Alliance of medical malls: Conditions for the establishment of network practice

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Abstract

Network practice is a method of efficiently sharing patient information and making patient referrals, while utilizing information network technology among doctors. Although realizing alliances in a medical mall is difficult, it may be possible if network practice is carried out with the right partners. One of the reasons why alliances are difficult to establish in medical malls is that they may not meet the conditions that make the network practice possible in the first place. To investigate these conditions, we focused on the diagnostic sensitivity of doctors (hereafter, "sensitivity") and conducted a model analysis to determine the optimal partners to form an alliance. First, if the sensitivity of doctors is ensured at a high level, and there is a complementary relationship, network practice may be established. Second, network practice incurs transaction costs, which are influenced by sensitivity. Therefore, the higher the sensitivity, the lower the transaction cost and the higher the incentive for network practice. Third, the lower this sensitivity, the greater the mismatch between the patient and doctor's areas of diagnosis, and thus the greater the risk that patients will be interrupted in the course of their care. Therefore, to realize alliances in medical malls, it is necessary to devise ways to reduce transaction costs and match the diagnosis areas of patients and doctors, while making full use of information network technology and fulfilling the conditions for network practice.

Keywords

Medical malls, Alliance; Conditions for the establishment of the network practice; Diagnostic sensitivity; Transaction costs

(1) Introduction

1. Identification of the Problem

Although health care is known to be a regulated industry that requires publicity, safety, and reliability, thus making it difficult for competition to work, there is fierce competition among health care organizations. This is due to dramatic changes in the external environment, including financial problems, health care reform, and soaring awareness of patients' rights (McSweeny-Feldand, Discenza, and Defeis, 2010; Bernardo, Valls, and Casadesus, 2012). In particular, Japan's long-term deflationary economy and rapidly aging population have led to an expansion of the health care cost-to-gross-domestic-product ratio, putting pressure on health insurance funding (Hashimoto et al., 2011). Therefore, to control the increasing rate of the country's overall health care costs and to make effective use of health care resources, the Japanese government is revising medical fees decreasingly, reducing the number of hospital beds, increasing patients' co-payments, and raising social insurance premiums and taxes on citizens. At the same time, hospitals and clinics are urged to rationalize and improve the efficiency of their management by promoting clear division of functions and mutual cooperation, as well as information technology, to provide low-cost, high-quality medical care (Ministry of Health, Labour and Welfare, 2015, 2016).

Owing to these circumstances, the number of hospitals peaked at 10,096 facilities in 1990 and has significantly decreased to 8,442 facilities in 2016, while the number of clinics has reached 101,529 facilities as of 2016, making the competitive environment surrounding clinics even more difficult (World Health Organization, 2018). However, it has been pointed out that clinics in Japan are usually run by a single specialist who has worked in a hospital, and thus have a small management scale and weak medical management and primary care[1]. As long as a single doctor runs a clinic, it is very difficult to ensure both the quality of medical care and the soundness of management. Therefore, medical malls have recently been adopted as a strategic alliance that transcends the boundaries of medical institutions. Their number has increased 6.7 times from about 375 in 2005 to 2,501 as of 2019 (Ito, 2020a).

To begin with, an alliance is defined as "*voluntary arrangements between firms involving exchange, sharing, or codevelopment of products, technologies, or services*" (Gulati, p. 293, 1998).

Although there is a long tradition and rich accumulation of management research on alliances, there are numerous definitions and no common concept due to the diverse perspectives and cross-cutting subject areas (Kinderis and Jucevičius, 2015). However, at the very least, there is no dispute that alliances represent a form of cooperation among multiple organizations to achieve a certain goal and that they are a strategic business form found in many markets regardless of industry. Its main effects are expected to be the following: an expansion of business scale, pursuit of profits, sharing of management resources, reduction of costs and risks, acquisition of learning effects including knowledge and know-how, and even reduction of excessive competition. However, there is no knowledge on medical malls (Kinderis and Jucevičius, 2015).

