Transforming Patient-Physician Interaction Through Asynchronous Online Health Interaction: A Relational Communication Perspective

Xiaofei Zhang
Harbin Institute of Technology, xiaofeizhang@hit.edu.cn

Yi Wu
Tianjin University, yiwu@tju.edu.cn

Joseph S. Valacich
University of Arizona, valacich@arizona.edu

Jeffrey L. Jenkins
Brigham Young University, jjenkins@byu.edu

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Transforming Patient-Physician Interaction Through Asynchronous Online Health Interaction: A Relational Communication Perspective

Xiaofei Zhang,[1] Yi Wu,[2] Joseph S. Valacich,[3] Jeffrey L. Jenkins[4]

[1]School of Management, Harbin Institute of Technology, China, xiaofeizhang@hit.edu.cn
[2]College of Management and Economics / Laboratory of Computation and Analytics of Complex Management Systems, Tianjin University, China, yiwu@tju.edu.cn
[3]Eller College of Management, University of Arizona, USA, valacich@arizona.edu
[4]Marriott School of Business, Brigham Young University, USA, jjenkins@byu.edu

Abstract

Digital transformation integrates technology to modernize traditional processes. Asynchronous online health interactions (AOHIs) have revolutionized patient access to health information globally. Despite widespread AOHI implementation, few studies have thoroughly examined patient satisfaction or assessed the success of AOHI processes. This study, grounded in relational communication theory, introduces three fundamental dimensions for conceptualizing the success of AOHI process—interaction depth, information intensity, and relationship duration. It delves into the correlation between these key interaction factors and patient satisfaction. Additionally, the study identifies two distinctive characteristics of AOHI—provision of medical records and indirect interaction—as contingent elements influencing the proposed relationships. The research model developed, termed the "asynchronous online health interaction model," underwent empirical testing using a robust dataset comprising 79,591 patient-physician interactions extracted from a prominent online healthcare platform. Results reveal that (1) interaction depth, information intensity, and relationship duration positively impact AOHI satisfaction, and (2) the provision of medical records and indirect interaction negatively moderate the effects of interaction depth and information intensity while amplifying the influence of relationship duration on AOHI satisfaction. This study significantly advances existing literature by providing a comprehensive conceptualization of the AOHI process. It highlights specific interaction behaviors and platform features pivotal for satisfaction and offers valuable insights for future healthcare research and practical applications, ultimately enhancing patient experience and healthcare delivery.

Keywords: Asynchronous Online Patient-Physician Interaction, Relational Communication Theory, Interaction Process, Provision of Medical Records, Direct Interaction, Indirect Interaction, Satisfaction

1 Introduction

Information technology has transformed many industries, including healthcare (Aron & Pathak, 2021; Faik et al., 2020). In this digital transformation, online healthcare platforms are commonly used by patients to seek and share health information (Yan & Tan, 2014). The Pew Internet and American Life Project reported that 80% of internet users (an estimated nearly 93 million) in the United States have searched for health information online (Demitz, 2018). Various online healthcare platforms enable patients, physicians, and

other stakeholders to exchange health and medical information. Prior studies have demonstrated that seeking and sharing online health information can benefit different stakeholders, including patients (Yan & Tan, 2014), physicians (Guo et al., 2017), and society generally (Cao & Wang, 2018; Mein Goh et al., 2016).

Among the various types of online health information-seeking and information-sharing behaviors, asynchronous online health interactions (AOHIs) between patients and physicians are an increasingly popular and powerful approach in the digital transformation of healthcare (Liu et al., 2020; Zhang et al., 2025a). AOHIs allow patients and physicians to conduct online interactions from different places and at different times; indeed, in many cases, AOHIs can replace (or augment) traditional face-to-face patient-physician interactions and provide benefits to both patients and physicians. For example, AOHIs save patients the time and effort required for in-person (i.e., offline) appointments, improve efficiency for medical information providers, allow physicians time for reflection before responding to a patient's questions or concerns, and increase patient participation in service encounters (Jucks & Bromme, 2007). Considering these benefits, several AOHI platforms, such as the Mayo Clinic, Practo, Haodf, CONCILIO, mediQuo, and Babylon, have been developed by gathering physicians from offline hospitals around the world to interact with and respond to patients' online queries. In addition, major healthcare providers such as UnitedHealthcare and Blue Cross Blue Shield provide AOHI capabilities to their subscribers. AOHI platforms have emerged throughout the world as a relatively low-cost method for providing non-emergency healthcare services to a broad range of patients (Zhang et al., 2025b).

However, one substantial drawback of the AOHI approach is the difficulty for patients in assessing the quality of the asynchronous text-based health information that these platforms typically provide (Jucks & Bromme, 2007; Kindig et al., 2004). Thus, best practices for designing and executing a successful AOHI are needed in practice and academia. In healthcare, patient satisfaction has been deemed a major indicator of quality (Derose et al., 2001) and thus AOHI quality. Therefore, this study elucidates the interaction process and its impact on satisfaction by exploring the first research question: *How does the patient-physician online interaction process influence AOHI satisfaction?*

The extant literature on online interactions in healthcare has yet to reach a consensus on the best method for assessing the interaction process. Drawing on the relational communication literature (Hancock & Dunham, 2001) and the unique organization of AOHIs (Yang et al., 2015a; Zhang et al., 2019), the present study proposes three core dimensions to conceptualize

the online patient-physician interaction process and determine the outcome of AOHIs and patient satisfaction. These three dimensions are interaction depth, information intensity, and relationship duration. In particular, *interaction depth* refers to the number of rounds of questions and associated answers in a single patient-physician interaction (Palmatier et al., 2006), *information intensity* indicates the overall amount of information exchanged in one patient-physician interaction (Hancock & Dunham, 2001; Iorio et al., 2017), and *relationship duration* specifies the time interval of a single patient physician interaction session (Hancock & Dunham, 2001; Iorio et al., 2017). Based on these three interaction dimensions, this study explores how AOHI questioners (i.e., patients or their representatives) derive satisfaction from interactions with online physicians.

Compared with other online interactions (e.g., buyer-seller interactions), AOHIs have several unique features. For example, the asynchronous nature of AOHIs allows patients to schedule consultations at their convenience, which is often impossible in synchronous or offline health interactions. Patients can provide physicians with medical records, test results, and imaging results to better facilitate online interactions (van der Eijk et al., 2013). According to information richness theory, the quantity and format of information can shape the interaction process (Daft & Lengel, 1986) and improve the outcomes of the interaction (Ramirez & Burgoon, 2004). Also, AOHI platforms provide patients with greater autonomy when deciding on the amount and type of medical record information to provide to physicians, which can shape the interaction process and outcomes. Thus, this study identifies the provision of medical records as a contingent factor of AOHI platforms.

In addition, AOHI platforms support indirect interaction, which occurs when a patient's representative engages in an online interaction with a physician on the patient's behalf, which differentiates AOHI from other common forms of online interactions. A national survey in the United States indicated that about one-third of AOHIs do not take place with the patients themselves but with their relatives or friends (Bass et al., 2006). Many patients are constrained by low information technology self-efficacy, disabilities, or poor health conditions, rendering them unable to use the AOHI platform. Such patients depend on a representative (e.g., family members, in-home care providers, or friends) when consulting a physician via an online platform (Ishikawa et al., 2005). Past studies have suggested that patients' interaction patterns (i.e., indirect versus direct interaction with physicians in AOHIs) can significantly shape the efficiency and quality of healthcare services (Kane & Alavi, 2008). However, the extant literature demonstrates a limited

understanding of how various AOHI capabilities and features—e.g., the provision of medical records and interaction patterns—shape satisfaction development in an AOHI context. Therefore, the present study defines the provision of medical records and indirect interactions as contingent upon the linkage between the interaction process and AOHI satisfaction. Accordingly, the second research question is as follows: *How is AOHI satisfaction influenced by the provision of medical records and indirect interaction?*

To address the research questions, we propose a theoretical model, the *asynchronous online health interaction model*, based on the existing AOHI environments, relational communication theory (RTC), information richness studies, and the indirect interaction literature. We tested his model and the associated hypotheses using an objective interaction dataset ($N = 79,591$) from a leading online healthcare platform.

This study contributes substantially to the extant literature. First, previous studies on online interactions have narrowly conceptualized the interaction process by considering only selected factors, such as informational and emotional support (Yan & Tan, 2014) and response speed and interaction frequency (Yang et al., 2015b). The present study adopts a broader conceptual approach to measure the AOHI process systematically in terms of interaction depth, information intensity, and relationship duration. Although online health interaction has been a popular topic in recent years, there is a dearth of work taking a comprehensive approach to conceptualizing the online interaction processes. In addition, this study is one of the first to conceptualize AOHIs by reconciling factors within RCT. Second, while AOHI is a popular and important topic in the digital transformation of healthcare, a dearth of research exists on the specific features of online interactions between patients and physicians and how such features shape satisfaction development. By identifying the specific features of AOHIs and testing their contingent roles, this study uncovers the underlying mechanisms of AOHIs from a practical and conceptual perspective. Third, through an in-depth examination of the interplay between core interaction factors and AOHI features, this study improves the understanding of the contingent importance of interaction process factors in the online context. Finally, this study reveals the outcome of indirect interactions in healthcare. Together, these contributions have meaningful implications for online health researchers, AOHI system features, and practitioners.

