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# Heterogeneity in Online Doctor–Patient Interaction Among Clinicians: An Empirical Study Based on Aggregated Occupational Profiles

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**Abstract:** With the continuous deepening of medical insurance payment-mode reform, the average length of hospitalization in public hospitals has been shortened significantly, and a large number of rehabilitation and follow-up treatment services have been transferred to the community and home settings. Online doctor-patient interaction has gradually transformed from a supplementary service to an important guarantee for continuous post-discharge health management, the reduction of unplanned readmissions, and the improvement of medical care quality. In order to realize the continuity of post-discharge care, many public hospitals have built "Internet-plus" medical service channels represented by Internet hospitals and Enterprise WeChat to carry out online asynchronous or real-time text communication between doctors and patients. However, obvious group-level differences exist in clinicians' willingness to participate, response quality, and adherence to work in online services, which have become a bottleneck restricting the standardized promotion of online follow-up management. From the perspective of group heterogeneity and organizational behavior, this paper takes the cross-system operation data from January to December 2025 as the research sample and empirically analyzes the heterogeneous characteristics of clinicians' online doctor-patient interaction behaviors based on their occupational attributes. The findings can provide a decision-making reference for hospitals to formulate differentiated incentive strategies and optimize the long-term operation mechanism of post-discharge online continuous care.

**Keywords:** Online doctor-patient interaction; Post-discharge continuous care; Clinician behavior; Group heterogeneity; Internet-plus healthcare

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## 1. Introduction

Due to the reform of medical insurance payment methods, hospital inpatient stays have been shortened, and postoperative rehabilitation and follow-up care have shifted to off-hospital scenarios. Online doctor–patient

interaction has become critical to ensuring continuous care quality and reducing hospital readmissions. This study defines such interaction as off-hospital text communication via Internet hospitals and Enterprise WeChat, measured by physicians' active message volume, reply rate, and first-response latency. Despite standardized digital service infrastructure, clinicians show prominent group heterogeneity in online service performance. Different from individual-level research, this study adopts organizational behavior and group heterogeneity perspectives. Using 2025 full-year cross-system data, it empirically analyzes clinicians' heterogeneous online interaction behaviors based on occupational group profiles.

## 2. Research methods and design

### 2.1. Literature analysis

We systematically reviewed classic Chinese and international literature on medical behavior, online doctor–patient interaction, the Job Demands–Resources (JD-R) model, and role theory, summarized key findings and recent theoretical advances, and identified research gaps. Addressing the limitations of prior work—which has largely been confined to front-end online consultations, revenue-generating online medical behaviors, and individual-level micro perspectives—this study uses literature-based deduction to extend the analytical focus to group-level heterogeneity among occupational-profile subgroups [1].

### 2.2. Questionnaire survey

Building on literature analysis and the Delphi method, the questionnaire comprised two parts. The first part captured profile-identifying characteristics along four dimensions: sex, professional rank, department, and years of clinical practice. The second part employed Likert-scale items to measure subjective perceptions along three dimensions: workload, role conflict, and professional efficacy. The survey was used solely to collect psychological-perception data for independent and mediating variables; dependent variables reflecting actual online interaction output were extracted strictly from system logs. Variable names and definitions are presented in **Table 1**.

**Table 1.** Variable names and definitions

| Variable | Definition |
|---|---|
| Workload | The overall pressure clinicians experience when completing work-related tasks within a given time frame—such as outpatient and emergency caseloads and numbers of surgical procedures—together with perceived time urgency and psychological exhaustion when multiple tasks overlap. |
| Role conflict | Internal strain arising when clinicians confront mutually incompatible tasks or expectations in actual work settings—for example, the structural role strain between fulfilling clinical care roles and taking on new responsibilities created by hospital Internet platforms. |
| Professional efficacy | Also termed personal accomplishment, this refers to physicians' positive psychological appraisal of their professional competence and the social value of their work—for instance, the sense of professional achievement derived from successfully addressing patients' genuine post-discharge medical needs via digital platforms. |
| Number of newly added patient contacts | Patient contacts who have added the physician's WeCom account, linked a patient profile, and completed identity verification. |
| Number of messages sent | The number of one-to-one (private-chat) messages sent by the physician. |
| Reply rate to patient-initiated chats | Within a calendar day, among conversations initiated by a patient, the proportion for which the physician provided a reply. |

| Variable | Definition |
|---|---|
| Average first-response time | Within a calendar day, first-response time is the elapsed time from a patient's first message to the staff member's reply. Average first-response time equals total first-response time divided by the number of private chats that received a reply. |

To clarify group characteristics, the continuous variable of years of clinical practice was segmented, and sex, professional rank, department, and years of clinical practice were used as key grouping variables to aggregate micro-level individual data. Mean values of objective behavioral indicators and subjective scale scores were calculated for individuals in the same profile group, yielding an aggregated dataset representing subgroup features. Subjective and objective feature tables were then merged horizontally, ultimately yielding 235 representative occupational-profile subgroup samples [2].