Medical malls, as a form of establishment in which multiple clinics and pharmacies are assembled in the same space, are mainly clustered in convenient locations for

[1] Primary care includes doctors, medical institutions, and medical services with which a patient comes into contact first. In Japan, it generally refers to outpatient care in clinics.

transportation and living, and they have the advantage of efficient access to appropriate specialists and departments, while selecting them according to the convenience of patients (Epstein, 2016; Ito, 2020b). Additionally, there are several advantages for even doctors. First, it allows for networked care. Network practice is a new method of efficient patient information sharing and referral coordination among doctors using information network technology. In medical malls, doctors are spatially close, so the introduction of networked care can be advantageous. It has long been common in primary care in Western countries for multiple doctors to collaborate to provide group practice, but the difference is that this is not necessarily based on the use of information network technology (Josi and Pietro, 2019). However, since networking is an essential element in realizing alliances, this paper discusses the premise of adopting a networked practice (Bernardo et al., 2012).

Another advantage is that high-cost medical equipment such as computed tomography and magnetic resonant imaging can be shared in a medical mall to guarantee utilization rate and reduce the risk of overinvestment. Furthermore, the sharing of consultation tickets issued to patients can reduce the waste of consultation procedures. As a result, doctors can be freed from these administrative tasks and concentrate on medical care.

As previously described, medical malls that have introduced networked medical care have an incentive to form alliances among doctors because they can strengthen management functions through efficient sharing of management resources and provision of high-quality medical care among clinics.

However, it should also be noted that alliances are not a universal management strategy or solution (Vattikoti and Razak, 2018). For example, it has been reported that half of the alliances fail and conversely, performance declines (Varadarajan and Cunningham, 1995). Nevertheless, few solutions to problems related to alliances have been identified (Albers, Wohlgezogen, and Zajac, 2013). In particular, medical malls have long been pointed out as a future management issue because of the difficulty of cooperation among clinics (Ito, 2016). So, how can alliances be realized in medical malls? This is the research question of this paper.

Then, can the network model of online shopping malls not be used as a reference? We may be able to refer to online shopping malls, which have already built models of matching stores and consumers and providing convenient services. In addition, several studies of online shopping malls have reported the results of research that modeled the relationship between stores and consumers (Ahna, Ryu, and Han, 2004; Macmillan, 2009). Indeed, the two are similar in that they both provide convenient and complex services through the concentration of multiple stores. Moreover, online shopping is highly appreciated because consumers value the quality of service that enables contactless shopping experience. This implication is also applicable to network practices. However, this approach should be applied with caution because the assumptions of transactions are fundamentally different in the medical and general commercial sectors. For example, price competition is not allowed in the medical field, and advertising is strictly regulated; therefore, one cannot advertise freely. Moreover, one cannot open a business without a doctor's license, and the barriers to entry are high. Furthermore, word of mouth and rankings do not always reflect the quality of medical care. Therefore, it is necessary to propose an original model that takes these circumstances into account.

2. Study Objectives and Methods

This study examines the management issues for the realization of alliances in medical malls. It has been pointed out that the background to the difficulty of alliances in medical malls is related to the large transaction costs between clinics (Ito, 2016). The following two issues are considered to be the main causes of this increased transaction cost.

The first is that the majority of clinics still rely on paper medical records and fax machines, and have not yet adopted information network technology, resulting in very inefficient collaboration among clinics. However, this problem should be solved by introducing the information technology mentioned earlier (Hajli et al., 2014). Second, the choice of partners is very important for the success of an alliance, but there has not been sufficient discussion on what kind of relationship is appropriate to establish (Hitt et al., 2000). In particular, to realize alliances in medical malls, incentives to establish network practice are necessary, but it is suspected that these may not be functioning effectively in practice. Medical care is inherently very different from other service industries in that it affects the prognosis of the patient's life, and it is a profession that requires safety and reliability with the highest priority. Therefore, doctors are strongly required to possess autonomy and ethics as professionals. For this reason, network practice, which pursues only commercial purposes and leads to a decline in quality, is not allowed. In other words, the quality of the partner doctor is considered to be a major incentive for the establishment of a network practice. Therefore, an alliance of medical malls may be feasible if the network practice can be carried out with appropriate partners. However, there are few studies on this topic because it is a sensitive issue that deals with the qualifications of doctors and has been avoided until now.