2 Literature Review

2.1 Related Work on Asynchronous Online Health Interaction

The use of information and communications technology (ICT) in healthcare has become ubiquitous throughout the world (Chen et al., 2019, 2025). One key innovation is the use of ICT to improve communication and information exchange between patients and physicians. Numerous online healthcare platforms have emerged to facilitate interactions among patients and between patients and physicians (Zhang et al., 2019). Moreover, these online platforms empower patients to manage their own health information, gain access to remote monitoring services, obtain general information about diseases and wellness, and engage with communities that share similar health interests or issues (Kamis et al., 2014). Among these activities, AOHIs have been found to be similar to face-to-face patient-physician visits in terms of time spent on health issues and ease of interaction (Dixon & Stahl, 2009). Therefore, AOHIs are an efficient approach for patients to access health information and consult online physicians. While AOHI includes any online communication between or among patients and physicians to reveal or exchange health and medical information (Moore, 1989), this study focuses on online interactions solely between patients and physicians.[1]

Although AOHIs have been widely deployed, there is limited understanding of this emerging and significant healthcare platform. One related research stream focuses on the influences of AOHIs on patients. For example, Lu et al. (2011) established that using interactive communication tools improves the relationship between physicians and cancer patients during offline interactions. AOHIs have also been shown to help patients reduce their medical costs (Yang et al., 2015a) and improve their health conditions (Yan & Tan, 2014). Another research stream concentrates on the social impacts of AOHIs. Here, several prior studies have shown that AOHIs can reduce urban-rural health inequality or disparities (Cao & Wang, 2018; Mein Goh et al., 2016).

As an important and emerging area of research, studies are beginning to uncover critical insights regarding the patient-physician interaction process. Specifically, the concept of social support—informational support, emotional support, and companionship—has been adopted to conceptualize online patient-patient interactions (rather than patient-physician interactions) and has been shown to positively influence the health

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[1] We also examine representative-physician interactions; however, for ease of explication, we generally refer to the "patient," meaning either the patient or their representative, except when it is necessary to specifically refer to the patient representative.

conditions of mental health patients (Yan & Tan, 2014). Chen et al. (2019) adopted a similar lens, dividing social support into the categories of provision or receipt. Additionally, Yang et al. (2015a) found that response speed and interaction frequency significantly affect patient satisfaction with the interaction process. Further, Zhang et al. (2019) explored how informational and interpersonal unfairness influences patient-physician relationship development. This prior work views AOHIs monolithically: that is, the studies did not focus on the unique characteristics of the patient-physician interaction process. Consequently, there is no consensus about how to theoretically conceptualize and empirically measure various aspects of AOHI. Additionally, scant knowledge exists about how asynchronous health-related interactions should be distinguished from more general online interactions.

AOHI relationship development has unique characteristics, given the absence of real-time communication and physical co-presence and the development of relationships between patients and physicians over repeated nteractions (Walther & Bunz, 2005; Lu et al., 2011). However, while relationship development is an important feature of AOHIs, it has received less research attention than related areas. Based on prior communication research, this study proposes RCT as a guiding theoretical lens for conceptualizing and measuring AOHI interactions and outcomes (Burgoon & Hale, 1987). RCT is an appropriate foundation for this investigation because it approaches communication motivations from two perspectives: information exchange and relationship development (O'Hair, 1989). RCT fits well with AOHI, since patients not only seek information from interactions with physicians but also develop relationships with them through the asynchronous process. Given that this theory has been widely adopted in health communication and incorporated into the features of AOHIs, it can provide a comprehensive approach for conceptualizing and measuring patient-physician interactions in such contexts.

RCT was initially proposed to conceptualize face-to-face interaction; however, there are two primary differences between AOHIs and general face-to-face interactions (Daft & Lengel, 1986; Dennis et al., 2008), making the core constructs of RCT insufficient for fully conceptualizing AOHIs. The first major difference is that online interactions give patients greater control over the amount and type of information shared with physicians. For example, patients can provide a range of information (e.g., history, prior test results) in various informational formats, including narrative text, charts, images, and multimedia. In contrast, during face-to-face interactions between patients and physicians during office visits or at hospitals, physicians actively guide the information exchange in real time and determine how much information is needed. As such, differences in information richness (provision of medical records or not)

influence not only media choice but also interaction understanding and performance (Dennis et al., 2008).

A second difference between AOHIs and general non-health-related interactions is that many patients are simply unable to communicate directly with a physician on AOHI platforms and instead need family members, friends, or caregivers to communicate indirectly on their behalf (Demitz, 2018). In contrast, in non-health-related question-and-answer interactions, questioners can directly pose questions and receive answers in most cases. Hence, this indirect interaction aspect of AOHI, which is so different from general non-health-related interactions, may further shape the interaction process and performance of AOHI.

Despite these distinguishing features between AOHIs and face-to-face, non-health-related interactions, little research attention has focused on these important aspects of online patient-physician interactions. To further elucidate the underlying mechanism of how the interaction process determines AOHI satisfaction, the present study explores whether and how the provision of medical records and direct versus indirect interaction influences communication success (i.e., AOHI satisfaction). This study extends RCT into the context of online patient-physician communication by conceptualizing and validating a new framework—the AOHI model—aiding future studies by exploring this increasingly important communication context.

2.2 Interaction Process: A Relational Communication Perspective

A key strength of leveraging RCT lies in its recognition of the informational and relational benefits of an interaction, which is particularly relevant in the healthcare context (O'Hair, 1989). People communicate to obtain and deliver information and to modify a social relationship (Watzlawick et al., 2011). Similarly, seeking information through interactions is a means of achieving instrumental and social goals, or a combination thereof (Ramirez et al., 2002). Therefore, from the RCT perspective, patient-physician interaction serves two goals for patients: obtaining health-related information and developing the patient-physician relationship. However, the relationship development aspect has been largely neglected in the current online healthcare research, yet the patient-physician relationship is becoming increasingly important worldwide. For example, online health services and platforms are becoming increasingly popular (Fan et al., 2023; Zhang et al., 2019). Patients, especially those in Eastern cultures, deem interpersonal relationships with online physicians important (Zhang et al., 2019). Thus, when measuring online health interactions, the relationship dimension should be considered, which renders RCT an appropriate theoretical lens through which to conceptualize AOHI.

From the perspective of information seeking (instrumental benefits) in relational communications, interaction depth and information intensity are two key aspects of the online patient-physician interaction process. *Interaction depth* is defined as the total count of question-and-answer rounds within a single patient-physician interaction (Palmatier et al., 2006). A key difference between online and face-to-face interactions is the convenience of retrieving prior interaction content (Zhang et al., 2019). For example, in face-to-face contexts, it is often difficult to recall accurately and fully all aspects of a prior interaction between the same two parties (Kaiya et al., 1995). Yet in online contexts, individuals are able to review and confirm earlier interactions freely (Zhang et al., 2019). Consequently, in subsequent rounds of online patient-physician interaction, a deeper and more focused discussion of a topic can emerge. Further, because the information exchanged between the patient and physician focuses on the patient's particular medical issue or condition, rather than being open to the issues and conditions of multiple patients in a general online community, the amount of focused information exchanged can be relatively high (Ren & Kraut, 2014). Thus, depending on how an AOHI is designed and used, interaction depth can vary among different AOHI configurations, making it essential to measure in order to understand and assess the interaction process.

Information intensity refers to the overall amount of information exchanged during a single patient-physician interaction session and is a key measure when assessing both offline and online interaction processes (e.g., interpersonal knowledge exchange and interpersonal activity) (Hancock & Dunham, 2001; Iorio et al., 2017). Because an AOHI is used to exchange information between physicians and patients, the amount of information exchanged during a single interaction session can vary. For this reason, information intensity is assessed by measuring the amount of information exchanged (Setia et al., 2013), and it is the second dimension we consider when conceptualizing the patient-physician interaction process.

