function is defined as follows:

$$R=\alpha T_{auth}+\beta T_{route}+\gamma T_{logic}+\delta T_{io}+\eta T_{push}+\xi T_{lock} \quad (1)$$

Here, R represents the total response delay of a single service request. T_{auth} indicates authentication time. T_{route} represents the service routing time. T_{logic} represents the business logic processing time; T_{io} represents the read and write time of database and image index. T_{push} represents the result push time;T_{lock} represents the resource lock waiting time under concurrent access. α, β, γ, δ, η and ξ denote the influence weights of each stage. The formula decomposes the platform operation process into a computable level, which makes it easy to determine whether the delay is from authentication, logic, storage or concurrency control, so as to support architecture tuning.

In order to represent the underlying load status under the joint action of different terminals, image devices and network nodes, and to uniformly evaluate the access stability level during high-frequency service periods, the hardware layer resource load model can be written as follows.

$$C_h=\sum_{i=1}^{n}\omega_i x_i+\lambda\sum_{i=1}^{n}\sum_{j=1,j\neq i}^{n}\frac{\rho_{ij}}{1+d_{ij}} \tag{2}$$

Among them, C_h represents the hardware layer comprehensive load; x_i denotes the immediate load of type i terminal or device; Let ω_i denote the corresponding load weight; Let ρ_{ij} denote the collaborative access strength between device i and device j; d_{ij} represents the delay distance between them in the link; Let λ denote the coupling correction coefficient. This formula shows that the underlying load degree not only depends on the pressure of a single device, but also is affected by the linkage call of multiple devices, so it is more suitable for the scenario of concurrent call of intraoperative images and preoperative information in hysteroscopy center.

In order to represent the process of multi-source records forming a unified expression vector after field alignment, semantic mapping and standardization, the heterogeneous business data fusion function can be expressed as follows:

$$Z=\phi\left(\sum_{k=1}^{m}\theta_k U_k X_k+b\right)+\mu\Omega \tag{3}$$

where Z represents the unified data vector after fusion. X_k denotes the original record of the k class of source system; U_k stands for field mapping matrix; Let θ_k denote the source weights; b represents the bias correction term; Let $\phi(\cdot)$ denote the normalization and encoding function; Ω represents the missing patch term; Let μ denote the repair strength coefficient. This formula shows that the business data layer does not simply copy external fields, but forms a stable data base through mapping, weighting and patching, which is the premise for the continuous operation of appointment management, report generation and statistical analysis.

In order to quantify the tightness of the linkage between multiple functional nodes before, during and after surgery, and reflect the continuous operation level of the business chain within the unified platform, the module collaboration strength function is defined as follows:

$$S=\frac{1}{m(m-1)}\sum_{p=1}^{m}\sum_{q=1,q\neq p}^{m}\frac{a_{pq}f_{pq}}{1+e_{pq}}+\nu\frac{\sum_{p=1}^{m}u_p}{m} \tag{4}$$

where, S represents the collaboration strength of platform modules. m represents the total number of modules. a_{pq} indicates whether there is a call relationship between module p and module q. f_{pq} denotes the number of calls per unit cycle. e_{pq} represents the number of exception corrections when executed across modules. u_p denotes the available state of module p; Let ν denote the availability correction coefficient. This formula considers not only the call relationship and frequency, but also the exception correction and availability level, so it can more truly reflect the module cooperation state in the platform.

In order to maintain consistent rule constraints between data access, task boundaries and audit traces for different roles, the permission decision matrix of the platform can be further formalized as follows.

$$P_{ab}=\begin{cases}1, & \rho_a \geq \sigma_b,\ \tau_a \in \Gamma_b,\ \kappa_b=0,\ \chi_{ab} \leq \varepsilon \\ 0, & \text{Other situations}\end{cases} \tag{5}$$

where P_{ab} represents the access result of role a to resource b; ρ_a denotes the role security level; σ_b denotes the resource sensitivity level; τ_a denotes the task domain to which the role belongs; Let Γ_b denote the set of task domains that the resource is allowed to access; κ_b denotes the resource locked state; χ_{ab} represents the access risk score; Let ε denote the risk threshold. This formula takes the level, task domain, resource status and risk score into the judgment conditions, which is more suitable for the specialized platform such as hysteroscopy center with multi-role collaboration and strict record keeping.

In order to comprehensively measure the archiving integrity and service availability level of the platform under continuous operation, and provide a unified architecture evaluation index for the application analysis in the following, the comprehensive stability of the system can be defined as:

$$Q=\left(\frac{1}{N}\sum_{j=1}^{N}\min\left(r_j,g_j,h_j\right)\right)\cdot(1-\lambda)\cdot\frac{1}{T}\sum_{t=1}^{T}M_t\,e^{-\mu L_t} \tag{6}$$

where Q represents the comprehensive stability of the system. N is the number of cases; r_j represents the base record completeness status of the j patient; g_j represents the state of image index establishment. h_j denotes the report collection status; Let λ denote the critical failure probability; T is the observation period; M_t denotes the service survival state at time t. L_t represents the average load level. Let μ denote the load attenuation coefficient. This formula puts file association and operational availability into the same framework, which can better reflect the engineering characteristics of the specialized wisdom platform.

Based on the above design, the three-tier architecture of the intelligent management platform of hysteroscopy center unitizes equipment access, data governance, process organization, authority control and archiving precipitation into the same technical structure, which can not only support the daily diagnosis and treatment and management collaboration of the current center, but also retain a stable interface for subsequent statistical analysis, operation evaluation, teaching broadcast and system expansion. Therefore, this architecture has strong specialty adaptability and engineering realization value.

3.2 Organization of multi-source business data and construction of collaborative processing flow in hysteroscopy center

The core of the organization of multi-source business data and the construction of collaborative processing flow in hysteroscopy center is not to simply connect the existing systems in the hospital to the same interface, but to transform the business records of different sources, different granularity and different update time into a unified data flow that can be calculated, tracked and written back. The patients in the center mainly come from three types of entrances: emergency, outpatient and inpatient day, and the appointment method, application form generation method, history writing path and preoperative examination organization form are not consistent. Without a unified data organization mechanism, it is difficult to form a continuous collaboration between preoperative verification, intraoperative retrieval, postoperative report and file collection. Based on this, the platform takes HIS as the main entry point and ESB as the exchange center, integrates LIS, PACS, EMR and

qualification management information into the same processing link, and constructs a collaborative processing process around the main index of patients, the sequence of diagnosis and treatment events and the mark of business status, so that the data can be identified, mapped, verified, distributed and archived after entering the platform.