The purpose of this study was thus to clarify the conditions for the establishment of networked medical care in medical malls, focusing on diagnostic sensitivity (hereafter, "sensitivity") as a quality of doctors.

First, in Section 2, we propose a method to evaluate the quality of doctors using sensitivity, and we conduct a model analysis of the difference in sensitivity between solo and network practice. In addition, we will classify alliances among doctors into three cases and elucidate the cases in which network practice can be established. Furthermore, we will analyze the problem of transaction costs, which is considered to be the main disincentive for network practice, in relation to the sensitivity of doctors. In Section 3, we discuss the conditions for the establishment of network medical care based on the results of these studies, as well as the limitations and future challenges of this research. Finally, in Section 4, we conclude with recommendations on the conditions for the establishment of networked medical care and issues for the realization of alliances.

(2) Model Analysis of a Network Practice

1. Solo Practice Model

The sensitivity discussed here refers to the probability that a doctor can correctly diagnose a patient's disease. Although it is difficult to measure the sensitivity of individual doctors strictly, it is possible to measure it experimentally by identifying diseases and using image findings. For example, a reading test can be conducted by mixing symptomatic and Diagnostic images to determine the sensitivity in this area (Ito, 2017). Alternatively, a method to determine sensitivity from the false positive rate can be considered.

In this paper, the following symbols will be introduced to discuss the sensitivity of doctors:

- i: Doctor's number ($i = 1, \cdots, m$)
- j: Number of the diagnosis area ($j = 1, \cdots, n$)

(In general, m and n can be different.)

-Sensitivity of doctor i: P_i ($i = 1, \cdots, m$)

-Sensitivity of diagnosis area j of doctor i: P_{ij}

$$(i = 1, \cdots, m, \qquad j = 1, \cdots, n)$$

-Total number of patients: N

-Number of patients who visit doctor i: N_i

$$\left(\sum_{i=1}^{m} N_i = N\right)$$

-Number of patients in diagnosis area j who see doctor i: N_{ij}

$$\left(\sum_{j=1}^{n} N_{ij} = N_i, \qquad i = 1, \cdots, m\right)$$

-Number of patients in diagnostic area j : N^j

$$\left(\sum_{i=1}^{m} N_{ij} = N^j, \qquad j = 1, \cdots, n, \qquad \sum_{j=1}^{n} N^j = N\right)$$

In this section, we assume that Ni = 1 or higher. This is because a doctor with Ni = 0 (For example, such case happens when the number of doctors is larger than patients, or when a particular doctor has a monopoly on patients) is assumed to have low sensitivity, and network practice with such a doctor is unrealistic to improve sensitivity. The sensitivity of doctor i, P_i , and the mean sensitivity of all doctors, P_{mean} of all the doctors are determined as follows:

$$P_i = \frac{\sum_{j=1}^{n} P_{ij} N_{ij}}{N_i} = \frac{P_{i1}N_{i1} + P_{i2}N_{i2} + \cdots + P_{in}N_{in}}{N_{i1} + N_{i2} + \cdots + N_{in}}$$

$$P_{mean} = \frac{\sum_{i=1}^{m} P_i}{m} = \frac{P_1 + P_2 + \cdots + P_n}{m}$$

When $m = n$, the network practice sensitivity P_g for the entire doctor population is defined as follows:

$$P_g = \frac{\sum_{i=1}^{n} P_{ii} N^i}{N} = \frac{P_{11}N^1 + P_{22}N^2 + \cdots + P_{nn}N^n}{N^1 + N^2 + \cdots + N^n}$$

As suggested by these equations, the sensitivity used in this study depends on the number of patients per diagnosis area. Hereafter, $m = n$.

