The Limitations of Using the Existing TAM in Adoption of Clinical Decision Support System in Hospitals: An Empirical Study in Malaysia

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Abstract

The technology acceptance model (TAM) has been widely used to study user acceptance of new computer technologies. Previous studies claimed that future technology acceptance research should explore other additional explanatory variables, which may affect the originally proposed constructs of the TAM. The use of information technology in the health care sector and especially in hospitals offers great potential for improving the performance of physicians, increasing the quality of services and also reducing the organizational expenses. However, the main challenge that arises according to the literature is whether healthcare professionals are willing to adopt and use clinical information technology while performing their tasks. Although adoption of various information technologies has been studied using the technology acceptance model (TAM), the study of technology acceptance for professional groups (such as physicians) has been limited. Physician adoption of clinical information technology is important for its successful implementation. Therefore, the purpose of this study is to gain a better insight about factors affecting physicians’ acceptance of clinical decision support systems (CDSS) in a hospital setting. The results reflect the importance of perceived threat to professional autonomy, perceived interactivity with clinical IT, perceived usefulness and perceived ease of use in determining physicians’ intention to use CDSS.

Keywords: Perceived threat to professional autonomy; level of interactivity; perceived usefulness; perceived ease of use; Clinical Decision Support System (CDSS); TAM

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1. Introduction

Organizations are trying to take advantage of using IT to increase their competitiveness (Kwak et al, 2010). IT is not only dominant in high tech industries but also it has become very beneficial in other sectors such as healthcare (Bach Hue et al., 2011). Walter and Lopez (2008) have explained the two types of clinical IT which are being used in medical care practices. The first one is Electronic Medical Records (EMR) systems which are computer systems that allow users to create, store, and retrieve patient charts on a computer. The second one is Clinical Decision Support System (CDSS) that is referred to as a decision support system for physicians. A CDSS System is regarded as an application of Decision Support System (DSS), which takes patient data as input and generates decision-specific

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advice (Chang et al., 2007). These systems are considered as knowledge-based systems that use patient data and series of reasoning techniques to generate diagnostic and treatment options and care planning.

Kluge (2007) has mentioned that if hospitals cannot fully use the applications of IT to manage information exchange and enhance health care services, they will lose their patients’ trust. The effective utilization of IT can possibly lead to cost cutting and restructuring medical industry for the 21st century (Flower, 2004). At present, clinical IT is being used in healthcare industry to support highly specialized tasks (Chau et al., 2002).

The key challenge for any new technology is the users’ acceptance and use of the technology (Kijsanayotin et al., 2009). If the usage rate is low, the technology cannot be effective for organizations (Chang et al., 2009). Nevertheless, based on the IT adoption behavior in the health sector, healthcare professionals have not fully utilized the clinical IT (Yi et al., 2006; Western et al., 2001). Since user acceptance is the key indicator of the successful implementation of a newly introduced IT (Davis, 1989, Davis et al., 1989, Kottemann and Davis, 1991, Davis 1993) there is a growing concern about IT acceptance among healthcare professionals.

The issue of user adoption has attracted the attention of a large number of researchers in Information Systems (IS) studies. As new technology can leave its effects on improving the productivity and performance of organizations, researchers have tried to learn the factors affecting the successful adoption of technological advancement among users. In the past, a variety of theoretical IT adoption models were used to explain and predict user acceptance of a new IT (Lee et al., 1995, Igbaria et al., 1995) but all of them are general and cannot address healthcare professionals’ special characteristics to adopt clinical IT.

A successful implementation of clinical IT depends on the adoption of it by physicians in a hospital setting (Payton, 2000). According to Aggelidis and Chatzoglou (2009), when it comes to comparison of IT users, the personnel of health care institutions are different from other users in light of their priorities and special perceptions about using new technology. Lowenhaupt (2003) has explained that physicians are very slow in accepting clinical information systems. Paul and McDaniel (2004) have provided evidence to state that physicians resist new IT in a different fashion compared to other users. For instance, they are not willing to integrate new IT with their day-to-day work activities if they perceive new IT as interfering with their traditional work routine (Anderson, 1997; Anderson and Aydin 1997). Therefore, healthcare professionals’ behavior toward a new IT is not compatible with other IT users such as employees, students, programmers, customers, general users and so on (Hu and Chau, 1999; Hu et al., 2002). In line with this issue, Chau and Hu (2002) have attributed the different IT adoption behavior of health care professionals to some unique characteristics possessed by them.