Even though both information intensity and interaction depth are related to information exchange during patient-physician interactions, they are independent in determining interaction quality. Interaction quality is the most important outcome of AOHI and encapsulates two fundamental elements of the service quality model of Brady and Cronin (2001), i.e., behavior and expertise. Specifically, the behavioral dimension is gauged through communication effectiveness (Yarimoglu, 2014). This aspect involves physicians' ability to communicate in understandable language, listen attentively, explain services clearly, and provide assurances about handling problems. Multiple rounds of questioning and answering assist in achieving effective communication; hence, interaction depth reflects the behavioral dimension determinants of AOHI interaction quality. The expertise dimension is anchored in the physician's competence—

namely, that the physician possesses the required skills and knowledge to perform the health consultation (Meng et al., 2024; Yarimoglu, 2014). The overall amount of information exchanged signals the expertise of the physician; thus, information intensity is directly associated with the expertise dimension determinant of AOHI interaction quality.

Finally, from the perspective of patient-physician relationship development (i.e., social benefit) in relational communications, *relationship duration*—defined as the time interval of a single patient-physician interaction—is a critical element in asynchronous interactions. Prior research has shown that relationship duration is a key factor in patient-physician relationship development (Hancock & Dunham, 2001; Petronio et al., 1989). Given that AOHI communication is asynchronous, time lags between patient questions and physician responses do exist, making AOHI communication different from face-to-face or other synchronous communication methods (e.g., phone, text chatting) (Jones et al., 2004). Therefore, this study adopts relationship duration to measure the third dimension of the patient-physician interaction process. In sum, following RCT, interaction depth and information intensity focus on health-related information seeking and sharing, and relationship duration aids in understanding patient-physician relationship development.

2.3 Online Interaction Feature: Provision of Medical Records

The theory of information richness (also known as media richness theory) shows how individuals *choose* a communication method (e.g., face-to-face, phone, email) based on the information requirements and the objectives of the communication event (Daft & Lengel, 1984, 1986). Other media-related research indicates that interaction performance, in addition to media choice, can be affected by the capabilities (or limitations) of an interaction method (Dennis et al., 2008; Lowry et al., 2009; Wang et al., 2016). As online communities and platforms play an important role in society, their capabilities evolve to support different forms of interaction; accordingly, information richness has been used to explore digital or online interaction topics, including electronic brainstorming (Valacich et al., 1993), decision-making (Kahai & Cooper, 2003; Valacich et al., 2009), organizations (Johnson & Lederer, 2005), email (Gattiker et al., 2007), electronic word-of-mouth (Gattiker et al., 2007), communication (Dennis et al., 2008; Lowry et al., 2009), and online communities (Goh et al., 2013), to name a few. In online contexts, studies have extended various aspects of information richness theory by including additional attributes such as the richness of information exchanged through online channels (Goh et al., 2013) or the number of distinct communication episodes a channel can effectively support (Valacich et al., 1993). Given the variety of information that can be exchanged in AOHI contexts (e.g., text, images, and charts) and the easy retrieval of prior communication

episodes, information richness theory and related research provide a strong conceptual foundation for theorizing how different types of information and interaction capabilities shape not only interaction effectiveness but also downstream perceptions, such as AOHI satisfaction.

In this study, we used the provision of medical records to measure the amount and range of information types exchanged during AOHIs. When patients interact with a physician in an AOHI, information containing a range of media—including text reports, numeric test results, charts, and pictures—can be provided (Gattiker et al., 2007). Among them, medical records provided at the beginning of the interaction, including a patient's diagnoses and investigation results from hospitals (Wang et al., 2012), can help the physician understand the patient's health condition quantitatively. Medical records provided at the start of an AOHI can be a significant factor that distinguishes the AOHI from other AOHIs that do not allow for the provision of such records and may have a meaningful influence on the subsequent interaction process. However, although exchanging personal medical records from hospitals is common on online platforms (Frost et al., 2014), the extent to which such information is provided and how this AOHI feature shapes satisfaction development has been underexplored in the current literature. To better understand the linkages between the interaction process and satisfaction, this study leverages the provision of medical records as an AOHI feature that effectively explores these linkages.

2.4 Health Interaction Feature: Interaction Patterns

The use of systems or services can be direct, indirect, or both (Tong et al., 2017). In this study, we define interaction patterns based on whether patients directly interact with physicians in an AOHI. Direct use occurs when a user personally engages with a service. Alternatively, indirect use occurs when one or more intermediary users engage with a service (Kane & Alavi, 2008; Tong et al., 2017) on another user's behalf. Prior research on direct and indirect interaction in healthcare contexts has primarily focused on exploring the physician's use of medical information systems, such as the antecedents (Tong et al., 2017; Xu et al., 2018) and consequences (Kane & Alavi, 2008) of indirect interaction. While some prior research has been conducted on indirect interaction, most prior studies on system or service use have primarily focused on direct use but have disregarded indirect interaction (Delone & McLean, 2003; Liu et al., 2023).

Many patients are unable to interact directly with an AOHI platform. These patients gain access through an intermediary (Bass et al., 2006), and this process illustrates the distinction between direct and indirect AOHI access. While indirect access is common in practice, the literature is scant on this important topic. As

previously discussed, there are many reasons why indirect interaction may occur (e.g., disability or low ICT self-efficacy). In indirect access, the patient's representative, who interacts with the physician, can be viewed as an advocate companion of the patient (van Dijk et al., 2003), supporting their agenda and acting as the patient's voice, thereby mediating the gap between the patient and the physician (Ishikawa et al., 2005). Unlike direct interactions between patients and physicians, indirect interactions incur high interaction costs for representatives. In particular, an indirect interaction requires the representative to enter the patient's information into the AOHI system and then deliver and possibly translate all information shared from the physician (Bisaso et al., 2008). Thus, indirect interaction can be more cumbersome and complicated than direct interaction (Xu et al., 2018). Moreover, Ishikawa et al. (2005) found that advocate companions spend relatively greater behavioral resources when conducting patient-physician interactions, owing to the stress and discomfort caused by exchanging highly personal information about the patient (Greenfield et al., 1985). Therefore, there is a significant interaction cost-benefit difference between direct and indirect interactions.

In the healthcare communication context, indirect interaction is common (Bass et al., 2006). In this case, a patient's representative devotes significant personal effort to developing an ongoing relationship with a physician to facilitate the patient's long-term health guidance (Ford et al., 2011). Although these representatives care about the patient's health, they may not have a clear understanding of the patient's health issues. Thus, they may be even more concerned about the patient's health condition than a patient responding directly would be (Harrison et al., 1995). In such contexts, the patient's representative will pay close attention to developing a long-term relationship with the physician. Thus, even though it requires effort for the representative to exchange information on behalf of a patient, they are likely to value the relationship with the physician because it allows them to advocate better for the patient, and the physician can become a reliable source of information. Therefore, this study identifies interaction patterns as an AOHI feature and further proposes that indirect interaction acts as a contingent factor when exploring AOHI satisfaction.

3 Research Model

The theoretical research model, the *asynchronous online health interaction model*, is presented in Figure 1. The AOHI model illustrates the relationships between core interaction factors (i.e., interaction depth, information intensity, and relationship duration) and AOHI satisfaction and shows that the provision of medical records and indirect interaction are contingency factors that may moderate the influences of core processes on AOHI satisfaction. The hypotheses are proposed in the subsections below.
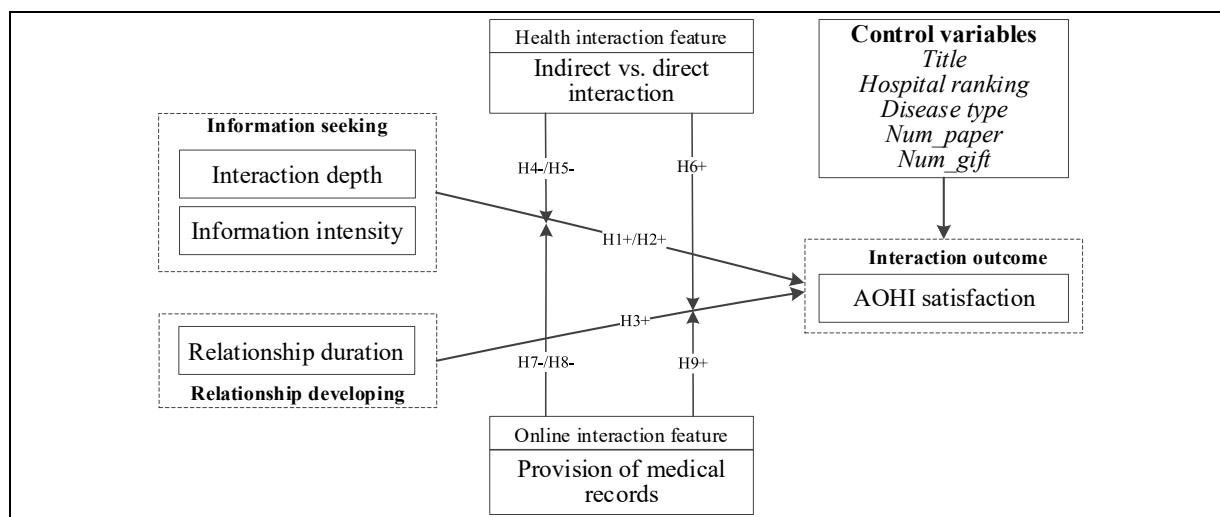
Figure 1. The Asynchronous Online Health Interaction Model