As previously described, by controlling the numerical values of P_{ij} and N_{ij}, we can consider various degrees of matching between the diagnosis area by the doctor and the diagnosis area required by the patient.

2. A Network Practice Model from the Perspective of Three Alliances

2.1 Cases of Complementary Relationships between Doctors

First, we consider the case where each doctor is a specialist and excels in diagnosing one of the medical areas.

In particular, doctor i is a case with great sensitivity in clinical area i:

$$P_{ii} \geq P_{ij} \ (j \neq i)$$

Consider the case where the above equation holds.

This means that doctors complement each other, and do not compete in their area of practice.

Case 1: The sensitivity of each doctor's specialty is equal

The first simple case

$$P_{11} = P_{22} = \cdots = P_{nn}$$

is equal. In this case,

$$P_g = \frac{\sum_{i=1}^{n} P_{ii} N^i}{N} = P_{11} \frac{\sum_{i=1}^{n} N^i}{N} = P_{11}$$

This means that the network practice sensitivity is equal to the sensitivity of each doctor's specialty area. In addition,

$$P_i = \frac{\sum_{j=1}^{n} P_{ij} N_{ij}}{N_i} \le \frac{P_{ii} \sum_{j=1}^{n} N_{ij}}{N_i} = P_{ii} = P_g$$

From the above equation, we can see that the network practice sensitivity is larger for any doctor. Also, in this case, $P_{mean} \le P_g$.

From this, we can say that there is an incentive to adopt network practice when the doctors are complementary, and each doctor has equal sensitivity in his or her area of expertise. The numerical example in this case corresponds to Case (a) in Tables 1 and 2.

Case 2: There is variation in sensitivity.

The difference between the network practice sensitivity and the average sensitivity of all doctors can be calculated as follows. First, from $P_i \le P_{ii}$,

$$P_g - P_{mean} = \frac{\sum_{i=1}^{n} P_{ii} N^i}{N} - \frac{\sum_{i=1}^{n} P_i}{n}$$
$$\ge \frac{\sum_{i=1}^{n} P_{ii} N^i}{N} - \frac{\sum_{i=1}^{n} P_{ii}}{n}$$

The above equation can be derived, but in order for it to be positive

$$\sum_{i=1}^{n} P_{ii} N^i \ge \frac{\sum_{i=1}^{n} P_{ii}}{n} N$$

That is, $N = \sum_{i=1}^{n} N^i$, and dividing by n on both sides, the following equation is obtained:

$$\frac{1}{n}\sum_{i=1}^{n} P_{ii} N^i \ge \left(\frac{1}{n}\sum_{i=1}^{n} P_{ii}\right)\left(\frac{1}{n}\sum_{i=1}^{n} N^i\right)$$

This is known as Chebyshev's sum inequality:

$$P_{11} \ge P_{22} \ge \cdots \ge P_{nn},$$
$$N^1 \ge N^2 \ge \cdots \ge N^n$$

When such a relationship exists, the inequality holds. In other words, this is a situation where the order of magnitude of the sensitivity of the doctor's areas of expertise exactly matches the order of the number of patients in each of those areas.

This shows that doctors are complementary to each other and have an incentive to adopt network practice whenever there is a patient in each domain corresponding to the magnitude of the doctor's sensitivity. The numerical example for this case is Case (b) in Table 1. However, since this is a sufficient condition, there may be situations where the network clinic sensitivity is greater even when there is no such correspondence. For example, consider Case (b) in Table 2.