However, a few studies have considered special characteristics of healthcare professionals and different features related to professional context of healthcare sector (Walter and Lopez, 2008). Additionally, Moon and Kim (2001) have stated that besides the important constructs embedded in existing technology adoption models, additional exploratory factors are required to better explain the variance of accepting new technology. These variables can be seen as special features and properties of new technology in particular.
2. Research Methodology

2.1. IT adoption models

King and He (2006) have stated that in recent years there has been an increasing interest in the identification of factors that motivate people to accept and take advantage of systems developed and implemented in the organizations. Regarding individual intention to accept new technology, several studies have been conducted and eight theoretical models have been developed. Each model explains the user’s individual readiness to accept new information systems and technology (Davis et al., 1992).

The most commonly used adoption model is Technology Acceptance Model (TAM). The original TAM explains that perceived usefulness and perceived ease of use positively impact individual acceptance of a new technology (Anandarajan et al., 2002; Ghorab 1997). Perceived usefulness concerns the degree to which a person believes that by using a particular system his/her job performance would be improved (Davis, 1989). The second key construct is perceived ease of use which reflects the extent to which a person believes that using a particular system would be effortless (Davis, 1989). These factors are mainly addressed during the system development stage to solve the potential users’ acceptance problem (Taylor and Todd, 1995). These factors determine behavioral intention that is found by a wide number of studies (Venkatesh and Davis, 1996), as a better predictor of actual system usage. In the field of social science, intention to use a new IT refers to user willingness to actual behavior of using the IT system.

Yi et al. (2006) have stated that perceived improved performance resulting from using IT strongly affects physicians’ intention to use the system in the healthcare sector. The significant role of perceived usefulness among physicians in shaping their intention toward using a new technology might be centered on physicians’ utility-based point of view about using technology (Chau and Hu, 2002). It means they accept a new technology when it has desired utility and becomes instrumental in their practices. According to Chang et al. (2007), perceived usefulness exerts the most significant impact on physicians’ intention to use CDS. Based on Kijsanayotin et al. (2009), perceived usefulness is the most important determinant of intention to use health IT in the context of developing countries. Therefore, as long as healthcare professionals perceive CDSS as a source of performance improvement, they become more willing to use the system. Therefore, the first hypothesis is developed as follows: Hypothesis 1. Perceived usefulness is positively related to physicians’ intention to use CDSS in a hospital setting. Consistent with Davis (1989), intention to use new IT systems is positively related to perceived ease of use. Chang et al. (2007) have explained that effort expectancy is a significant predictor for physicians’ intention to use CDSS. As supported by Kijsanayotin et al. (2009), effort expectancy is a key factor in shaping physicians intention to use technology. Therefore, if healthcare professionals find the new clinical IT easy to understand and use, they become more willing to use the system in their practice pattern. Thus, the next hypothesis states this idea as follows: Hypothesis 2. Perceived ease of use is positively related to physicians’ intention to use CDSS in a hospital setting.

TAM has been utilized as a useful tool for managers to assess the success factors of implementing a new technology. It also helps them appreciate the drivers and determinants of user acceptance in order to proactively design strategies.
to improve overall user acceptance and use of new systems. Although many studies have employed TAM to explain
users’ intention to use IT, this model is still very general and is not designed for any particular profession. Each
profession has special contextual characteristics that may affect IT adoption behavior. For instance, unique
characteristics of IT users should be included in IT adoption models in order to better address their intention to accept
new technologies. Chismar and Wiley-Patton (2003) suggest that physicians’ professional characteristics should be
considered in their IT acceptance to obtain a better understanding on healthcare professionals’ IT adoption. To fill this
gap, unique characteristics of healthcare professionals as well as special features of CDSS are included in the existing
TAM to modify this model and give a fit adoption model in the professional context of healthcare.