## 3. Econometric model specification

Empirically, we first used Pearson correlation coefficients to examine the direction of associations among subgroup-level workload, subjective perceptions, and objective behavioral outputs, and then conducted multiple regression analysis using weighted least squares (WLS), with the actual number of individuals in each aggregated group assigned as the weight for each observation. This approach helps correct for heteroskedasticity and assigns greater fitting weight to larger, more representative groups, thereby enhancing the robustness and statistical credibility of the regression results. The baseline econometric model for testing the effects of subgroup subjective perceptions on objective online doctor–patient interaction behavior is specified as follows:

$$Y\_g = \beta_0 + \beta_1 Workload\_g + \beta_2 RoleConflict\_g + \beta_3 Efficacy\_g + \varepsilon\_g$$

where g denotes the g-th occupational-profile subgroup; Y_g represents the subgroup's mean objective online interaction indicators from system logs (e.g., mean number of messages sent and mean first-response time); Workload_g, RoleConflict_g, and Efficacy_g denote the subgroup's mean scores for workload, role conflict, and professional efficacy, respectively; and ε_g is the stochastic error term [3].

## 4. Empirical results and analysis

### 4.1. Measurement model assessment

Given that the empirical analysis constructs profile subgroups from group-aggregated data, reliability and validity tests of the subjective psychological-perception variables were first conducted using individual-level data to ensure the accuracy and methodological soundness of the aggregation basis. In the reliability assessment, Cronbach's alpha coefficients for the workload, role conflict, and professional efficacy scales all substantially exceeded the conventional acceptability threshold of 0.70, indicating sound internal consistency. For validity, confirmatory factor analysis (CFA) was used to evaluate the fit of the measurement model for the core constructs. Results indicated that the three-factor model fit the data well. Standardized factor loadings for all items ranged from 0.515 to 0.927 and were significant at the 0.001 level. Moreover, composite reliability (CR) for each latent variable exceeded 0.70, and average variance extracted (AVE) met the stringent criterion of greater than 0.50, indicating satisfactory convergent validity (see **Table 2**).

**Table 2.** Reliability and validity of subjective variables

| Dimension | Item | Standardized Loading | Cronbach's α | CR | AVE |
|---|---|---|---|---|---|
| Workload | q7 | 0.608 | 0.820 | 0.818 | 0.678 |
| | q8 | 0.625 | | | |
| | q9 | 0.927 | | | |
| | q10 | 0.886 | | | |
| Role conflict | q11 | 0.741 | 0.872 | 0.871 | 0.730 |
| | q12 | 0.890 | | | |
| | q13 | 0.818 | | | |
| | q14 | 0.713 | | | |
| Professional efficacy | q15 | 0.515 | 0.877 | 0.877 | 0.675 |
| | q16 | 0.835 | | | |
| | q17 | 0.915 | | | |
| | q18 | 0.869 | | | |
| | q19 | 0.696 | | | |
| | q20 | 0.538 | | | |

## 4.2. Descriptive statistical analysis

This study conducted descriptive statistics on 235 clinician occupational subgroups. The results revealed significant group heterogeneity and polarization in both subjective perceptions and objective online doctor–patient interaction performance. Clinicians reported generally high and consistent workload pressure (M = 78.54, SD = 9.77) across departments and ranks. By contrast, role conflict varied greatly among groups (M = 63.33, SD = 14.28, range = 31.25–87.50), reflecting distinct role strain when balancing offline clinical work and online services. Clinicians maintained moderate professional efficacy (M = 57.42). Objectively, the overall patient chat reply rate was merely 24.97%, and the average first-response time reached 43.46 minutes with extreme individual fluctuations. Such disparities stem from varied clinical scheduling intensity and inconsistent online work engagement among clinician groups [4]. See **Table 3**.

**Table 3.** Descriptive statistics

| Variable | N | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Workload | 235 | 78.54175 | 9.771629 | 50 | 95.3125 |
| Role conflict | 235 | 63.32584 | 14.27869 | 31.25 | 87.5 |
| Professional efficacy | 235 | 57.42324 | 10.33834 | 39.334 | 83.33 |
| Newly added patient contacts | 235 | 254.8058 | 327.7769 | 1.0 | 1507 |
| Messages sent | 235 | 1250.254 | 2162.577 | 1.0 | 12150 |
| Reply rate to patient-initiated chats | 235 | 0.249696 | 0.1708403 | 0.1 | 0.71 |
| Average first-response time | 235 | 43.45874 | 37.23494 | 0.1 | 174.5 |

## 4.3. Correlation and weighted least squares regression analyses

### 4.3.1. Correlation analysis

Correlation analysis was conducted to preliminarily assess the direction and strength of associations between subjective psychological perceptions and objective online doctor–patient interaction behaviors across occupational-profile subgroups.