3.1 Effects of the Interaction Process on Satisfaction

Patients will obviously need to gain informational value from the AOHI process in order to feel satisfied. The concepts of *interaction depth* and *information intensity* are proposed to explain the informational value of a patient-physician interaction from the patient's perspective (Kim et al., 2010). Interaction depth was measured as the number of question-and-answer rounds between a patient and a physician in a given AOHI, reflecting the behavioral dimension of interaction quality (Brady & Cronin, 2001). More rounds of interaction imply a greater investment of effort by a physician in comprehending the patient's self-reported symptoms and in communicating professional medical information, which increases the quality of the interaction. Thus, high-quality interactions, as noted by Mauksch et al. (2008), are associated with patients attaining a more comprehensive understanding of their health condition and the available treatments. Accordingly, greater interaction depth (i.e., more question-and-answer exchanges) is more likely to result in the patient viewing the interaction as helpful and interactive, thus improving satisfaction. Therefore, we propose:

H1: The interaction depth of the patient-physician interaction will have a positive influence on AOHI satisfaction.

Information intensity represents the total amount of information exchanged in each AOHI session, indicating the physician's expertise and knowledge in treating the patient (Hancock & Dunham, 2001; Iorio et al., 2017). Therefore, increased information intensity will provide patients with more information about the health issue (e.g., a specific and professional range of information about the condition and the available treatments), which will enable patients to better understand their health condition, leading to higher evaluations of the quality of the interaction. A higher intensity of the information gained by patients from

physicians will thus likely result in associated positive effects regarding both the outcome of the interaction (Ramirez & Zhang, 2007; Xiao et al., 2014) and the patient's evaluation of the quality of the interaction (Brady & Cronin, 2001). Prior studies have shown that positive patient-physician interaction increases satisfaction with the physician and the interaction (Stewart et al., 2000). Therefore, we propose the following:

H2: The information intensity of the patient-physician interaction will have a positive influence on AOHI satisfaction.

As a type of relational communication, patient-physician interactions not only serve to satisfy a patient's informational needs in diagnosing their condition but also serve to develop the relationship between the patient and the physician (Zhang et al., 2019). Seeking disease-related information from a physician reflects the patient's recognition of the expertise of the physician and a willingness to engage in interactions with the physician, which can serve as a foundation for the potential development of a longer-term patient-physician relationship (Burgoon & Hale, 1987). Accordingly, *relationship duration* reflects how long a patient-physician interaction persists, indicating the physician's patience and concern for the patient. In online patient-physician interactions, two-way dyadic interaction aids relationship development between the patient and the physician (Brady & Cronin, 2001; Burgoon et al., 2001). Hence, relationship duration is a proxy for the relational value of the patient-physician interaction within an AOHI. Greater relational value better aligns with the information seeker's preferences for the outcomes of the relational communication (Xu et al., 2010). These observations suggest the following:

H3: The relationship duration of the patient-physician interaction will have a positive influence on AOHI satisfaction.

3.2 Moderating Effects of Indirect Interaction

In the context of indirect communication with an AOHI, Ishikawa et al. (2005) showed that patient representatives tend to expend considerably more behavioral resources—in terms of time and effort—than they would in conducting patient-physician interactions for themselves because of the increased difficulty in obtaining highly personal health-related advice in this context (Greenfield et al., 1985). Further, indirect interaction requires the representative to enter the patient's health information into the AOHI system and also convey diagnostic and related information shared by the physician (Bisaso et al., 2008). Hence, the behavioral resources expended during indirect patient-physician interactions may be much greater than those expended in direct AOHI contexts.

Prior research shows that consumers place a higher value on the behavioral resources expended on behalf of others versus themselves (Moreau et al., 2011). Thus, representatives engaging in direct interaction with a physician would experience a higher cost-to-benefit ratio than patients engaging in direct interactions with a physician. Additionally, contexts that require more representative-physician interactions (and thus require greater effort) versus patient-physician interactions may be less likely to result in high levels of satisfaction. Thus, representative-physician interactions may need to be more effective than patient-physician interactions to yield the same level of satisfaction.

This conjecture remains applicable in the context of parents taking on the role of representatives to manage interactions on behalf of their children. Although children always require parental oversight for their healthcare needs, parents tend to place their children's healthcare needs above their own, as indicated by Weaver et al. (2020). Consequently, these interactions may similarly need to be more effective than regular patient-physician interactions in order to yield the same level of satisfaction for parent representatives. Thus, all other factors being equal, we posit that indirect AOHI interaction is associated with lower levels of satisfaction overall.

H4: Compared with direct AOHI, the positive influence of interaction depth on AOHI satisfaction will be weaker in indirect AOHI.

H5: Compared with direct AOHIs, the positive influence of information intensity on AOHI satisfaction will be weaker in indirect AOHIs.

As stated, the behavioral resources required for indirect (vs. direct) interactions are relatively greater because patients' representatives may invest more effort or place a higher value on their time and effort than they would if they were engaging in direct interactions to manage their own healthcare (Moreau et al., 2011). Thus, representatives may be even more interested than regular patients in investing effort to develop a high-quality

relationship with a physician whom they could then consult in the future when the patient has other needs that arise (Ishikawa et al., 2005). Relationship duration is a proxy for relationship strength and continuity between a patient/representative and a physician (Stewart et al., 2000). We thus anticipate that relationship duration will be even more highly valued by patient representatives operating in indirect-interaction contexts than by patients in direct-interaction contexts, and that the influence of relationship duration will thus be stronger for indirect interactions. Formally, we hypothesize:

H6: Compared with direct AOHIs, the positive influence of relationship duration on AOHI satisfaction will be stronger in indirect AOHIs.

3.3 Moderating Effects of Providing Medical Records

For successful AOHIs, physicians need accurate and complete patient information to provide precise diagnoses and treatment recommendations (Zhang et al., 2019). Some patients will choose to provide the physician with comprehensive information, including test results, reports, and images, in addition to narrative text descriptions of their condition. This information, which often comes from multiple sources (Wang et al., 2012) and has varying levels of richness, enables a physician to better understand a patient's health condition. Thus, entering comprehensive patient medical records into an AOHI will increase the information richness of the interaction and allow the physician to render a more accurate medical assessment.

However, patients who provide physicians with extensive information, in the form of medical records, test results, imaging, etc., may tend to have higher expectations regarding the AOHI, and expect the physician to similarly provide comprehensive and detailed responses about their medical condition. Hence, compared to patients providing textual narration of their health concerns only, patients providing extensive and information-rich medical records may evaluate the AOHI less positively, given the same informational value (i.e., interaction depth and interaction intensity) of the physician's response (Zhang et al., 2019). Such patients may be more likely to question the physician's ability to provide an accurate diagnosis, despite the informational support, causing them to be less satisfied with the AOHI. Therefore, we propose:

H7: The positive influence of interaction depth on AOHI satisfaction will be weaker in AOHIs where medical records are provided compared to AOHIs where no medical records are provided.

H8: The positive influence of information intensity on AOHI satisfaction will be weaker in AOHIs where medical records are provided compared to AOHIs where no medical records are provided.

Nevertheless, providing detailed information about a patient's medical history signals trust and confidence in the physician (Arrow, 1963). Providing comprehensive medical documentation is a signal of the value the patient places on their relationship with the physician (Mennecke et al., 2000). In addition, providing medical records will likely help the physician make faster and more accurate diagnoses. This will all lead to a more positive relationship between the patient and the physician compared to patients providing limited textual information only. Thus, given the same relationship duration, patients who provide extensive medical records are more likely (than patients who do not) to feel that the physician is treating them with more patience and importance and are thus likely to view the relationship as more valuable relative to the richness of the information they provided (i.e., the exchange has more benefits than costs from a social exchange theory perspective) (Cropanzano & Mitchell, 2005), leading to a higher level of satisfaction derived from the relationship duration. Thus, we hypothesize:

H9: The positive influence of relationship duration on AOHI satisfaction will be stronger in AOHIs where medical records are provided compared to AOHIs where no medical records are provided.

4   Research Methodology

4.1   Data Collection and Measures

To test the research model and hypotheses, we chose a leading online healthcare platform operating in China, Good Physicians Network (anonymized name),[2] as the research context. This platform brings together various physicians from various hospitals in China to provide online health services to patients remotely using AOHIs. Since its establishment, it has engaged more than 100,000 physicians and serves several hundred thousand patients daily. The platform provides each physician with a homepage (see Figure 2) and a community section (see Figure 3). The homepage presents the physician's basic information, such as professional title, area of expertise, and offline hospital affiliation, as well as online descriptive information, including the number of online patients they have replied to, their contribution experience, and their platform tenure. Based on this information, patients can choose which physician to consult. The community section of the website facilitates online interactions between patients and physicians. Here, patients obtain health information from a selected physician. After

choosing a physician, patients post questions and documents to a specific physician's community. The community section presents a sequence of questions and answers, which enables asynchronous health interactions. Figure 3 shows an example of an interaction.