Its specific process is shown in Fig. 1. Firstly, the platform received the original business records from HIS, LIS, PACS, EMR and qualification scheduling unit, and established a unified master index according to the patient identification, visit number, hospitalization number and application number. After the main index was merged, the system converted the examination, imaging, medical records, appointment and intraoperative acquisition records into standardized event units, and then triggered cross-module collaborative processing according to the rules of admission verification, scheduling linkage, image retrieval and report writeback. The processing results then enter the modules of patient access management, surgery scheduling management, graphic and text report management, authority file management and statistical analysis, and are written back to the platform archive and shared query end after the process is finished, forming a continuous closed loop of "data access, index matching, event organization, collaborative trigger and result precipitation".

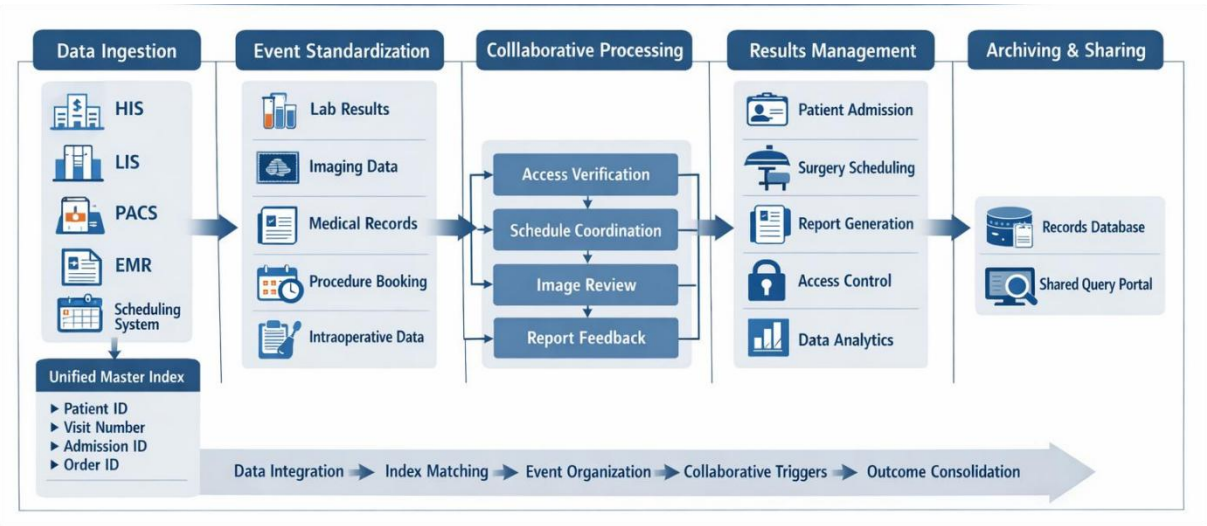

Figure 1: Flow chart of multi-source business data organization and collaborative processing in hysteroscopy center

In order to quantitatively express the comprehensive access quality of multi-source data in three dimensions of field integrity, time validity and source credibility after entering the platform, and provide a unified input criterion for subsequent mapping and scheduling, the access integrity function is defined as follows:

$$E=\frac{\sum_{Q=1}^{Q}\omega_s\left(\alpha c_s+\beta q_s+\gamma v_s\right)}{\sum_{s=1}^{S}\omega_s} \tag{7}$$

where E represents the integrity of multi-source access; Q is the number of source systems. c_s denotes the field completeness rate of source s; q_s stands for effective timestamp; v_s indicates source credibility; ω_s denotes the system weights; α, β, γ represent the adjustment coefficients of the three dimensions. The formula is used to determine whether a case has the basis to continue to participate in the main index merging and process linkage when entering the platform, and the records with too many missing items, time misalignment

or insufficient credibility can be identified in advance, thereby reducing the subsequent mismatching probability.

In the process of establishing the main index of patients across the system, only relying on a single ID number or medical number cannot cover all business scenarios. Therefore, the platform adopts a multi-key joint matching strategy to improve the identification stability of emergency and daytime patients, and its matching probability can be written as:

$$M_{ij}=\frac{\exp\left(\lambda_1 \mathrm{sim}(u_i,u_j)+\lambda_2 \mathrm{sim}(n_i,n_j)+\lambda_3 \mathrm{sim}(a_i,a_j)-\lambda_4 \Delta t_{ij}\right)}{\sum_{k=1}^{K} \exp\left(\lambda_1 \mathrm{sim}(u_i,u_k)+\lambda_2 \mathrm{sim}(n_i,n_k)+\lambda_3 \mathrm{sim}(a_i,a_k)-\lambda_4 \Delta t_{ik}\right)} \tag{8}$$

Here, M_{ij} represents the matching probability that record i and record j belong to the same patient. u stands for identity; n denotes the visit number or hospitalization number; a denotes the application number; $\mathrm{sim}(\cdot)$ represents the similarity function; Δt_{ij} is the time difference between two records. λ_1 to λ_4 represent the weight parameters. This formula builds the main index through multi-key combination rather than single key determination, which is more suitable for the scenario of outpatient, emergency and inpatient day in hysteroscopy center.

In order for the preoperative exam, appointment request, intraoperative image and postoperative report to form a orderable and traceable chain of events on the same case, the platform needs to perform a uniform alignment of records on different time scales, and its timing cost function is as follows:

$$J=\sum_{p=1}^{P}\sum_{q=1}^{Q} \pi_{pq}\left(\eta_1 |t_p-t_q|+\eta_2 \|e_p-e_q\|_1+\eta_3 \delta_{pq}\right) \tag{9}$$

where J represents the total cost of event pair alignment; P and Q represent the sizes of the two types of event sets to be aligned. Let π_{pq} denote the pairing coefficient between event p and event q; t_p,t_q denote event time; e_p and e_q represent event attribute vectors; Let δ_{pq} denote the event type inconsistency penalty term. η_1 to η_3 denote the weighting coefficients. This formula is used to organize preoperative examinations, appointment scheduling, intraoperative acquisitions, and postoperative reports into a continuous sequence of events, allowing the platform to process cases rather than isolated records.