In general, it can also be calculated as follows:

$$P_g - P_{mean} = \frac{\sum_{i=1}^{n} P_{ii} N^i}{N} - \frac{\sum_{i=1}^{n} P_i}{n}$$
$$= \frac{1}{n}\left(\frac{n \sum_{i=1}^{n} P_{ii} N^i}{N} - \sum_{i=1}^{n} \frac{\sum_{j=1}^{n} P_{ij} N_{ij}}{N_i}\right)$$
$$= \frac{1}{n}\sum_{i=1}^{n}\left(\frac{\sum_{j=1}^{n} P_{jj} N^j}{N} - \frac{\sum_{j=1}^{n} P_{ij} N_{ij}}{N_i}\right)$$
$$= \frac{1}{n}\sum_{i=1}^{n}\sum_{j=1}^{n}\left(\frac{P_{jj} N^j}{N} - \frac{P_{ij} N_{ij}}{N_i}\right)$$

Therefore, for each i, j

$$\frac{P_{jj} N^j}{N} - \frac{P_{ij} N_{ij}}{N_i} \ge 0$$

we can say that there is an incentive to adopt a network practice. Even if this becomes a negative number for some i, j, the sum for all i, j should be positive. Further in text, we consider a situation where this inequality holds. First, for $i = j$, the inequality is as follows.

$$\frac{N^i}{N} \ge \frac{N_{ii}}{N_i}$$

Table 1 Comparison of mean sensitivity P_{mean} and network practice sensitivity P_g for Doctor 1 and Doctor 2

Case	(P_{11}, P_{12})	(P_{21}, P_{22})	(N_{11}, N_{12})	(N_{21}, N_{22})	N^1	N^2	P_1	P_2	P_{mean}	P_g
(a)	(0.9, 0.6)	(0.5, 0.9)	(500, 500)	(500, 500)	1000	1000	0.75	0.70	0.73	0.90
(b)	(0.9, 0.4)	(0.5, 0.7)	(800, 200)	(400, 600)	1200	800	0.80	0.62	0.71	0.82
(c)	(0.9, 0.4)	(0.5, 0.7)	(200, 600)	(1000, 200)	1200	800	0.53	0.53	0.53	0.82
(d)	(0.9, 0.3)	(0.2, 0.5)	(300, 100)	(100, 1500)	400	1600	0.75	0.48	0.62	0.58
(e)	(0.9, 0.7)	(0.9, 0.6)	(600, 400)	(600, 400)	1200	800	0.82	0.78	0.80	0.78
(f)	(0.9, 0.7)	(0.9, 0.6)	(900, 500)	(100, 500)	1000	1000	0.83	0.65	0.74	0.75
(g)	(0.9, 0.7)	(0.3, 0.4)	(800, 800)	(200, 200)	1000	1000	0.80	0.35	0.58	0.65
(h)	(0.9, 0.7)	(0.3, 0.4)	(200, 100)	(200, 1500)	400	1600	0.83	0.39	0.61	0.50

Source: Created by the author.

Then, the left-hand side is the percentage of patients seen by doctor i after the network practice, and the right-hand side is the percentage of patients in practice area i seen by doctor i before the network practice. In other words, the proportion of patients seen by doctor i who specializes in area i must increase with the implementation of network practice. This is a requirement that must be met when introducing network medical care.

Then for $i \neq j$, the inequality is

$$\frac{N^j}{N} \geq \frac{P_{ij}}{P_{jj}} \cdot \frac{N_{ij}}{N_i} \qquad \ldots *)$$

and this equation is rewritten as *),

where the left-hand side represents the percentage of patients that doctor j sees after the network treatment, the first part of the right-hand side represents the ratio of the sensitivity of doctor i and doctor j to diagnosis area j, and the back part represents the percentage of patients in clinical area j for doctor i before the network treatment. Since $P_{ij}/P_{jj} \leq 1$ if $P_{jj} \geq P_{ij}$, we know that network practice should result in the proportion of patients seen by a specialist being greater than the proportion of patients seen by a non-specialist multiplied by the sensitivity ratio. This is a situation that should be met in many cases when network practice is used, but in some very special cases, $P_{mean} \geq P_g$ (see Case (d) in Tables 1 and 2).