We collected the online interaction data and homepages of 620 physicians from two areas of expertise—diabetes and lung cancer—to control for medical context. These are both chronic diseases that often require multiple interactions between patients and physicians (Yang et al., 2019). Further, diabetes and lung cancer both have conceptual and practical significance—they are both fairly common diseases with large patient populations. The physicians interacted with 79,591 patients who completed their consultations between 2014 and 2015.[3] Detailed information about these 79,591 interactions and the physicians' basic information were incorporated into the dataset as controls when testing the hypotheses.

Since it is impossible to measure AOHI satisfaction directly from the objective interaction data collected for this study, we drew on the questioner's last post in a given interaction to indicate whether they were satisfied. A patient (or representative) who is satisfied with a physician's interaction would be more likely to post a satisfaction bonus note (worth about 2-3 USD) at the end of the interaction to express gratitude, and this feature is supported by the platform. In addition, sending a satisfaction bonus note to the physician incurs a monetary cost to the patient, requiring an additional payment to the AOHI. Thus, concluding a patient-physician interaction with a satisfaction bonus note suggests that the patient recognized the quality of the physician's replies (Yang et al., 2015a), and we thus used this measure as a proxy for AOHI satisfaction. We measured AOHI satisfaction as a binary measure: satisfied patients sent a satisfaction bonus note, whereas dissatisfied patients did not.

To test the reliability of this measure, we further conducted a sentiment analysis using Linguistic Inquiry and Word Count (LIWC, 2015) to compare the overall use of emotional words in a patient's communication after a physician's first reply in each interaction. Results of this analysis show that patients who sent satisfaction-bonus notes used more positive words ($\overline{x}$ = 9.42 vs. 3.19, $F(1, 79,589)$ = 10,403.19, $p < 0.001$) and fewer negative words ($\overline{x}$ = 1.94 vs. 2.45, $F(1, 79,589)$ = 546.04, $p < 0.001$) compared with those who did not. Thus, we concluded that the satisfaction bonus note is likely a strong proxy measure of AOHI satisfaction.

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[2] Owing to a confidentiality agreement with the AOHI platform, identity information for patients and the platform has been anonymized.

[3] The platform enforced a new interaction mechanism in early 2016 (a new mechanism to motivate physicians to reply to patients), which may be a confounding effect that could have shaped the interaction between patients and physicians.
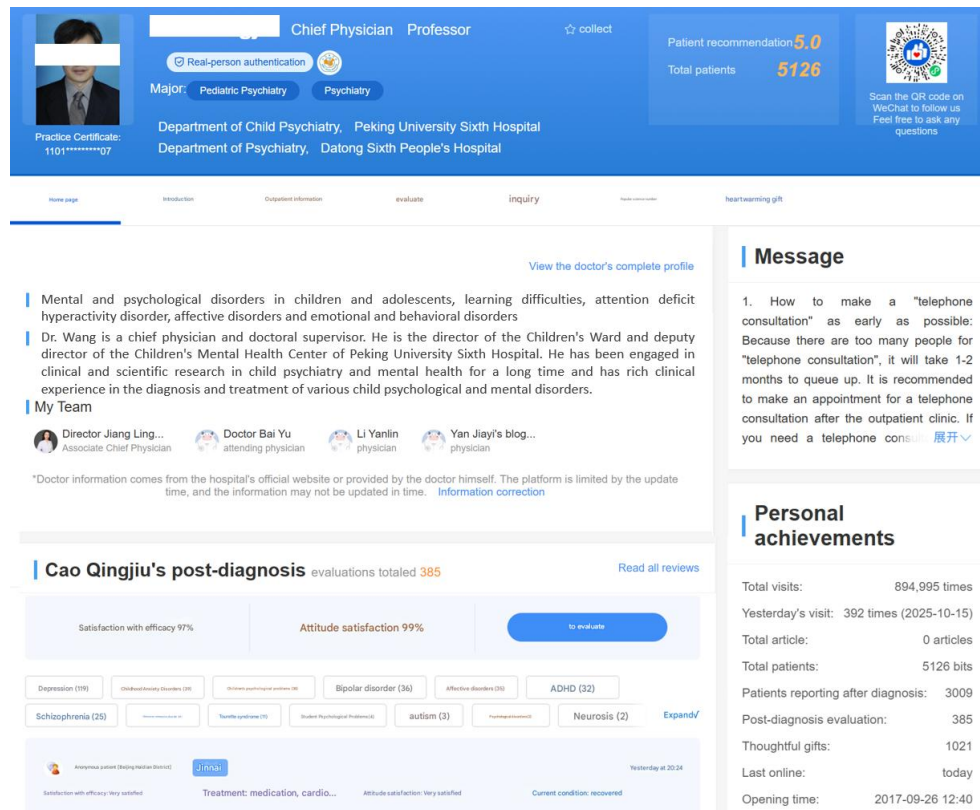
Figure 2. Homepage Screenshot

Title: What medicine is needed for subclinical hypothyroidism
Disease:
Subclinical hypothyroidism was found in pre-pregnancy physical examination
Length of Disease:
Less than half a year
Disease Description:
I am a 27 years old female. My TSH level was high. After that, it became lower. Now I want to have a test-tube baby, which requires TSH around 2.5. But the examination in the last month shows mine to be about 3. I have not taken any medication yet. I want to know how to lower TSH with medication and how long I need wait before having another examination.
Help Needed:
Hope the physician can guide me to lower the TSH with medicine.
Hospital Visited:
Department of Endocrinology, the Fifth Hospital of Shenyang

Time: 2019-02-17

Physician Reply:
Have you used Euthyrox?

Time: 2019-02-17

Patient Inquiry:
Not yet. I want to know how long to take Euthyrox, and how long to wait before having another examination.

Time: 2019-02-17

Physician Reply:
25mg Euthyrox every day before breakfast. And Take another examination after one month.

Time: 2019-02-17

Patient Inquiry:
Okay, Doctor. Thank you.

Time: 2019-02-17

Figure 3. An Example of an Asynchronous Online Health Interaction

Interaction depth was measured by the number of distinct question-and-answer rounds within a single patient-physician interaction (e.g., two questions sequentially posted by a patient or several answers posted by a physician to one question were treated as one round).[4] This measurement method was used because more rounds of question-and-answer interactions would suggest that the patients posted increasingly more detailed and/or nuanced questions based on previous interaction rounds, indicating a high level of interaction depth. *Information intensity* was measured by the average number of words exchanged in each question-and-answer round during a single patient-physician interaction session.[5] More words in a conversation correlate with more information exchanged between a patient and a physician (Baek et al., 2012). *Relationship duration* was measured by the time length of the patient-physician interaction session, which can be used to infer the duration of the service. The length of service indicates how long the patient-physician relationship persisted during the service, which also indicates the duration of the relationship.

Additional AOHI variables—namely, provision of medical records and indirect interaction—were measured by examining the characteristics of each patient-physician interaction session. Specifically, the *provision of medical records* was measured by whether the patient provided medical records of diverse types to physicians on the AOHI platform at the beginning of an interaction. To measure whether patients had direct or indirect interaction with a physician, a text analysis of the patients' inquiries to the physician was performed. Specifically, keywords embedded in the interaction texts were used to identify those patients who directly or indirectly used the platform. Keywords such as "my father," "my mother," "my wife," "my husband," "my child," and "my friend" were used to identify patient representatives and measure *indirect interaction* with the AOHI platform. Because the platform requires a patient's account to be tied to that patient, representatives cannot use patients' accounts on their behalf. Thus, we assumed that the interaction was conducted solely by either the patient or their representative.[6]

Physicians' demographic and professional statistics were captured from their homepage on the AOHI platform and used as control variables. These data included various offline attributes (e.g., hospital rank, professional title, and specialization) and site-specific information (e.g., the number of papers published and the number of virtual gifts received by physicians). Table 1 presents a summary of all variables and measures. Table 2 shows that the correlations between any two variables were not high. Further, we tested multicollinearity and confounding issues with variance inflation factors (VIFs) for each independent variable in the model estimation. The VIFs varied from 1.02 to 1.41, as shown in Table 2, indicating the absence of multicollinearity in our model.

4.2 Model Estimation

The research model was analyzed using hierarchical regression. First, the effects of the control variables were tested. Then, the independent variables were included in the model estimation to test the direct effects of the interaction process variables. Next, the interaction terms were added to test the moderating effects. Because AOHI satisfaction was measured using a binary variable, the regressions were tested using logistic regression models. Table 3 reports the main results with Models (1)–(4) and indicates the model estimation results.