As shown in **Table 4**, workload was significantly and positively correlated with role conflict (r = 0.5996, $p = 0.0001$), and was negatively, though non-significantly, correlated with professional efficacy (r = −0.083, $p = 0.6353$). These patterns suggest that, in routine clinical environments, groups carrying heavier workloads not only experience more severe role strain but may also experience some attenuation in their sense of accomplishment in medical work. Workload was significantly and negatively correlated with both messages sent (r = −0.3688, $p = 0.0292$) and the reply rate to patient-initiated chats (r = −0.3447, $p = 0.0426$), indicating less active online interaction output among high-workload groups. Professional efficacy was significantly and positively correlated with newly added patient contacts (r = 0.5796, $p = 0.0003$), messages sent (r = 0.4858, $p = 0.0031$), and the reply rate to patient-initiated chats (r = 0.4264, $p = 0.0106$).

Notably, role conflict was significantly and negatively correlated with average first-response time (r = −0.3981, $p = 0.0179$), whereas professional efficacy was significantly and positively correlated with average first-response time (r = 0.4360, $p = 0.0088$); in other words, groups with higher efficacy exhibited longer objective response latencies. This phenomenon is further examined in the subsequent regression analysis.

**Table 4.** Correlation analysis

| | Workload | Role conflict | Prof. efficacy | New patient contacts | Messages sent | Chat reply rate | First-response time |
|---|---|---|---|---|---|---|---|
| Workload | 1 | | | | | | |
| Role conflict | 0.5996 (0.0001) | 1 | | | | | |
| Prof. efficacy | −0.083 (0.6353) | −0.3549 (0.0364) | 1 | | | | |
| New patient contacts | −0.1271 (0.4668) | −0.169 (0.3318) | 0.5796 (0.0003) | 1 | | | |
| Messages sent | −0.3688 (0.0292) | −0.2462 (0.154) | 0.4858 (0.0031) | 0.7190 (0) | 1 | | |
| Chat reply rate | −0.3447 (0.0426) | −0.209 (0.2283) | 0.4264 (0.0106) | 0.3937 (0.0193) | 0.6565 (0) | 1 | |
| First-response time | −0.0618 (0.7245) | −0.3981 (0.0179) | 0.4360 (0.0088) | 0.2876 (0.0939) | 0.3764 (0.0258) | 0.5935 (0.0002) | 1 |

Note: Figures in parentheses are *p*-values.

### 4.3.2. Least squares regression analysis

To estimate the net effects of different perceptual characteristics on online doctor–patient interaction behaviors more precisely, WLS regression models were constructed with aggregated subgroup size as the weight. For all three dependent-variable specifications, the model significance tests (Prob > F) were below 0.05, indicating that the models were jointly significant (see **Table 5**).

In Model M1 (proactive online interaction output; dependent variable: number of messages sent), workload exerted a marginally significant negative effect on messages sent (coefficient = −68.5165, $p = 0.068$). That is, a one-unit increase in the workload score was associated with an average reduction of approximately 68.5 proactive messages sent by the group over the observation period. This indicates that high clinical workload is a core factor inhibiting physicians' proactive initiation of online communication. In Model M2 (response timeliness; dependent variable: average first-response time in minutes), professional efficacy had a significant positive effect on first-response time (coefficient = 1.3652, $p = 0.015$). A one-unit increase in

mean efficacy was associated with a 1.36-minute increase in average first-response latency. In Model M3 (interaction conversion; dependent variable: reply rate to patient-initiated chats), workload showed a marginally significant negative effect on reply rate (coefficient = −0.0063, $p = 0.063$), indicating that groups with heavier workloads were less likely to convert patient inquiries into effective interactions (a one-unit increase in the score corresponding to a 0.63-percentage-point decline in reply rate). Professional efficacy, by contrast, exerted a significant positive effect (coefficient = 0.0062, $p = 0.014$): profile-defined groups with higher efficacy replied to a significantly larger share of patients (a one-unit increase corresponding to a 0.62-percentage-point absolute increase in reply rate).