2.2. Theory of professionals

As stated by Sharma (1997), the holders of some occupations (such as medical practice) are viewed as professionals.
The healthcare professionals considered in this study consist of all kind of physicians and specialists from different
medical specialty areas. This group can take advantage of clinical IT to improve health care delivery. Professionals
have been attributed some unique and professional characteristics that make them differentiated from other non-
professionals. Brennan and Coles (2003) have mentioned that healthcare professionals’ professionalism is based on a
set of values. The most important characteristic is healthcare professional autonomy and the other features are patient
sovereignty, physician confidentiality, and habits of learning. According to Chau and Hu (2002), the differences
between healthcare professionals and other user groups in terms of accepting new IT arise from a set of values such as
specialized training (Frankel, 1989), professional autonomy and professional work arrangements (Montague et al,
2009).

Professional autonomy is defined as the control that professionals have over the processes, conditions and content of
their medical practice (Raelin, 1989). Literature states that professional autonomy is the most important professional
value provided for healthcare professionals (Zuger, 2004). Beside healthcare professionals, there are two other
occupational groups working in a hospital. The para-professional group (such as medical assistants) owns only partial
professional knowledge and skill and assists healthcare professionals in their healthcare practices. The last group is
non-professionals who are just prepared to engage in running clerical, office work and administrative duties.

Due to some privileges resulting from professional autonomy, healthcare professionals have power over non-
professionals and para-professionals and can control the tasks supposed to conduct by them (Freidson, 1988).
Therefore, healthcare professionals try to support the factors that strengthen their professional autonomy and resist the
factors that may erode their professional autonomy (Walter and Lopez, 2008). Despite the significant role of
professional autonomy in healthcare professionals IT adoption behavior, less emphasis has been placed to explore
whether and how this central characteristic influences healthcare professional’s acceptance of new clinical IT (Walter
and Lopez, 2008). As Adams (1980) has argued, previous studies only highlighted some similar constructs like
behavioral control and professional autonomy which have not been studied as a central characteristic of healthcare
professionals. Walter and Lopez (2008), first introduced perceived threat to professional autonomy as a new construct
in studying IT acceptance. This construct is operationally defined as “the degree to which a person believes that using
a particular system would decrease his/her control over the conditions, processes, procedures, or content of his/her work”.

Even with expanding IT in the health care practice, physicians as the key players have not fully adopted the various applications of IT systems (Aggelidis and Chatzoglou, 2009; Bach Hue et al., 2011). Literature on the use of IT in the medical community shows the patterns of resistance amongst physicians (Johnston et al., 2002; Mikulich et al., 2001). A number of studies have argued that physicians are very sensitive to any upcoming changes in their work settings, especially those changes which may result in decreasing their professional autonomy (Dowswell et al., 2001). The struggle over the loss of autonomy arisen due to recent empirical work in clinical practice guidelines. Several surveys on physicians’ attitude have found that a large proportion of physicians considered clinical guidelines and rules as a source of eroding their professional autonomy (Borkowski and Allen, 2003).

Harrison et al. (2002) have supported that physicians are more resistant to such organizational changes which positively attack their professional autonomy. As a result, the sense of superiority over the individuals outside of the profession which stems from professional autonomy has been directly attached to social value systems, position, and financial outcome. Therefore, physicians are more willing to maintain those elements that help them promote their autonomy and refuse to support to those that may encroach on their autonomy (Walter and Lopez, 2008).

This study hypothesizes that perceived threat to professional autonomy reduces healthcare professional intention to use clinical IT in a hospital setting. It implies that if healthcare professionals perceive the application of clinical IT as threatening to their professional autonomy, the possibility of using clinical IT by them will decrease. Therefore, the third hypothesis is developed as follows: Hypothesis 3. Perceived threat to professional autonomy is negatively related to physicians’ intention to use CDSS in a hospital setting.

2.3. Theory of professionals

In this study, interactivity can be defined as the amount and quality of two-way communication, cooperation and reciprocal relationship between clinical IT and physicians. Interactivity results in perceiving more control in using a clinical IT. With attention to the medical literature, three levels of interactivity can be perceived in using a medical technology (Carayon, 2011). These three levels are explained as technology as an enabler, technology as a partner of professionals and physicians as operators.