After the mapping and alignment of multi-source records is completed, the platform also needs to determine whether the key fields of the same case in different systems are consistent, so as to ensure that the admission judgment, information retrieval and report generation are based on stable data. The consistency score can be expressed as:

$$D=1-\frac{\sum_{r=1}^{R} \mu_r \left|x_r^{(a)}-x_r^{(b)}\right|}{\sum_{r=1}^{R} \mu_r \max\left(x_r^{(a)},x_r^{(b)},\varepsilon\right)} \tag{10}$$

where D represents the cross-system consistency score; R denotes the number of critical fields; $x_r^{(a)}$ and $x_r^{(b)}$ represent the values of the field r in both systems; μ_r represents the field weight; Let ε denote the stable term that prevents the denominator from being zero. The closer D is to 1, the more stable the corresponding relationship between the basic information of the patient, the examination results and the application content in different systems, and the more reliable the platform can perform admission and retrieval accordingly.

When the patient completes the admission verification and enters the business scheduling

phase, the system needs to consider the urgency of the disease, resource occupation, doctor scheduling and inspection completeness at the same time to determine the execution priority of collaborative processing. The priority function is defined as follows:

$$H=\sigma(\theta_1 u+\theta_2 c+\theta_3 g+\theta_4 a-\theta_5 r) \tag{11}$$

where H represents the priority of collaborative processing; Let $\sigma(\cdot)$ denote the normalization function; u denotes the urgency of the disease; c denotes check completeness; g represents the matching degree between the current available time and the operating room resources; a represents the fitness of doctor scheduling; r represents resource congestion; The values θ_1 to θ_5 represent the weight parameters. This formula unified the condition, examination, scheduling and resources into the same scoring framework, so that the platform could give a more structured collaborative processing order when facing patients from different sources.

Through the above organization, the platform organizes patient information, test results, imaging data, surgical records and report texts originally scattered in different systems into a continuous sequence of events under the same case object, and enables preoperative, intraoperative and postoperative functional modules to be called around a unified data base. After this process, doctors no longer rely on manual switching between multiple systems when viewing the basic information, test results and previous documents of patients during surgery, and head nurses and managers can also directly obtain the results classified by time, operation method and operator when conducting appointment verification, qualification verification and statistical analysis. At the same time, the platform retains standardized interfaces for subsequent patient follow-up, medical record retrieval, teaching broadcast and scientific research statistics, so that new services can continue to expand on the existing data structure.

3.3 Design and collaborative implementation of platform core function modules

After the hierarchical architecture deployment and multi-source data merging of the intelligent management platform of hysteroscopy center, the function layer is organized around a continuous link of "patient case object - business status node - function call result" instead of using independent page splicing. The platform integrates preoperative access verification, information retrieval, operation scheduling, intraoperative image acquisition, graphic and text report generation, doctor qualification management, authority control and file trace into a unified execution framework, so that all operations can be triggered, recorded, written back and tracked under the same case index, thus forming a modular collaborative structure for the specialized process of hysteroscopy center.

From the perspective of implementation path, the core functions of the platform can be merged into three sub-modules: clinical collaboration, management control and data feedback. Clinical collaboration is responsible for preoperative and postoperative business processing, management control is responsible for qualification audit, resource matching, role authorization and process retention, data feedback is responsible for summarizing and analyzing surgical records, workload, time distribution, patient sources and equipment use results, and writing the results back to the platform operation link. The three sub-modules maintain linkage through a unified service interface and shared state variables. The patient access status will affect the scheduling results, and the scheduling results will limit the call scope of intraoperative collection and report, so the platform shows obvious collaborative computing characteristics in function implementation. The architecture consists of three core

functional sub-modules, as detailed in Table 2.

Table 2: Framework of core functional modules of hysteroscopy central platform

Submodule	Main Input	Core Methods and Processing Logic	Main Output
Clinical collaboration submodule	Patient demographic information, preoperative examination results, appointment requests, intraoperative images	Organizes admission verification, information retrieval, image acquisition, and report generation based on a unified case index	Admission status, intraoperative information, image-text reports
Management control submodule	Physician qualifications, scheduling information, role permissions, archive requests	Performs qualification review, resource matching, permission allocation, and archive trace recording according to the rule base	Scheduling results, review results, access control results
Data feedback submodule	Surgical records, workload, operation duration, equipment status	Conducts classified statistics, visual analysis, and result write-back for operational data	Reports, analysis results, basis for subsequent optimization

In the clinical collaboration sub-module, patient admission management is the process starting point. The system synchronously read the information of examination, examination, anesthesia evaluation and medical record from HIS, LIS, PACS and EMR, and correlated it with the surgical application, so as to automatically mark the unfinished items, abnormal items and normal items, and avoid the information breakage caused by manual item-by-item checking. In order to transform the preoperative verification process into a computable unified score and facilitate the platform to perform consistent admission judgment among patients from different sources, the comprehensive admission index is defined as follows:

$$A_i=\sigma(\alpha_1 c_i-\alpha_2 e_i+\alpha_3 m_i+\alpha_4 b_i+\alpha_5 s_i) \tag{12}$$

where A_i represents the comprehensive admission index of the i patient; Let $\sigma(\cdot)$ denote the normalization function; c_i represents the completion of preoperative examination; e_i represents the abnormal item penalty value. m_i indicates passing status of anesthesia assessment; b_i indicates the completeness of medical records; s_i represents the consistency score of the surgical application; α_1 to α_5 represent the regulation coefficients. This formula converts the preoperative verification from manual judgment to structured scoring, which helps the platform to uniformly display the current operable state of the patient and provides preconditions for subsequent scheduling calls.

After the patient passes the admission, the platform enters the stage of information collaboration and resource allocation. The patient information management function supports doctors to view basic information, test results, inspection reports, medical orders and medical documents at any time during the operation, while the doctor management function is also responsible for qualification review, shift arrangement and workload settlement. In order to make the operation time allocation take into account the condition urgency, admission status, doctor qualification, operating room resources and current load level, the scheduling priority value after module collaboration can be expressed as follows:

$$Y_i = \frac{\beta_1 u_i + \beta_2 A_i + \beta_3 q_i + \beta_4 d_i}{1 + \beta_5 r_i + \beta_6 o_i} \tag{13}$$

Here, Y_i represents the scheduling priority value of the i patient. u_i indicates the urgency of the condition. A_i represents the comprehensive access index; q_i stands for application time factor; d_i represents the qualification suitability of doctors; r_i represents the degree of operating room resource congestion; o_i represents the amount of conflict in the same time period; β_1 to β_6 represent the weight parameters. This formula is not a separate service scheduling page, but a unified decision expression of admission management, doctor management and surgical resource management, so it can better reflect the collaborative implementation characteristics of the platform.