Model (2) tested the significant impacts of interaction depth ($\beta = 0.792$, $p < 0.01$), information intensity ($\beta = 0.002$, $p < 0.01$), and relationship duration ($\beta = 0.001$, $p < 0.01$) on AOHI satisfaction. Thus, the three core dimensions of the interaction all positively induced satisfaction, supporting H1, H2, and H3.

Model (3) tested the moderating role of indirect interaction. The results show that indirect interaction negatively moderated the relationship between interaction depth and AOHI satisfaction ($\beta = -0.386$, $p < 0.01$) and the relationship between information intensity and AOHI satisfaction ($\beta = -7.796\text{e-}04$, $p < 0.01$), supporting H4 and H5. In addition, indirect interaction positively moderated the relationship between relationship duration and AOHI satisfaction ($\beta = 0.002$, $p < 0.01$), indicating support for H6.

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[4] We also measured interaction depth using latent Dirichlet allocation (LDA) to extract topics from physicians' replies and calculate Shannon entropy. By inputting physicians' replies into LDA, we generated a predefined number (K) of topics and a posterior distribution of topics for each reply. Testing models with $K = 10, 15$, and 20, we found 15 topics to be optimal based on posterior log-marginal likelihood. We then computed the entropy of physician replies, assuming that entropy is negatively related to interaction depth. With this new measure of interaction depth, the results remained consistent.

[5] We also measured information intensity by conducting text mining to identify professional terms in physicians' replies. We

first performed word segmentation and then identified emotional-support and medical terms using dictionaries from Peking University Open Research Data (for medical terms) and LIWC (for emotional-support terms). Using the total number of these terms to measure information intensity, the results remained consistent.

[6] Two research assistants, blind to the objectives of the research, coded 200 interactions that were randomly selected from the full sample in parallel and found that 99.0% of all patient-physician interactions were conducted by one person, achieving a coding consistency (i.e., reliability) of 98.0%.

Table 1. Variables and Measures

Variables	Measures	Mean	*SD*	Min	Max
AOHI satisfaction	Whether the interaction is ended by a patient's satisfaction bonus note	.216	.412	0	1
Interaction depth	The number of Q&A rounds in the interaction	1.620	1.100	1	36
Information intensity	The average number of words in all rounds of the interaction	318	242	0	6,528
Relationship duration	The time length of the interaction (in days)	7.450	30.100	0.0004[a]	492
Indirect interaction	Whether the interaction is conducted by the patient's representative	.240	.427	0	1
Provision of medical records	Whether the patient uploaded medical records in the interaction	.444	.497	0	1
Title[b]	The professional title of the physician in hospital (ranked from 1 to 4)	3.470	.674	1	4
Hospital ranking	Whether the hospital of the physician is ranked as 3A (i.e., the highest rank in the Chinese medical rank system)	.932	.252	0	1
Disease type	The patient's disease type (1 for lung cancer and 0 for diabetes)	.618	.486	0	1
CumNum_paper	The cumulative number of medical papers published by the physician on the platform	66.400	141	0	936
CumNum_gift	The cumulative number of virtual gifts (such as virtual flowers with words expressing gratitude) received by the physician on the platform	124	179	0	960

Note: There were 620 physicians with 79,591 patient-physician interactions. [a] The unit of time breadth is "day"; hence, this minimum value (i.e., 0.0004 days) equals about 35 seconds, indicating a fast and fully completed interaction. [b] Coding schema for Title: 1: resident physician, 2: attending physician, 3: associate chief physician, and 4: chief physician. In the model estimation, we used title dummies as controls with Title = 1 as the baseline.

Table 2. Correlations of Variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	VIF
(1) AOHI satisfaction	-											
(2) Interaction depth	.319	-										1.38
(3) Information intensity	.016	-.225	-									1.41
(4) Relationship duration	.122	.282	.001	-								1.11
(5) Indirect interaction	.131	.132	.144	.064	-							1.06
(6) Provision of medical records	.096	.075	.062	.011	.035	-						1.02
(7) Title	-.022	-.049	.046	.013	.014	-.047	-					1.13
(8) Hospital ranking	.003	-.024	.016	.017	-.008	.030	.138	-				1.08
(9) Disease type	-.027	.001	.049	-.027	.001	.037	.120	.179	-			1.07
(10) CumNum_paper	.014	-.011	.084	.035	.074	-.005	.289	.127	.100	-		1.27
(11) CumNum_gift	-.017	-.018	.098	-.002	.000	-.039	.205	-.038	.161	.415	-	1.31

Table 3. Model Estimation Results

DV: AOHI satisfaction	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
Interaction depth		.792**	.917**	.893**	1.012**
Information intensity		.002**	.002**	.002**	.002**
Relationship duration		.001**	.001	.000	-.000
Indirect interaction × Interaction depth			-.386**		-.383**
Indirect interaction × Information intensity			-7.796e-04**		-7.685e-04**
Indirect interaction × Relationship duration			.002**		.002**
Provision of medical records × Interaction depth				-.196**	-.189
Provision of medical records × Information intensity				-8.824e–04**	-8.533e-04**
Provision of medical records × Relationship duration				.002**	.002**
Indirect interaction	.668**	.403**	1.30**	.366**	1.292**
Provision of medical records	.450**	.344**	.343**	.888**	.868**
Title dummies	YES	YES	YES	YES	YES
Hospital ranking	.061†	.152**	.155**	.154**	.155**
Disease type	-.153**	-.204**	-.191**	-.202**	-.189**
CumNum_paper	-.000**	-.000**	-.000**	-.000**	-.000**
CumNum_gift	.000**	.000**	.000**	.000**	.000**
Constant	-1.560**	-3.206**	-3.473**	-3.482**	-3.734**

Note: We also tested Model (5) with all the interaction terms, and the results were consistent. † $p < 0.10$, * $p < 0.05$, ** $p < 0.01$. There are 79,591 interactions from 620 physicians.

Model (4) tested the moderating role of the provision of medical records. The results show that provision of medical records weakened the positive effects of interaction depth ($\beta = -0.196$, $p < 0.01$) and information intensity ($\beta = -8.824\text{e–}04$, $p < 0.01$) on AOHI satisfaction, supporting H7 and H8. In contrast, the provision of medical records strengthened the positive effect of relationship duration on AOHI satisfaction ($\beta = 0.002$, $p < 0.01$), indicating support for H9.

4.3 Robustness Checks

To test the robustness of the research findings, we conducted additional analyses. First, because AOHI satisfaction was measured as a binary variable, linear probability models with robust standard errors were further used to test the models. As shown in Table 4, the results were consistent with those reported in Table 3 (except that the interaction term, Provision of medical records × Interaction depth, was negative but not significant). Thus, the results remained robust when different regression methods were applied.

Second, even though our data was organized at the interaction level, we drew on fixed effects (FE) models to eliminate the influences of the physician-level factors. This is appropriate because FE estimations assume that the differences across analysis units can be captured using an intercept term for each unit (Littel et al., 1996), and FE models can also control for unobserved heterogeneity at the unit level in cross-sectional settings (Angrist & Pischke, 2009). Our dataset, organized at the interaction level, allowed physicians to differ in their general interactions with patients. Thus, the unobserved physician-specific heterogeneities were controlled for at the interaction level; Models (1)–(3) in Table 5 present the FE model results. The results indicate that, apart

from a negative but not significant effect of Provision of Medical Records × Interaction Depth on AOHI satisfaction, all other effects were significant and quantitatively consistent with the findings reported in Table 3. Thus, controlling for physician-specific heterogeneities mostly produced robust results.

In the main analyses, the AOHI satisfaction measure was recorded by determining whether the AOHI interaction was concluded with a satisfaction bonus note. To examine the robustness of the results further, the study identified whether the patient sent a virtual gift to the physician or purchased additional, prepaid future interactions with the physician as an alternative measure of AOHI satisfaction. The decision to prepay for future interactions with the physician indicates that the patient was satisfied with the previous interactions and intended to maintain an enduring relationship with the physician (Zhang et al., 2019). As another proxy of AOHI satisfaction in the logistic regression models, a third robustness check examined whether the patient made a payment in an AOHI as a virtual gift to the physician or to pay for more questions. Table 6 shows that our alternative effects were all quantitatively consistent with the main results. Together, these various robustness checks were highly consistent with the main results reported in Table 3.

The analyses described above show that the main findings of this study were consistent irrespective of whether different regression methods were adopted, whether physician-specific heterogeneities were controlled for, and how the dependent variable was measured, yielding greater confidence in the validity and reliability of the results. Next, we discuss the study's key findings, theoretical implications, and practical implications as well as its limitations and our suggestions for future research directions.