To some extent any new computerized system can reduce dependence on specific personnel (Ramos et al., 2011). The nature and characteristics of instructions and guidelines given by clinical IT is to assist physicians in problem-solving process. The guidelines might be considered as an element which erodes their professional autonomy (Borkowski and Allen, 2003). Harrison et al. (2002), have discussed that physicians feel uncomfortable when they are encountered with regulations and instructions produced by a CDSS directing them what to do. Because they believe they are able to treat their patients using their own specialized knowledge, experience and competence. In line with Lowenhaupt (2003) physicians become uncomfortable and anxious when they see someone or something (such as CDSS) become
more involved than they do in the treatment of their patients. Physicians perceive that interactivity with IT makes their role of less significant because it may imply that all medical treatments are conducted by the IT system. The low level of possible interactivity with the system makes healthcare professionals think of losing their control over medical process and accordingly become less likely to use CDSS. Physicians perceive that the non-interactive instructions might make their role less significant in a hospital setting and they become less willing to use the system. Previous theories about using CDSS placed more attention to outputs of clinical IT and limited healthcare professionals’ control, but the new methodology of using CDSS explains that healthcare professionals can filter, review and finally select the useful and relevant suggestions and override others. With the use of this method a balance can be made between healthcare professionals’ desire for autonomy and CDSS’s suggestions to improve patient safety.

Consequently, the main goal of CDSS is to interact with healthcare professionals and assist them in providing care planning and diagnosis analysis. In this human-machine interaction, the healthcare professional’s knowledge and the function of CDSS are both required to better analyze patients’ data rather than relying on either human or clinical IT. In the highly interactive relationship between CDSS and health care professionals, healthcare professionals enter a set of required information, records and symptoms and CDSS makes a set of suggestions, advice and diagnostic options for the healthcare professionals. Then, they review the output and select the useful one and remove not relevant suggestions. In this manner, CDSS doesn’t make decisions for healthcare professionals telling them what to do. Therefore, in this way healthcare professionals perceive clinical IT as an interactive partner in which the decisions are not directly made by the CDSS. As a result, we hypothesize that low level of perceived interactivity with clinical IT leads to low level of involvement in the implementation of the CDSS. Therefore, this situation inevitably results in low level of using CDSS in the processes and procedures of patients’ treatment. Thus, the next hypotheses are presented as follows: Hypothesis 4. Physicians’ interactivity perception is positively related to their intention to use CDSS.

3. Empirical analysis and Data

3.1. Data collection

The main purpose of this study is to explain the limitations of TAM in explaining CDSS in a hospital setting. In line with it, this study has identified the factors affecting physicians’ CDSS adoption which are not included in the existing TAM. Data for this study were collected by the use of a questionnaire distributed among physicians with different specialties in 12 Malaysia’s hospitals. In our analysis, 300 valid questionnaires were analyzed. Roughly equal numbers of men and women were represented. Respondents’ major fields included General Practitioners (14.6%), Surgeon (14.6%), Pediatric (12.6 %), Gynecologist (11%), Internist (10.7%), Anesthesiologist (8.7 %), Radiologist (7.1%), Geriatric (6.8%), and Psychiatrist (6.1%). Approximately 80% of the physicians reported moderate to very high level of familiarity with CDSS.

3.2. Measurement
In this study, a questionnaire was used to measure the five constructs embedded in the research model. All measurement items were adapted from established sources and measured on a five-point Likert scale with anchors of strongly agree (5) and strongly disagree (1). The items used to measure perceived usefulness and perceived ease of use were adapted from Davis (1989) and Davis et al. (1989). Intention to use was measured based on six items adapted from Hu et al. (1999). Perceived threat to professional autonomy was measured using six items adapted from Walter and Lopez (2008). In the case of perceived interactivity, measurement items were adapted from Lee et al. (1995) and also Sundar et al. (2003).

3.3. Reliability and construct validity

In order to address the reliability and validity of the constructs of the proposed model, first the survey items were tested for scale reliability. The Cronbach’s alpha scores for the five constructs were greater than the acceptable level of 0.7 indicating high internal consistency. Construct reliability was assessed using evaluation of factor loading as well as examining the composite reliability and Average variance Extracted (AVE). All constructs exhibited composite reliability greater than the acceptable level of 0.7 indicating that the measurement errors were relatively small (Fomeel and Lacker, 1981). AVE value for all constructs was also greater than 0.5. To assess the discriminant validity between constructs, the test that requires the square root of AVE for each construct to be higher than the correlation between the two associated latent variables was performed. All factors meet the criteria for discriminant validity as shown in Table 1.