In order to facilitate the explanation of the division of labor boundaries, trigger conditions and system behaviors of different functional modules within the platform, the core modules and collaborative implementation methods are sorted out as shown in Table 3. The contents in the table correspond to the clinical application and management application functions of the platform that have been put into use, which also reflect that the modules do not run in isolation, but continuously interact around the same case object.

Table 3: Main functional modules and collaborative behaviors of hysteroscopy central platform

Functional Module / Component	Trigger Basis	Main Objective	Typical System Behavior
Patient admission management	After completion of laboratory tests and examinations	Determine whether surgical conditions are met	Displays uncompleted items, abnormal items, and normal items, and provides the corresponding status
Patient information management	During preoperative review or intraoperative access	Ensure continuous visibility of information	Synchronously displays demographic information, laboratory results, examination results, documents, and medical orders
Image-text report management	After completion of intraoperative acquisition	Generate structured reports	Captures images and videos, invokes templates, and generates and prints reports
Physician management	During scheduling or qualification updates	Support workforce and qualification control	Performs qualification review, duty scheduling, and workload settlement
Permission and archive management	During requests for live streaming, downloading, or inquiry	Ensure security and traceability	Allocates permissions, records operation traces, and performs archive management
Data analysis module	After completion of business operations	Support management and evaluation	Generates statistical reports, workload analysis, and visualized results

Graphic report management is the functional link that can best reflect the characteristics of specialized business in the platform. The system supports real-time acquisition, parameter setting, saving and calling of intraoperative images and videos, and shortens the time of report entry through template management and thesaurus management, so that the process of report formation changes from simple text writing to simultaneous generation of images, structure fields and conclusions. In order to express the overall comprehensive effect of image coverage, template matching, field integrity and audit consistency in report generation, the report completion function is defined as follows:

$$G_i=\gamma_1 p_i+\gamma_2 t_i+\gamma_3 f_i+\gamma_4 h_i-\gamma_5 w_i \tag{14}$$

Here, G_i represents the reporting completion of the ith patient; p_i represents key image coverage; t_i represents template matching degree; f_i represents the structural field completion rate; h_i represents the approval rate; w_i represents the number of manual rework; γ_1 to γ_5 denote the weighting coefficients. This formula can be used to evaluate the structured degree of the platform in the report generation stage, and can also be used as a quantitative basis for subsequent quality management and template iteration.

Above the above three sub-modules, authority and file management assume the dual role of result solidification and data security. The system assigns access rights according to the boundaries of roles, sets different levels of application paths for surgery live broadcast, image download, report view and data export, and forms a complete record of the operation behavior. At the same time, the data feedback sub-module continuously summarizes the operation information such as the source of patients, the workload of doctors, the operation structure and the operation duration, which provides the basis for subsequent statistical analysis, performance appraisal and department scheduling. It can be seen that the design of the core function module of the platform is not around a single point page, but around the case object, role permissions and business status to build a continuous linkage relationship. The collaborative mechanism thus formed not only meets the current clinical use and management control requirements of hysteroscopy center, but also retains a stable interface for subsequent data insight, follow-up expansion and scientific research utilization.

4 Experimental Design

The data samples selected in this experiment are from 600 patient records that have been included in the unified management after the intelligent management platform of hysteroscopy center has been officially put into clinical use in December 2025. At the same time, the operation application form, preoperative examination results, imaging data, medical record documents, authority log and graphic report data are combined. The sources of patients cover three types of entrances: emergency, outpatient and inpatient daytime, which can reflect the data access status and business collaboration characteristics under different treatment paths. The hysteroscopy center of our hospital undertakes nearly 7,000 hysteroscopic surgeries of various subspecialties every year, and is equipped with high-definition hysteroscopy, multimodal image management platform, online management platform for surgical images and a broadcasting system inside and outside the hospital. Therefore, the sample has continuous, real and stable specialty application attributes.

The experiment in this paper is completed in the existing deployment environment of the platform. In terms of hardware, the platform relies on the existing digital operating room and network environment of the center, and is supported by terminal equipment, image acquisition equipment and server resources. In terms of software, the system adopts a three-tier structure

based on B/S mode, uses MySQL as the core data storage engine, and establishes standardized exchange links with HIS, LIS, PACS, EMR and other hospital information systems through ESB. So as to ensure that the basic information of patients, test results, imaging data and medical records can be read, transmitted and written back in a unified platform.

The verification contents selected in this paper include modules that have been put into use, such as patient access management, patient information management, graphic and text report management, doctor management and authority file management. The corresponding observation dimensions include the integrity of cross-system data synchronization, the continuity of business status transmission, the accessibility of intraoperative information retrieval, the efficiency of graphic and text report formation, the effectiveness of permission retention, and the support ability of the platform for surgical qualification management, appointment organization, patient unified management, quality data collection and personnel statistics. At the same time, the experiment records the differences in qualification audit methods, appointment methods, patient management scope, quality information collection and personnel statistics before and after the use of the platform, so as to complete the comprehensive verification from two levels of clinical application and department management, and enhance the interpretability and comparability of the results.

5 Analysis of experimental results

5.1 Analysis of experimental results of performance and data processing response of platform hierarchical architecture

This section analyzes the performance of the platform hierarchical architecture and the response of data processing. The statistical object is 600 patient records that have been included in the unified management since the platform was put into clinical practice in December 2025, and the service performance of the system in the business environment is verified by combining with five types of high-frequency logs such as patient access, information retrieval, graphic and text reports, authority control and file writeback. Since the platform adopts B/S three-tier structure and establishes standardized exchange links with HIS, LIS, PACS, and EMR through ESB, this section simultaneously focuses on the continuity of three levels: page response, cross-system call, and result writeback.