Table 4. Robustness Check I: Using Linear Probability Models

DV: AOHI satisfaction	Model (1)	Model (2)	Model (3)
Interaction depth	.118**	.140**	.120**
Information intensity	2.123e-04**	2.372e-04**	2.505e-04**
Relationship duration	3.647e-04**	1.795e-04*	2.448e-04*
Indirect interaction × Interaction depth		-.058**	
Indirect interaction × Information intensity		-7.650e-05**	
Indirect interaction × Relationship duration		5.503e-04**	
Provision of medical records × Interaction depth			-.006
Provision of medical records × Information intensity			-7.510e-05**
Provision of medical records × Relationship duration			2.861e-04*
Indirect interaction	.071**	.185**	.071**
Provision of medical records	.054**	.053**	.078**
Title dummies	YES	YES	YES
Hospital ranking	.019**	.020**	.019**
Disease type	-.029**	-.027**	-.029**
CumNum _ paper	-.000**	-.000**	-.000**
CumNum_gift	.000**	.000**	.000**
Constant	-.049**	-.089**	-.095**
R-squared	0.122	0.127	0.122
Note: † $p < 0.10$, * $p < 0.05$, ** $p < 0.01$. There are 79,591 observations from 620 physicians.			

Table 5. Robustness Check II: Using FE Models

DV: AOHI satisfaction	Model (1)	Model (2)	Model (3)
Interaction depth	.120**	.142**	.121**
Information intensity	1.7e–04**	1.9e–04**	2.0e–04**
Relationship duration	4.2e–04**	3.6e–04**	4.0e–04**
Indirect interaction × Interaction depth		-.057**	
Indirect interaction × Information intensity		-7.6e–05**	
Indirect interaction × Relationship duration		3.6e–04**	
Provision of medical records × Interaction depth			-.003
Provision of medical records × Information intensity			-5.6e–05**
Provision of medical records × Relationship duration			1.8e–04†
Indirect interaction	.065**	.179*	.065**
Provision of medical records	.047**	.056**	.063**
Title Dummies	YES	YES	YES
Hospital ranking	YES	YES	YES
Disease type	YES	YES	YES
CumNum_Paper	YES	YES	YES
CumNum_gift	YES	YES	YES
Constant	-.054***	-.093***	-.062***
R-squared	0.119	0.124	0.119

Note: † $p < 0.10$, * $p < 0.05$, ** $p < 0.01$. There are 79,591 observations from 620 physicians.

Table 6. Robustness Check III: An Alternative Measure of AOHI Satisfaction

DV: Patient payment	Model (1)	Model (2)	Model (3)
Interaction depth	.611*	.717**	.579**
Information intensity	.001*	.002**	.002**
Relationship duration	.006*	.005**	.006**
Indirect interaction × Interaction depth		-.226**	
Indirect interaction × Information intensity		-.001*	
Indirect interaction × Relationship duration		.002*	
Provision of medical records × Interaction depth			-4.205e-04
Provision of medical records × Information intensity			-1.201e-04
Provision of medical records × Relationship duration			.062
Indirect interaction	.343**	1.198**	.342**
Provision of medical records	.514**	.505**	.375
Title dummies	YES	YES	YES
Hospital ranking	.431*	.494*	.409†
Disease type	.029	.053	.028
CumNum_paper	-.001*	-.001*	-.001*
CumNum_gift	-.000	-.000	-.000
Constant	-7.859**	-8.278**	-7.758**

Note: † $p < 0.10$, * $p < 0.05$, ** $p < 0.01$. There are 79,591 observations from 620 physicians.

5   Discussion

5.1   Key Findings

The results of this study can be summarized in four key areas. First, the three core dimensions used to conceptualize the patient-physician interaction—interaction depth, information intensity, and relationship duration—all positively contributed to AOHI satisfaction. These relationships show that many conversations, a high-intensity information exchange process, and a long relationship duration contributed to patients' satisfaction with their online interactions with physicians. The positive effects of the information intensity and relationship duration dimensions are consistent with findings from previous communication research showing that such factors can improve interaction outcomes (Hancock & Dunham, 2001) and knowledge transfer (Iorio et al., 2017). These effects verifiably remained vital determinants of AOHI satisfaction. Further, interaction depth was considered an important feature of the one-to-one patient-physician interaction, demonstrating that when a greater depth of information (manifested as more rounds of conversations on the same topic) was exchanged, patients were more satisfied with the interaction.

Second, we found that indirect interaction weakened the positive effects of interaction depth and information intensity on AOHI satisfaction. The results show that when a patient's representative interacted with the physician, the depth and intensity of this interaction contributed less to AOHI satisfaction. These effects likely stemmed, at least in part, from the inherent

differences in the information exchange process. Indirect interactions require the representative to invest time and energy in fully understanding the patient's medical condition, conveying this information to the physician, and then explaining the physician's comments and recommendations to the patient. As the depth and intensity of interaction increase, the time and effort invested will also increase, which, in turn, may weaken the development of satisfaction. Thus, the positive effects of interaction depth and information intensity on AOHI satisfaction were weaker when the AOHI was conducted by a patient representative.

Third, the provision of medical records also weakens the effects of interaction depth and information intensity on AOHI satisfaction. Our findings suggest that when patients provided detailed medical records to AOHI physicians, the depth and intensity of their interactions with physicians lowered their level of AOHI satisfaction, compared with patients who did not provide detailed medical records. This finding is likely explained, at least in part, by the unmet expectations of patients who provided detailed medical records. Specifically, these patients likely had higher expectations of the outcomes compared with those who did not; that is, patients who took the time and effort to present detailed medical records were more likely to be dissatisfied with the physician's medical recommendations than patients who simply provided textual input on the AOHI platform. Thus, the positive effects of interaction depth and information intensity on AOHI satisfaction were weakened when patients provided information-rich, detailed medical records.

Finally, both indirect interaction and the provision of medical records positively moderated the effect of relationship duration on AOHI satisfaction. Because relationship duration indicates the relationship continuity between the patient and the physician in the AOHI, a longer relationship duration was more highly appreciated by representatives engaging in an indirect interaction than by patients. A longer relationship duration may also lead patients presenting detailed medical records to perceive that they are being treated with more diligence by the physician, causing them to feel more valued by the physician. Therefore, the effect of relationship duration on AOHI satisfaction is stronger among indirect, representative-physician interactions and among interactions that included detailed medical records.

5.2   Theoretical Implications

This study investigates the effects of the interaction process, interaction patterns, and provision of medical records on AOHI satisfaction. Building on the previous literature, which offers no consensus on how to conceptualize the online interaction process (Yang et al., 2015a; Zhang et al., 2019), this work contributes to the body of literature on online interaction and health communication in several ways.

First, our findings extend the understanding of the online patient-physician interaction process in healthcare by using the AOHI model. While online interaction has been extensively explored in the communication and information systems fields (Demitz, 2018; Hancock & Dunham, 2001; Moore, 1989; Zhang et al., 2019), many previous studies have conveniently drawn on sometimes ill-fitting factors when conceptualizing the interaction process. Hence, a comprehensive approach to conceptualizing online interaction processes is lacking. Based on RCT and the characteristics of AOHIs between patients and physicians, this study proposes a new conceptual model—the AOHI model—that outlines how patients obtain health-related information and develop a patient-physician relationship. The AOHI model proposes three distinct dimensions to measure aspects of the AOHI process: interaction depth, information intensity, and relationship duration. The AOHI model further proposes that these factors can significantly affect AOHI satisfaction. Thus, this study provides a novel, comprehensive, and theoretical approach, the AOHI model, for conceptualizing patient-physician interaction on an AOHI platform.

Second, the findings contribute to the health communication literature by identifying the unique features of online healthcare interaction platforms. Online health information seeking is becoming an increasingly effective and useful approach for patients to access health information, rendering AOHI a vital topic in health research and practice. While prior studies have investigated how AOHI operates or provides benefits for different stakeholders (Guo et al., 2017; Lu et al., 2011; Yan & Tan, 2014), few have explored the specific characteristics of online interactions between patients and physicians and how these characteristics shape the outcome development process. Drawing on the specific characteristics of a commercially deployed AOHI platform, this study identifies two important contingency factors—indirect interaction and provision of medical records—that play important roles in shaping the interaction process and satisfaction. Therefore, this study verifies that satisfaction development in AOHI is a complicated process that needs a guiding theoretical framework and additional investigation to verify and extend the AOHI model used to guide this research.