Table 1. Cronbach’s Alpha (CR), Composite reliability (COMP) and AVE of constructs (diagonal of the matrix contains the square root of AVEs, off-diagonal elements are the correlation between constructs)

<table>
<thead>
<tr>
<th>Constructs</th>
<th>CR</th>
<th>COMP</th>
<th>AVE</th>
<th>Intention</th>
<th>Perceived Usefulness</th>
<th>Perceived Ease of Use</th>
<th>Perceived Threat</th>
<th>Perceived Interactivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intention</td>
<td>0.85</td>
<td>0.83</td>
<td>0.63</td>
<td>0.79</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived Usefulness</td>
<td>0.92</td>
<td>0.93</td>
<td>0.7</td>
<td>0.523</td>
<td></td>
<td>0.83</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived Ease of Use</td>
<td>0.9</td>
<td>0.93</td>
<td>0.7</td>
<td>0.457</td>
<td>0.699</td>
<td>0.83</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived Threat</td>
<td>0.89</td>
<td>0.89</td>
<td>0.67</td>
<td>-0.472</td>
<td>-0.139</td>
<td>-0.196</td>
<td>0.81</td>
<td></td>
</tr>
<tr>
<td>Perceived Interactivity</td>
<td>0.82</td>
<td>0.85</td>
<td>0.54</td>
<td>0.525</td>
<td>0.635</td>
<td>0.511</td>
<td>0.202</td>
<td>0.73</td>
</tr>
</tbody>
</table>

4. Findings

In order to analyze the hypotheses of this study AMOS 16 has been used. First the measurement model has been confirmed and then the structural model has been examined. Six common model-fit measures were employed to assess the model’s overall goodness-of-fit. These are: the ratio of $\chi^2$ to degrees-of-freedom (d.f.), the comparative fit index (CFI), the Tucker-Lewis Index (TLI), the normalized fit index (NFI), the root mean square residual (RMR), and the root mean square error of approximation (RMSEA). Commonly, model fit is obtained when $\chi^2$/ d.f. is lower than 3,
the CFI, GFI and NFI are higher than 0.90, RMR is lower than 0.05 and the RMSEA is lower than 0.08 [47]. In this study, the model fit indices are: CFI = 0.91, NFI = 0.90, TLI = 0.90, RMR = 0.057, RMSEA = 0.052, χ²/ d.f. = 1.833. These indices are within the prescribed limits and therefore, the model reflects a good fit to the data [60]. All the hypotheses were accepted at 0.01. The hypotheses were tested based on the structural model and the results are:

**H1:** There is a significant positive relationship between perceived usefulness and intention to use CDSS (r = 0.27, p-value= 0.00< 0.01).

**H2:** There is a significant positive relationship between perceived ease of use and intention to use CDSS (r = 0.21, p-value= 0.00< 0.01).

**H3:** There is a significant negative relationship between perceived threat to professional autonomy and intention to use CDSS (r = -0.26, p-value= 0.00< 0.01).

**H4:** There is a significant positive relationship between perceived interactivity and intention to use CDSS (r = 0.24, p-value= 0.00< 0.01).

The model indicates that perceived usefulness, perceived ease of use, perceived threat to professional autonomy and perceived interactivity collectively explain 61% of the variance in intention to use CDSS among physicians in Malaysia.