As shown in Fig. 2, there are stable differences in the average response delay of core modules under different service entries. In the outpatient entrance, the average delay of patient admission, information retrieval, graphic and text report, authority management and file writeback were 0.86 s, 1.12 s, 1.42 s, 0.74 s and 1.28 s, respectively. The corresponding emergency entrance was 0.91 s, 1.18 s, 1.57 s, 0.79 s and 1.35 s. The corresponding daytime entrance was 0.88 s, 1.15 s, 1.49 s, 0.76 s and 1.31 s. On the whole, the graphic and text report module was always in the highest time-consuming area, followed by patient information retrieval, and the lowest authority management, indicating that the main performance pressure of the platform was concentrated in image calling, field writing and cross-system information integration. The module ordering of the three types of entry is basically consistent, indicating that the hierarchical architecture maintains a relatively stable response boundary state under different patient sources.

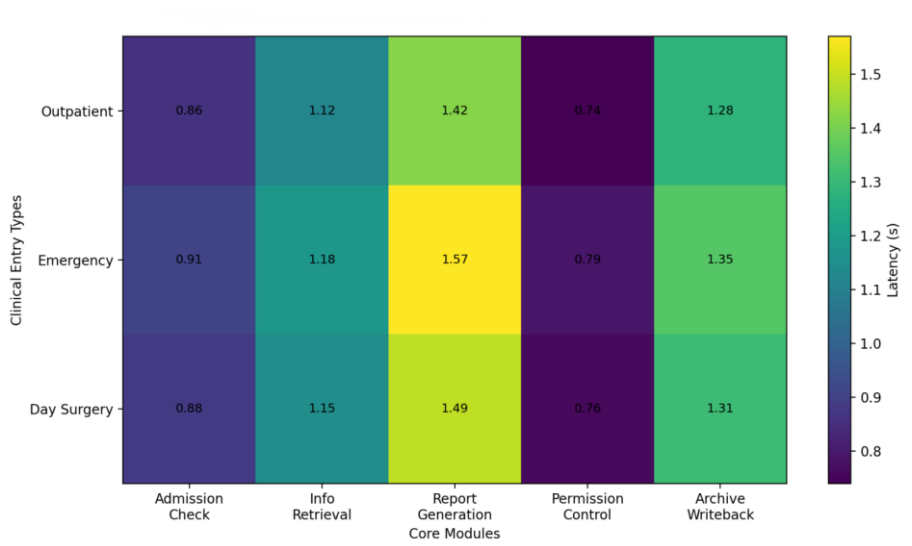

Figure 2: Heat map of the average response delay of the core module under different service entries

As shown in Fig. 3, the delay distribution of high-frequency requests presents different stability levels. The median delay of patient admission verification request was 0.84 s, and the interquartile range was 0.21 s, indicating that the processing process of the module was more concentrated. The median delay of intraoperative information retrieval request was 1.18 s, and the 95% quantile value was 1.96 s, indicating that there was still a certain tail delay in the high-frequency stage of cross-system real-time reading. The median delay of image acquisition and saving request was 1.37 s, and the upper demand extended to 2.31 s, with the highest dispersion degree, reflecting the influence of intraoperative continuous writing and parameter synchronous updating on performance. The median delay of the report printing request is 0.73 s, and the box is the shortest and the abnormal point is the least, which indicates that this link has entered a stable output stage after the template generation. On the whole, the instantaneous load of the platform is mainly concentrated in the image acquisition and intraoperative call chain. The fluctuation of patient admission and report printing is small, and the overall operation is in the acceptable range.

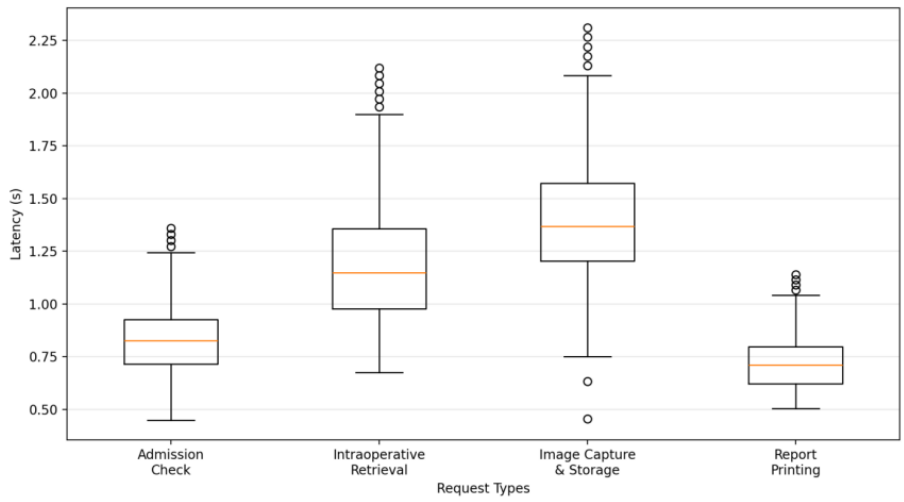

Figure 3: Distribution of box lines for high-frequency request processing delay

As shown in Fig. 4, cross-system data exchange shows a clear scatter distribution of multi-round observations between call size and writeback time consumption. The 10-round observation points of HIS link are mainly distributed between 668-696 / day and 1.03-1.13 s, and the central position corresponds to the average daily exchange capacity of 682 and the average write-back time of 1.08 s. The scatter points of LIS links are mainly concentrated in the range of 520-548 / day and 0.91-1.01 s, and the central value is 534 / day and 0.96 s. The scatter distribution of PACS links is between 403-431 / day and 1.39-1.49 s, and the central value is 417 / day and 1.44 s. The scatter points of EMR links are mainly located between 589 and 617 / day and 0.97 and 1.07 s, and the center value is 603 / day and 1.02 s. There is no obvious overlap between the scatter clusters of each system, which indicates that different switching links have clear performance boundaries in terms of call size and writeback time. Among them, PACS still has higher writeback time consumption when the exchange amount is not the highest, indicating that the current data response pressure of the platform is still mainly concentrated in the stage of image large object processing, while the exchange efficiency of text and structured records is relatively stable.