2.2 Cases of Competing Doctors

Second, we will consider the case where the sensitivities of the doctors are in a competitive relationship. In other words, the sensitivity of a certain Doctor 1 and Doctor 2 is $P_{11} \leq P_{21}$. In this case, $P_{21}/P_{11} \geq 1$, and N_{21}/N_2 must be small enough to satisfy the inequality*). This means that the percentage of patients in Diagnosis Area 1 that Doctor 2 sees is small. This case is unlikely to occur because Doctor 2 specializes in Diagnosis Area 1. In other words, there is no incentive to provide network care in cases where there is a competitive relationship (see Tables 1 and 2 Cases (e) and (f)). However, since the sensitivity of the two doctors is the same, and the quality of their medical care is guaranteed, there may be an incentive to form an alliance if the clinic is closed for some reason or if the number of patients increases and other doctors are needed to support the clinic. In other words, this can be interpreted as a conditional establishment of a network practice when

Table 2 Comparison of mean sensitivity P_{mean} and network practice sensitivity P_g for Doctor 1, Doctor 2, and Doctor 3

Case	(P_{11}, P_{12}, P_{13}) / (N_{11}, N_{12}, N_{13})	(P_{21}, P_{22}, P_{23}) / (N_{21}, N_{22}, N_{23})	(P_{31}, P_{32}, P_{33}) / (N_{31}, N_{32}, N_{33})	N^1	N^2	N^3	P_1	P_2	P_3	P_{mean}	P_g
(a)	(0.9, 0.6, 0.3) / (500, 500, 500)	(0.5, 0.9, 0.4) / (500, 500, 500)	(0.3, 0.5, 0.9) / (500, 500, 500)	1500	1500	1500	0.60	0.60	0.57	0.59	0.90
(b)	(0.9, 0.6, 0.3) / (800, 300, 200)	(0.5, 0.8, 0.4) / (500, 700, 400)	(0.3, 0.5, 0.7) / (300, 400, 900)	1600	1400	1500	0.74	0.61	0.58	0.64	0.80
(c)	(0.9, 0.6, 0.3) / (300, 400, 800)	(0.5, 0.8, 0.4) / (600, 300, 600)	(0.3, 0.5, 0.7) / (800, 400, 300)	1700	1100	1700	0.50	0.52	0.43	0.48	0.80
(d)	(0.9, 0.7, 0.6) / (100, 400, 1000)	(0.6, 0.7, 0.6) / (100, 400, 1000)	(0.4, 0.4, 0.5) / (100, 300, 1200)	300	1100	3200	0.65	0.63	0.48	0.58	0.57
(e)	(0.9, 0.6, 0.3) / (800, 500, 300)	(0.8, 0.5, 0.4) / (800, 500, 300)	(0.7, 0.5, 0.2) / (800, 300, 200)	2400	1300	800	0.69	0.63	0.58	0.63	0.66
(f)	(0.9, 0.6, 0.3) / (800, 500, 300)	(0.8, 0.5, 0.4) / (500, 800, 300)	(0.3, 0.5, 0.9) / (200, 300, 800)	1500	1600	1400	0.69	0.58	0.72	0.66	0.76
(g)	(0.9, 0.8, 0.7) / (1000, 900, 800)	(0.4, 0.5, 0.3) / (400, 500, 300)	(0.1, 0.2, 0.3) / (100, 200, 300)	1500	1600	1400	0.81	0.42	0.23	0.49	0.57
(h)	(0.9, 0.8, 0.7) / (300, 200, 100)	(0.4, 0.5, 0.3) / (200, 500, 400)	(0.1, 0.2, 0.3) / (200, 800, 1800)	700	1500	2300	0.83	0.41	0.26	0.50	0.46

Source: Created by the author.

doctors are competing with each other in their areas of practice.