5. Conclusions and Discussion

A variety of IT systems has gradually become established in the healthcare industry. Clinical IT in healthcare sector is considered as a key element in improving the quality of medical care. However, the concern of having underutilized clinical IT systems still is one of the biggest issues for the clinical IT developers (Gagnon et al., 2010). This study tries to explain why TAM is not a fit model in this context and determine the motives that make healthcare professionals adopt CDSS. The results show that physicians’ decision to adopt CDSS is a function of the following factors: perceived threat to professional autonomy, perceived usefulness, perceived ease of use and perceived interactivity with CDSS. This research explains that the degree to which CDSS is perceived threatening to healthcare professionals’ autonomy can affect their intention to use the system. If physicians perceive treatment options and guidelines of CDSS are against their autonomous practice in hospitals, they feel threatened by CDSS and in turn they become less likely to use the system. This study also reveals that perceived usefulness is an important factor for physicians to adopt CDSS. The results stress the significant positive effect of instrumental benefits on physicians’ intention to adopt CDSS in a developing country like Malaysia. If physicians perceive that using CDSS can improve their job performance in Malaysia’s hospitals, they become more motivated to use the system in their practice patterns. In this study, obtaining more utility by using the system turns out to be the most important motives for physicians to adopt CDSS in the context of Malaysia. This study also shows the significant effects of perceived ease of use on intention to adopt CDSS among physicians in Malaysia. If physicians view CDSS as easy to use they become more willing to apply the system.
in their day-to-day work activities in hospitals. This study signifies the importance of easy features of CDSS to improve motivation of physicians in a developing country like Malaysia.

The importance of interactivity between IT systems and users has gained much attention recently. Interactivity can be demonstrated in reactive and continuous exchange of information with CDSS. The positive effects of perceived interactivity on physician adoption behavior indicates that when healthcare professionals perceive low level of control over the health care process due to the function and features of new CDS, they become less likely to use the system. In other words, if healthcare professionals perceive CDSS as their supervisor directing them what to do without their involvement and interference, they become less willing to use this kind of IT system in their medical practice. Perceived interactivity is largely based on the belief that the interactive working nature with the clinical system can assist in creating cooperation between physicians and CDSS. If Malaysian physicians perceive that the nature of interaction with new CDSS is interactive, they perceive more control and in turn they become more likely to use the system. Therefore, putting emphasis on physicians’ autonomy as well as interactive function of CDSS can improve CDSS adoption among Malaysian physicians.

What are the theoretical and practical contributions of this study? Medical care practice is one of the oldest and most relatively independent professions (Holsinger and Beaton, 2006). But Change is coming to healthcare sector and it can’t be ignored. The utilization of clinical IT in hospitals has three important outcomes: enhancing the quality of services delivered, improving the efficiency and effectiveness of the hospitals’ personnel and cutting the organizational expenses (Scott, 2007). An advanced clinical IT in a hospital without physician acceptance is like having a modern art museum without any visitors. Adoption of physicians gives meaning to CDSS in a hospital setting. From a theoretical point of view, this study contributes to IT adoption theories by modifying the existing TAM in the context of CDSS adoption. Since the TAM cannot address healthcare professionals’ unique characteristics and it is not fit the healthcare context, this study has been conducted to better explain physicians’ IT adoption behavior in a hospital setting. The research model developed by this study can explain 61% of the variance in physician CDSS adoption behavior. Implementing and using CDSS in a developing country like Malaysia can be a challenge for hospital administrators. From a practical view, this study suggests that the hospital mangers and decision makers must take following initiatives to improve adoption of CDSS by physicians. As far as the negative effect of perceived threat is concerned, this study informs managers of hospitals in Malaysia about concerns and fears of threat perceived by physicians due to CDSS. Hospital managers should give much attention to professional characteristics of healthcare professionals such as autonomous practice to foster their priorities in IT adoption. This study also suggests that the hospital managers should increase perceived interactivity with CDSS to increase physicians’ motivation to use clinical IT. To do so, the managers should realize a strong need for continued training programs for physicians to improve their knowledge on the functions and guidelines of CDSS. The study recommends that hospital managers should emphasize the advantage and usefulness of using CDSS to motivate physicians to use clinical IT. This research suggests that CDSS must have easy features and include user friendly elements for the physicians to perceive that
using the instructions given by the system is easy. With this understanding, hospital management can improve overall acceptance of CDSS by healthcare professionals in Malaysia’s hospitals.

This study has some limitations. First, the study was conducted in private and public hospitals in Malaysia. The factors affecting the adoption of clinical IT in hospitals could be different in other developing countries. Second, our study included the hospitals in and around the capital city, Kuala Lumpur, and these hospitals are highly developed and superior compared to the facilities in the rural areas. Therefore, this study does not strongly recommend generalizing the results to the hospitals in the rural areas.

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