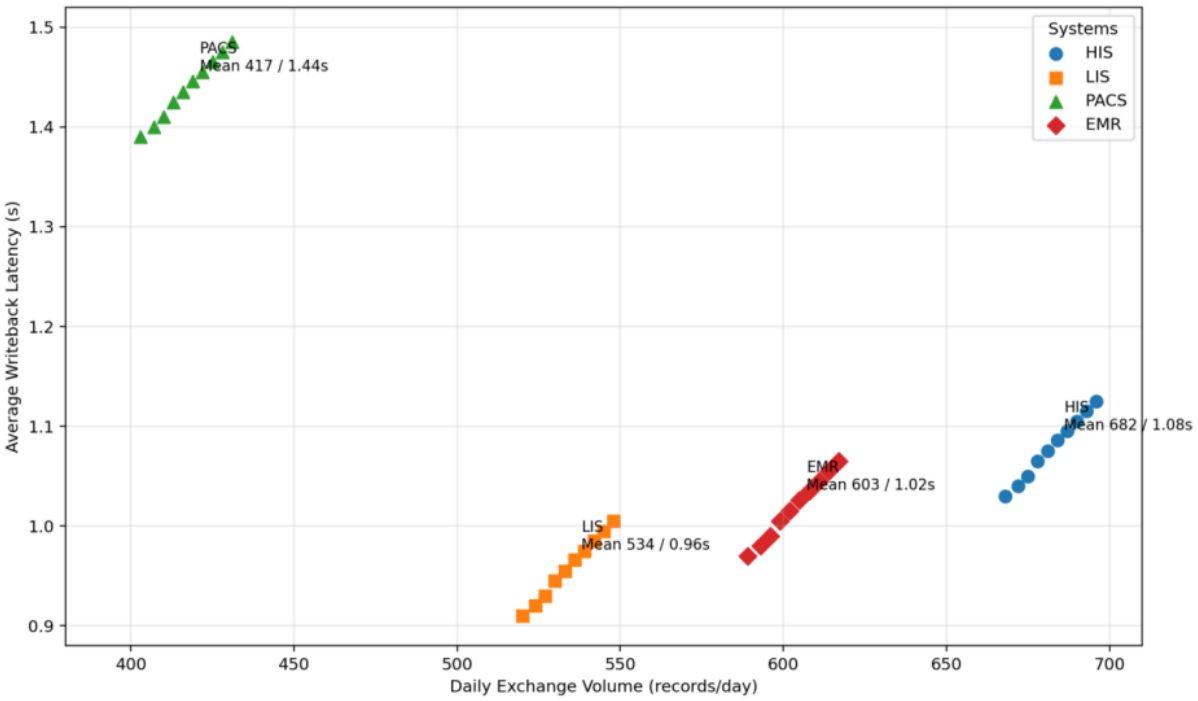

Figure 4: Scatter plot of data exchange volume and writeback time consumption across systems

To further observe the steady-state characteristics of the platform under continuous operation conditions, Table 4 summarizes the statistical results of 10 rounds. The success rate of interface calls remained between 98.9% and 99.4%, with an average of 99.2%±0.16%. The service availability remained between 99.3% and 99.5%, with an average of 99.4%±0.08%. The average time of file writeback decreased from 1.34 s to 1.21 s, with an average of 1.28±0.04 s. The session anomaly rate was controlled between 0.71% and 0.82%, with an average of 0.77%±0.05%. The small discrete range indicates that there is no obvious jitter of the platform during continuous use.

Table 4: Statistical results of platform stability in continuous operation

Metric	Round 1	Round 5	Round 10	Mean ± Standard Deviation
Interface invocation success rate / %	99.1	99.3	99.2	99.2 ± 0.16
Service availability / %	99.3	99.4	99.4	99.4 ± 0.08
Average archive write-back time / s	1.34	1.27	1.21	1.28 ± 0.04
Session anomaly rate / %	0.82	0.76	0.71	0.77 ± 0.05

Synthesizing the analysis in this section, it can be seen that the platform layered architecture forms a stability boundary in the specialized environment. The pressure of request processing is mainly concentrated on the link of graphic and text report and image exchange. The success rate of cross-system calls is still high, and there is no obvious delay in file writeback and permission trace. The existing structure can not only support the current clinical use intensity of hysteroscopy center, but also reserve a reliable calculation foundation for subsequent statistical analysis, teaching transmission and function expansion.

5.2 Platform core function module collaboration and intelligent management application analysis

In this section, after the hierarchical architecture of the platform and the data processing response analysis are completed, the collaborative application effect of the core function modules is verified. The statistical object was 600 patient records included in the unified management of the platform. Combined with the access judgment log, information retrieval log, graphic and text report records, authority audit log and the statistical results of the management end, the clinical collaboration ability and management support ability were comprehensively analyzed. This section examines both the linkage strength between modules and the actual role of the platform in qualification supervision, appointment integration, patient management and quality data collection.

As shown in Fig. 5, the synergy matrix among the five types of core modules presents a hierarchical relationship. The linkage strength of patient access management and patient information management reached 0.91, the linkage strength of patient information management and graphic and text report management was 0.88, and the linkage strength of graphic and text report management and authority file management was 0.84, indicating that once the case object entered the platform, preoperative verification, intraoperative call and postoperative filing had formed a continuous call chain. The linkage value between doctor management and graphic report management was 0.76, which was higher than 0.69 between doctor management and patient access management, indicating that qualification review and scheduling information played more roles in operation execution and report formation.

Figure 5: Heat map of collaboration strength of core functional modules

As shown in Fig. 6, in the overall collaborative loss comparison, the baseline method decreases rapidly in the first 20 rounds, then enters the slow convergence stage, and stabilizes around 0.432 in the 200th round. The proposed method also decreases rapidly in the initial stage, but has entered a lower fluctuation range after about 60 rounds, and the final stable value is about 0.378. The results show that the module organization method of the proposed platform has higher consistency in terms of case index unification, state flow compression and function call cohesion, so it can form a more stable collaboration boundary in a shorter iteration cycle. The bottom half shows the change of constrained response loss. The baseline method stabilizes at about 1.256 after 200 rounds, while the corresponding value of the proposed method is 1.147, which is lower than the control method as a whole. Neither of the two sets of curves showed a significant rebound in the later stage, indicating that the platform maintained good structural stability under the constraints of permission control, archive writeback and resource matching. It can be seen that the proposed method is superior to the baseline method in module cooperative organization and constraint response control, which is more suitable for supporting the multi-module linkage operation scenario of hysteroscopy center.