Third, this study provides insight into the linkage between specific interaction processes and satisfaction while also considering the characteristics of patient-physician interaction (i.e., direct versus indirect interaction) and practical contingency features (i.e., provision of medical records). While previous studies have examined how patients derive satisfaction from AOHIs (Yang et al., 2015a, 2019; Zhang et al., 2019), no prior research has explored how the effects of the interaction process on satisfaction vary depending on the specific features of the health field. By explicitly exploring the interplay between these three core interaction factors and AOHI features in

satisfaction development, we found that these distinctive factors have differing effects when patients provide detailed medical records (i.e., provision of medical records) or when they directly vs. indirectly engage in an AOHI. This study confirms that the linkage between the interaction process and AOHI satisfaction is contingent on the specific features of the AOHI platform and the interaction context. Our study is among the first to identify the measures and features of AOHI and conceptualize their interplay to explain AOHI satisfaction. Nevertheless, future research is needed to consider these as well as other possible AOHI features and factors.

Finally, this study is the first to explicitly investigate how indirect interaction with an AOHI platform influences the interaction process and AOHI satisfaction development. In practice, indirect interaction in AOHIs is common because many patients are physically unable to directly access the system. Although physicians' indirect interaction with healthcare information systems has been explored in prior studies (Kane & Alavi, 2008; Tong et al., 2017), few have investigated indirect interaction from the patient perspective, which has become popular in AOHIs. For example, 24% of the interactions in our sample were determined to be indirect (see Table 1). Additionally, our results show that indirect interaction plays a significant role in AOHI satisfaction development, thereby moderating the effects of the central interaction process on AOHI satisfaction. This finding not only confirms findings from prior related research but also enhances the current knowledge of AOHI design and deployment, highlighting the significant role that indirect interaction plays in the relationship between interaction patterns and AOHI satisfaction.

5.3   Practical Implications

The present study also has practical implications for AOHI stakeholders in the era of digital transformation. First, AOHI providers or physicians who offer AOHI services should be aware of the three core dimensions of the interaction process within the AOHI model that shape AOHI satisfaction: interaction depth, information intensity, and relationship duration. Thus, to enhance AOHI satisfaction, physicians should conduct multiple question-and-answer rounds with patients to obtain more specific information about patients' health conditions. During these additional question-and-answer rounds, physicians should also provide extensive information to patients about their condition and treatment options. Finally, physicians should strive to maintain long-term interactions with patients (e.g., tracking their health progress and communicating their concerns). Given the power of these factors for influencing AOHI satisfaction, AOHI providers can build features into their platform to encourage and support physicians in following best practices for enhancing AOHI satisfaction.

Second, regarding the influence of indirect interaction and provision of medical records on AOHI satisfaction, platform providers and physicians should employ different interaction strategies in different contexts. In the case of indirect interaction, AOHI platform providers and physicians should focus more on relationship duration than on interaction depth or information intensity. Since representatives interact indirectly, they may be less personally concerned about the health-related information obtained from an AOHI, but their AOHI satisfaction will be increased by a longer duration of the representative-physician interaction.

Third, patients who use AOHIs for their own health should be trained in how to improve their perceptions and the outcomes of the patient-physician interaction. Specifically, patients should be informed about how information depth and information intensity help develop a strong patient-physician relationship. Further, patients should be encouraged to maintain a longer-term relationship with the physician to achieve improved outcomes. If patients provide detailed medical records during an AOHI, they should also understand that such records may increase their expectations, which may influence their AOHI satisfaction. By understanding the implications of their interaction behaviors, patients will be better positioned to make informed decisions about their AOHI use.

Finally, regarding patients using an indirect representative, the representative should acknowledge that the indirect nature of their interactions can potentially bias their AOHI satisfaction development. Specifically, indirect representatives are likely to highly value their relationship development with the physician but may find less value in the information exchange process. Thus, representatives engaging indirectly should be aware of the factors that can drive their satisfaction with the AOHI process and try to shape their usage patterns to maximize this important outcome.

5.4   Limitations and Future Directions

Like all research (Dennis & Valacich, 2001), this study has limitations that can be addressed by future research. First, to measure the online interaction process accurately and avoid bias from self-reported data, secondary objective interaction data were used. However, regardless of how well the objective interaction data reflects the measurement of the study's variables and despite following the best practices offered in the extant literature, the gap between the theoretical variables and the objective measures is always a matter of concern. For example, AOHI satisfaction was measured according to whether patients sent satisfaction bonus notes, which may not have revealed the true level of satisfaction. Future research could enhance the consistency between the interaction process variables and measures by adopting other objective measures or combining both interaction-

derived and perceptual measures. Second, we measured indirect interaction by analyzing how representatives referred to the patient using a text-mining approach. However, it is possible that the patients themselves were also involved in some part of the multisession asynchronous interaction process. For this study, we did not have the granularity or visibility to definitively ascertain such hybrid use. In future research, steps should be taken to identify definitively when representatives initiate a patient-physician interaction and to confirm whether this configuration is retained for every interaction session. Third, in data analyses, we controlled for several physician-level factors, but we did not control for any unobserved patient-level factors because we could not access any detailed patient-level data from the AOHI platform due to privacy restrictions. Finally, the research context and dataset are from a single text-based asynchronous online healthcare platform, which may not generalize to other contexts, such as platforms focusing on countries with different types of medical systems, platforms that enable synchronous video- or audio-enabled interactions, or patients with medical problems different from the two populations examined in this study. Future research is essential to test the relationships outlined in the AOHI model on different platforms and in different patient groups and to conceptualize the interaction process from a new perspective.

6   Conclusion

Online healthcare communities and platforms are rapidly growing throughout the world because of the digital transformation of healthcare. Among the different online health-information exchange approaches, AOHIs have become a popular means for patients to obtain health information from online physicians. However, the current literature on AOHIs has yet to reach a consensus on how to measure online interactions between patients and physicians. In this study, a conceptual research model based on RCT—the AOHI model—was developed. This model comprises three dimensions for measuring online interaction (interaction depth, information intensity, and relationship duration) and their effects on AOHI satisfaction. To improve the understanding of the underlying mechanism of AOHI satisfaction development, this study proposes two important AOHI attributes—indirect interaction and provision of medical records—as contingent factors that shape the linkages between the interaction process and AOHI satisfaction. Objective data were collected to test the hypothesized direct and moderating effects. This study contributes to the extant literature by conceptualizing the online interaction process and extends the current understanding of online patient-physician interactions and various interaction patterns. The findings also provide implications for AOHI practitioners, physicians, patients, and their representatives. In conclusion, the research findings help expand the understanding of online health behavior and motivate additional research on the complex interplay of online patient-physician interactions.

Acknowledgments

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About the Authors

Xiaofei Zhang is a professor of information systems at School of Management, Harbin Institute of Technology. He obtained PhD degrees from the Hong Kong Polytechnic University and Harbin Institute of Technology. His research centers on generative AI, e-health, and platform operations. His work has been published by journals such as *MIS Quarterly*, *Information Systems Research*, *Journal of the Association for Information Systems, European Journal of Information Systems*, *Information & Management*, *Information Systems Journal*, and *International Journal of Production Economics*.

Yi Wu is an associate professor in the Department of Information Management and Management Science, Tianjin University, China. He received a BEng degree in information systems from the Renmin University of China, China, and PhD degree in information systems and analytics from the National University of Singapore. His research interests include e-healthcare, online crowdfunding, and sharing economy. His work has been published in *Information Systems Research, Journal of Management Information Systems, Journal of the Association for Information Systems, European Journal of Information Systems, Information Systems Journal,* and elsewhere.

Joseph (Joe) S. Valacich is the Muzzy Endowed Chair and Professor of Management Information Systems at the University of Arizona. A prolific scholar, he has over 100 journal publications, including 37 in FT-50 journals, with a Google Scholar citation count exceeding 35,000 and an h-index of 82. His research centers on human-computer interaction. In 2014, he co-founded Neuro-ID, Inc., a behavioral analytics firm acquired by Experian in 2024. An award-winning educator, Valacich has co-authored leading computing textbooks and shaped online education at Washington State University and the University of Arizona. His accolades include the AIS Leo Award (2022), AIS Impact Award (2021), and Senior Membership in the National Academy of Inventors (2020). Tech Launch Arizona named him I-Squared Inventor of the Year (2016) and Neuro-ID Startup of the Year (2020). In 2024, he received the University of Arizona's Distinguished Innovation and Entrepreneurship Award.

Jeffrey L. Jenkins is a professor of information systems at Brigham Young University. He is an expert in detecting human states such as cognitive conflict, uncertainty, emotional reactions, and deception through data captured by computer input devices. Based on this research, he co-founded Neuro-ID, Inc. in 2014, which was acquired by Experian in 2024. During this time, Jeff served as chief technology officer, chief innovation officer, and board member. His research has been published extensively in top academic journals and conference proceedings, including the Financial Times journals *MIS Quarterly*, *Information Systems Research*, and *Journal of Management Information Systems*. Jeff earned his master's degree in management information systems from Brigham Young University and his PhD in information systems management from the University of Arizona. Prior to his career in academia, he was a software engineer.