2.3 Case of a Superior–Inferior Relationship between Doctors

Third, consider a case in which one doctor has high sensitivity and the other doctor has extremely low sensitivity, i.e., a "superior–inferior" relationship. In other words, if the sensitivity of Doctor 1 and Doctor 2 is assumed to be satisfied.

$$\min_k P_{1k} \geq \max_k P_{2k}$$

This is the case where the sensitivity of all regions of Doctor 2 is lower than the least sensitive region of Doctor 1. In this case, as in the case of (1), $P_g \geq P_{mean}$, and there is an incentive to adopt network practice. However, considering the very rare case, $P_{mean} \geq P_g$ may also be true (see Table 1 case(e)(h)). In addition,

$$\min_i P_{ii} = P_{22}\,,\ \max_i P_{2i} = P_{22},$$

and so on. In other words, Doctor 2 has Area 2 as the highest sensitivity, but it is lower than the sensitivity of any other doctor's specialty.
In this case,

$$P_g = \frac{\sum_{i=1}^{n} P_{ii} N^i}{N} \geq \frac{\sum_{i=1}^{n} P_{22} N^i}{N} = P_{22}$$

$$P_2 = \frac{\sum_{j=1}^{n} P_{2j} N_{2j}}{N_2} \leq \frac{\sum_{j=1}^{n} P_{22} N_{2j}}{N_2} = P_{22}$$

and $P_g \geq P_2$ always holds.

This implies that there is an incentive for Doctor 2 to have a network practice. This has implications for the possibility of supporting low-sensitivity doctors as a whole (see Tables 1 and 2 Case (g), (h)). This finding is also consistent with the view that there is an endorsement effect when low quality organizations join alliances (Stuart, 2000).

2.4 Sensitivity Analysis

In this section, we attempted a sensitivity analysis for the three cases mentioned above, with several numerical examples thrown in. Table 1 shows the results for $n = 2$, and Table 2 shows the results for $n = 3$. However, we fixed $N = 2{,}000$ for $n = 2$ and $N = 4{,}500$ for $n = 3$. In both cases, Cases (a), (b), (c), and (d) show complementary relationships, Cases (e) and (f) show competitive relationships, and Cases (g) and (h) show dominance–subordination relationships.

In Case (a), the sensitivity of the specialty was equal, as well as the number of patients; in Case (b), there was a small difference in the sensitivity of the specialty, but the number of patients was correspondingly large; and in Case (c), the sensitivity of network practice was high when many patients visited doctors from different diagnosis areas. Conversely, in Case (d), the network practice sensitivity was small when there were few patients who should visit a doctor with high sensitivity and many patients who should be seen by a doctor with low sensitivity. In addition, (e), which is competitive, was reversed. The same was true for (f), which was competitive but had a higher network practice sensitivity. Even in the dominant–subordinate relationship, there were cases where (g) network sensitivity was high, and cases where (h) network sensitivity was low.

3. A Network Practice Model That Reflects Transaction Costs

When providing networked medical services, a variety of labor and coordination burdens are incurred. For example, there are many transaction costs, such as obtaining patient consent, preparing referral letters, sending and receiving clinical information, transcribing medical records and test data, and coordinating retest requests and hospital admissions and discharges. The magnitude of these costs is thought to depend on the quality of the doctor. For example, if a doctor is highly sensitive, he or she will be able to provide appropriate medical care efficiently and collaborate seamlessly with other doctors. Conversely, if the doctor's sensitivity is low, the medical treatment will be inappropriate, and when collaborating, many tasks will need to be reconfirmed, and questionable referrals will occur, which is inefficient and may increase transaction costs. For this reason, the introduction of diagnostic support systems and electronic health records (EHR) has recently been recommended to reduce such transaction costs, but it has not necessarily spread to the national level (Tanaka, 2007). However, as long as the existence of transaction costs is left unaddressed, it is difficult to develop networked medical care, so it is necessary to understand transaction costs to improve the problem.