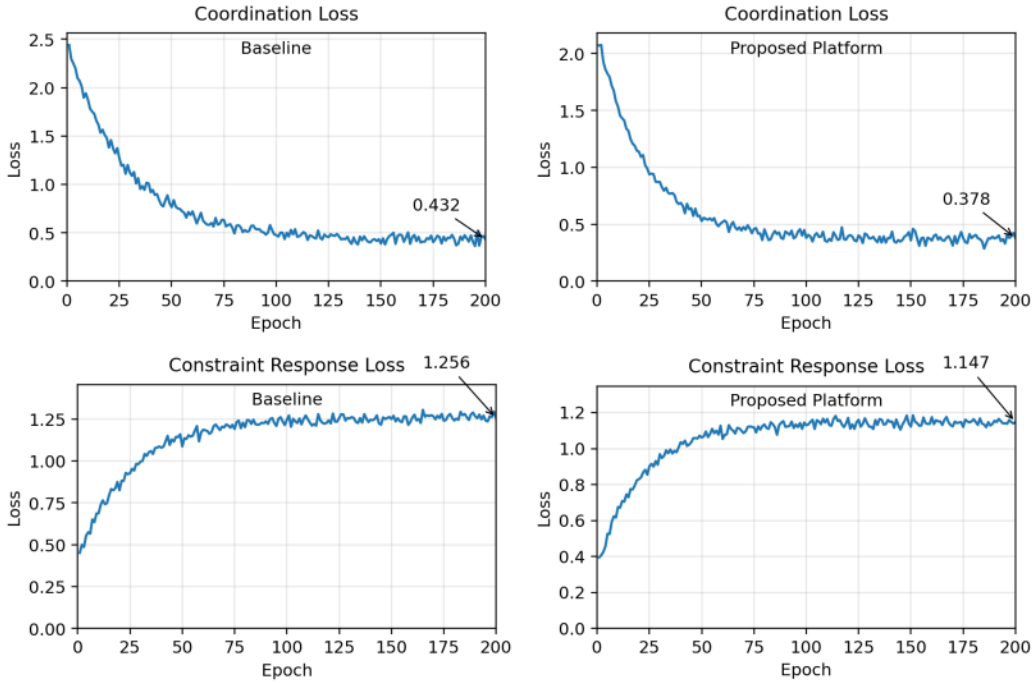

Figure 6: Comparison plot of collaborative optimization loss convergence of platform core function modules

Table 5 summarizes the changes in the five management indicators before and after the launch of the platform. Surgical qualification management was changed from manual audit by head nurses to dynamic supervision after interworking with the qualification supervision system, and the audit time was reduced from 6.8 minutes to 2.1 minutes. After the integration of the appointment path, the single appointment confirmation time was reduced from 9.4 minutes to 3.6 minutes. After the integration of patient management into the unified case object, the number of cross-system data checks was reduced from 3.7 to 1.2. After the quality data collection, the preparation time of monthly statistics was reduced from 124 minutes to 38 minutes. The deviation rate of workload settlement was reduced from 4.6% to 1.3% after the personnel management was changed from manual statistics to automatic platform summary.

Table 5: Comparison of smart management application effects before and after the platform launch

Management Dimension	Without Dedicated Platform	Smart Management Platform	Change Range
Surgical qualification management	Manual review by the head nurse, 6.8 min/case	Interconnected qualification system, 2.1 min/case	-69.1%
Appointment pathway	Multiple channels including manual appointment, 9.4 min/case	Unified entry, 3.6 min/case	-61.7%
Patient management	Hybrid management, 3.7 verifications/case	Full-cycle unified management, 1.2 verifications/case	-67.6%
Quality management	Scattered information, 124 min/month	Classified aggregation, 38 min/month	-69.4%
Personnel management	Manual statistics, deviation rate 4.6%	Automatic aggregation, deviation rate 1.3%	-71.7%

To further verify the contribution of different modules to the overall synergy effect, Table 6 presents the ablation experiment results. The complete platform reached 93.8%, 91.6%, 96.4% and 98.1% in the four indicators of collaborative completion rate, report formation efficiency, management and statistics accuracy rate and permission retention integrity rate, respectively. After removing patient admission management, the collaborative completion rate dropped to 86.9%. After removing the graphic report management, the report formation efficiency was reduced to 82.7%. After removing doctor management, the accuracy of management statistics decreased to 90.8%. After removing the management of permission files, the integrity rate of permission retention drops to 89.6%.

Table 6: Results of ablation experiments for core functional modules

Model Configuration	Collaboration Completion Rate / %	Report Generation Efficiency / %	Management Statistics Accuracy / %	Permission Trace Integrity / %
Full platform	93.8	91.6	96.4	98.1
Without patient admission management	86.9	90.8	95.7	97.9
Without image-text report management	91.2	82.7	95.9	97.4
Without physician management	92.4	90.5	90.8	97.6
Without permission and archive management	92.7	91.1	95.8	89.6

Based on the above, it can be seen that the core function modules of the platform have formed a collaborative structure, which interacts under the unified case object, unified state flow and unified authority boundary. This implementation method not only enhances the continuity of access verification, information retrieval and report generation, but also enhances the management support ability of qualification supervision, quality collection and personnel statistics, so that the platform has the application foundation.

6 Discussion

Based on the above experimental results, it can be seen that the value of the intelligent management platform of hysteroscopy center is not only reflected in the independent operation of a single module, but also in the platform with the help of B/S three-tier architecture, ESB exchange link and MySQL data base. Patient access, information retrieval, graphic and text reports, doctor management and authority file management are put into the unified case object and unified status flow. With this structure, outpatient, emergency and inpatient day patients can follow a relatively fixed digital path to complete verification, review, report and filing after entering the system, which reduces the process of manual switching systems and repeated checking information. Since the platform went online, 600 patient records have been included, indicating that the structure has a continuous carrying capacity in a real specialist environment. At the same time, the changes in the methods of qualification audit, appointment organization, quality collection and personnel statistics also show that intelligent construction has shifted from single tool use to continuous operation support of departments. However, the functions of statistical analysis, data insight and system Settings of the current platform are still in the stage of continuous refinement, and there is still

room for further improvement in the efficiency of image large object processing, interface expansion ability, permission granularity and rule configuration flexibility. In the future, if the depth of data governance and module reuse ability are further enhanced, the platform will form a more stable computing support in the specialized service organization, quality management, teaching support and scientific research utilization. From the system perspective, this support is not a simple information aggregation, but a compression of clinical processes, management actions and data traces into the platform boundary, so that subsequent extensions are established in a unified interface and unified data semantics.