**Table 5.** Weighted least squares regression results

| Variable | M1: Proactive interaction | M2: Response timeliness | M3: Interaction conversion |
|---|---|---|---|
| Workload | −68.516* | −0.149 | −0.006* |
| Role conflict | −2.281 | −0.351 | 0.004 |
| Professional efficacy | 39.132 | 1.365** | 0.006** |
| Constant | 4720.736* | 2.901 | 0.163 |
| Number of subgroups (N) | 235 | 235 | 235 |
| Model significance (F) | 4.31** | 3.80** | 3.31** |
| $R^2$ | 0.295 | 0.269 | 0.243 |
| Adjusted $R^2$ | 0.226 | 0.198 | 0.169 |

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

# 5. Results and discussion

## 5.1. Workload significantly suppresses clinicians' proactive online interaction

The findings indicate that workload exerted marginally significant negative effects on both clinicians' proactive online doctor–patient interaction and interaction conversion rates. From an occupational-profile perspective, groups with poorer online interaction performance were clustered in two types of subgroups. The first comprised physicians in the surgical system with intermediate or lower professional ranks and fewer than 10 years of clinical practice. Such subgroups shoulder intensive offline physical and cognitive demands—including substantial surgical assistance, perioperative management, and inpatient care—with significantly elevated mean workloads, while message volume and reply conversion rates fell in the lower percentiles among the 235 subgroups. The second comprised junior- and intermediate-rank subgroups in the medical system with high outpatient volumes. Although online interaction scenarios are, in principle, well aligned with their chronic-disease management needs, heavy independent outpatient caseloads and substantial time outside patient encounters devoted to documentation and order processing leave severely insufficient remaining cognitive capacity. The Job Demands–Resources (JD-R) model provides theoretical grounding for these patterns: when job demands remain chronically overloaded, individuals preferentially allocate limited cognitive and temporal resources to offline tasks subject to mandatory performance constraints, while online interaction—a discretionary task lacking immediate penalty mechanisms—is the first to be deferred or handled superficially. This fundamentally explains why high-workload subgroups not only lack willingness to initiate online communication proactively but also struggle to achieve effective interaction conversion even when responding to patient-initiated inquiries. Accordingly, under constraints on total human resources,

relying solely on administrative mandates or high-pressure appraisal to compel universal participation in online doctor–patient interaction is unrealistic; high-workload groups objectively possess no surplus temporal or cognitive resources that can be redirected online.

## 5.2. Level

### 5.2.1. Departmental level: Differentiated task allocation and real-time support mechanisms

For high-workload, low-performing interaction subgroups (typified by junior- and intermediate-rank surgical physicians with fewer than 10 years of clinical practice), department heads should identify peak workload periods in light of surgical schedules and outpatient routines and proactively provide task relief and process support. Specifically, departments may establish "exemption windows" for online messages on peak surgical days, with head nurses or departmental assistants centrally handling standardized patient inquiries (e.g., dressing-change schedules, follow-up appointments, and common postoperative precautions), thereby avoiding the transfer of all messaging pressure onto attending surgeons.

Meanwhile, departments should create necessary infrastructural conditions for core physicians' online work—for example, configuring dedicated message-processing terminals in doctors' lounges and establishing standardized quick-access portals for follow-up appointments—thereby reducing operational friction in online workflows and lowering the effort required to initiate online work.

### 5.2.2. Hospital management level: Differentiated performance appraisal and structural scheduling systems

In designing performance appraisal systems, hospitals should abandon the practice of applying a single "first-response time" or "number of messages sent" metric as a uniform standard for all staff, and instead establish differentiated appraisal frameworks matched to occupational-profile subgroups. For high-workload, low-performing interaction subgroups, appraisal emphasis should fall on participation rather than output volume, with baseline compliance defined by whether a basic online consultation channel has been established and whether critical messages have received triaged responses—thereby avoiding high-intensity quantitative targets that drive these groups into acute role conflict and provoke greater resistance. For such subgroups, annual performance plans should explicitly specify "online interaction exemption conditions": when a physician's monthly surgical caseload or outpatient volume exceeds a designated multiple of the departmental mean, the weight of online interaction indicators in appraisal may be correspondingly reduced, embodying institutional accommodation of high offline workloads [5].

# 6. Conclusions

Drawing on Hospital D's 2025 interaction data, this study moves beyond the limitations of individual-level analysis and constructs a dataset of 235 occupational-profile subgroups. Empirical results demonstrate that clinicians' online doctor–patient interaction behaviors are highly heterogeneous. Intensive workload constitutes the core resource constraint impeding groups' proactive engagement in online interaction and improvement of conversion rates, whereas higher professional efficacy, although objectively lengthening response latency to online inquiries, significantly safeguards ultimate interaction completion rates and is associated with superior interaction quality. This study provides objective and empirically grounded group-level classification evidence for hospital managers seeking to reconfigure human-resource allocation and

performance indicators for online doctor–patient interaction management.

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## Disclosure statement

The authors declare no conflict of interest.

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