7 Conclusions

This paper focuses on the design and function implementation of the intelligent management platform of hysteroscopy center. Combined with the actual scene of complex patient sources, large operation volume, decentralized system and multiple management links in the center, a dedicated platform based on B/S three-tier architecture, ESB service bus and MySQL data engine is constructed. The platform takes the unified case object as the core, and integrates patient access management, patient information management, graphic and text report management, doctor management and authority file management into the same data link and status chain, and realizes the continuous flow of test, image, medical record and surgery information through cross-system interconnection. The application verification shows that the platform has gradually formed a more stable operating boundary in terms of module collaboration, data response and management support, which not only compresses the cost of manual verification and system switching, but also enhances the digital processing capabilities of qualification audit, appointment organization, quality collection and personnel statistics.

There are still some limitations in this paper. First, the current validation samples are mainly from 600 patient records after the platform is officially launched, and there is still room for further expansion of the sample size and operation cycle, which is not sufficient to cover the fluctuation characteristics under a longer time span. Second, the functions of statistical analysis, data insight and system setup are still in the stage of continuous improvement, and the current advantages of the platform mainly focus on clinical collaboration and management linkage. Thirdly, image large object processing, fine-grained authority control and cross-hospital interface expansion still need to be further refined with subsequent deployment.

The follow-up research can be promoted from three directions: first, continue to expand the case scale and operation cycle to enhance the stability of the platform evaluation; The second is to improve the ability of data governance, rule configuration and visual analysis, and enhance the adaptive management level of the platform. The third is to expand the reuse interface for teaching support, scientific research utilization and cross-institution collaboration, so that the platform is further developed from a specialized application tool to a sustainable evolution of the digital operation base.

References

[1] Görtz M, Byczkowski M, Rath M, et al. A platform and multisided market for translational, software-defined medical procedures in the operating room (OP 4.1): proof-of-concept study[J]. JMIR Medical Informatics, 2022, 10(1): e27743.

[2] Leung F, Lau Y C, Law M, et al. Artificial intelligence and end user tools to develop a nurse duty roster scheduling system[J]. International journal of nursing sciences, 2022, 9(3): 373-377.

[3] Curchoe C L, Bormann C, Hammond E, et al. Assuring quality in assisted reproduction laboratories: Assessing the performance of ART Compass—A digital art staff management platform[J]. Journal of Assisted Reproduction and Genetics, 2023, 40(2): 265-278.

[4] Chen M, Kong W, Li B, et al. Revolutionizing hysteroscopy outcomes: AI-powered uterine myoma diagnosis algorithm shortens operation time and reduces blood loss[J]. Frontiers in Oncology, 2023, 13: 1325179.

[5] Demir K C, Schieber H, Weise T, et al. Deep learning in surgical workflow analysis: a review of phase and step recognition[J]. IEEE Journal of Biomedical and Health Informatics, 2023, 27(11): 5405-5417.

[6] Choksi S, Szot S, Zang C, et al. Bringing artificial intelligence to the operating room: edge computing for real-time surgical phase recognition[J]. Surgical Endoscopy, 2023, 37(11): 8778-8784.

[7] Samad M, Angel M, Rinehart J, et al. Medical Informatics Operating Room Vitals and Events Repository (MOVER): a public-access operating room database[J]. JAMIA open, 2023, 6(4): ooad084.

[8] Cheikh Youssef S, Haram K, Noël J, et al. Evolution of the digital operating room: the place of video technology in surgery[J]. Langenbeck's archives of surgery, 2023, 408(1): 95.

[9] Bottani E, Bellini V, Mordonini M, et al. Internet of things and new technologies for tracking perioperative patients with an innovative model for operating room scheduling: Protocol for a development and feasibility study[J]. JMIR Research Protocols, 2023, 12(1): e45477.

[10] Ellis L B, Barcroft J, St John E, et al. Digital consent in gynecology: an evaluation of patient experience[J]. Archives of Gynecology and Obstetrics, 2024, 309(2): 611-619.

[11] Li B, Chen H, Lin X, et al. Multimodal learning system integrating electronic medical records and hysteroscopic images for reproductive outcome prediction and risk stratification of endometrial injury: a multicenter diagnostic study[J]. International Journal of Surgery, 2024, 110(6): 3237-3248.

[12] Bellini V, Russo M, Domenichetti T, et al. Artificial intelligence in operating room management[J]. Journal of medical systems, 2024, 48(1): 19.

[13] Laterza V, Marchegiani F, Aisoni F, et al. Smart operating room in digestive surgery: A narrative review[C]//Healthcare. MDPI, 2024, 12(15): 1530.

[14] Cramer E, Kucharski A B, Kreimeier J, et al. Requirement analysis for an AI-based AR assistance system for surgical tools in the operating room: stakeholder requirements and technical perspectives[J]. International Journal of Computer Assisted Radiology and

Surgery, 2024, 19(11): 2287-2296.

[15] Alves M, Seringa J, Silvestre T, et al. Use of Artificial Intelligence tools in supporting decision-making in hospital management[J]. BMC Health Services Research, 2024, 24(1): 1282.

[16] Azriel D, Rinott Y, Tal O, et al. Surgery duration prediction using multi-task feature selection[J]. IEEE Journal of Biomedical and Health Informatics, 2024, 28(7): 4216-4223.

[17] Kang D W, Zhou S, Niranjan S, et al. Predicting operative time for metabolic and bariatric surgery using machine learning models: a retrospective observational study[J]. International Journal of Surgery, 2024, 110(4): 1968-1974.

[18] Lin X, Liang C, Liu J, et al. Artificial intelligence–augmented clinical decision support systems for pregnancy care: systematic review[J]. Journal of medical Internet research, 2024, 26: e54737.

[19] Brandão M, Mendes F, Martins M, et al. Revolutionizing women's health: A comprehensive review of artificial intelligence advancements in gynecology[J]. Journal of Clinical Medicine, 2024, 13(4): 1061.

[20] Patel D J, Chaudhari K, Acharya N, et al. Artificial intelligence in obstetrics and gynecology: transforming care and outcomes[J]. Cureus, 2024, 16(7).

[21] Levin I, Rapoport Ferman J, Bar O, et al. Introducing surgical intelligence in gynecology: automated identification of key steps in hysterectomy[J]. International Journal of Gynecology & Obstetrics, 2024, 166(3): 1273-1278.