Here, we define it as follows:

- $1 - P_{ij}$: cost incurred by doctor i to see one patient in area j
- k : a uniform burden rate for providing network medical services.

In other words, the higher the sensitivity, the lower the cost. In this case, the total cost before network clinic is the following equation:

$$C_{before} = \sum_{i=1}^{n}\sum_{j=1}^{n}(1 - P_{ij})N_{ij}$$

The total cost of a network practice can be calculated as follows:

$$C_{after} = \sum_{i=1}^{n}(1 - P_{ii})N^{i}$$

Furthermore, if $k \cdot C_{after} \leq C_{before}$, the total

Table 3 Total cost comparison before and after the network practice (corresponding to the cases in Tables 1 and 2 (left) n=2, (right) n=3)

Case	Before	After	1/k
(a)	550	200	0.36
(b)	580	360	0.62
(c)	940	360	0.38
(d)	930	840	0.90
(e)	400	440	1.10
(f)	450	500	1.11
(g)	580	700	1.21
(h)	1090	1000	0.92

Case	Before	After	1/k
(a)	1850	450	0.24
(b)	1650	890	0.54
(c)	2320	900	0.39
(d)	1930	1960	1.02
(e)	1630	1530	0.94
(f)	1540	1090	0.71
(g)	1680	1930	1.15
(h)	2830	2430	0.86

Source: Created by the author.

Table 4 Comparison of interruptions in outpatient care (corresponding to the cases in Tables 1 and 2 (left) n=2, (right) n=3)

Case	L1	L2	Lg
(a)	0.25	0.30	0.10
(b)	0.20	0.38	0.18
(c)	0.48	0.47	0.18
(d)	0.25	0.52	0.42
(e)	0.18	0.22	0.22
(f)	0.17	0.35	0.25
(g)	0.20	0.65	0.35
(h)	0.17	0.61	0.50

Case	L1	L2	L3	Lg
(a)	0.40	0.40	0.43	0.10
(b)	0.26	0.39	0.43	0.20
(c)	0.50	0.48	0.57	0.20
(d)	0.35	0.37	0.53	0.43
(e)	0.31	0.37	0.42	0.34
(f)	0.31	0.43	0.28	0.24
(g)	0.19	0.58	0.77	0.43
(h)	0.17	0.59	0.74	0.54

Source: Created by the author.

cost of adopting network practice will be small and there is an incentive. Moreover, if

$$1/k = C_{before}/C_{after}$$

we can estimate how much we can bear when adopting network practice. Table 3 summarizes the values of C_{before}, C_{after}, and $1/k$ for the cases in Tables 1 and 2. For example, Case (a) with the smallest $1/k$ in the left table ($1/k$ =0.36) means that there is an incentive even if the transaction cost corresponding to 100% - 36% = 64% is incurred as a result of network treatment. On the other hand, (g), has the highest $1/k$, that is, 1.21. However, there is no incentive because the network practice generates transaction costs equivalent to 121%, which, conversely, is an increased burden compared to the solo practice. Hence, (a) can be interpreted as more desirable than (g).

4. The Problem of Interruption of a Visit to an Outpatient Clinic

4.1 Outpatient Clinic Interruption Model

Furthermore, to increase the effectiveness of network practice, it is important to match the areas of practice of patients and doctors as much as possible. In a study by National Federation of Health Insurance Societies (2000), it was reported that 32.2% of patients visited more than one medical institution at the same time for the same injury or illness, so this may be happening because of a mismatch between patients' and doctors' practice areas (National Federation of Health Insurance Societies, 2017). Therefore, the risk of these mismatched patients interrupting the course of their care is

Interruption level: L_i

$$L_i = 1 - P_i, (0 \leq L \leq 1)$$

As shown above, it can be calculated by simply subtracting the sensitivity of the target doctor from the maximum sensitivity value. Thus, we can use the following numerical examples for each parameter

$$P_{11} = 0.8,\ P_{12} = 0.6,\ P_{21} = 0.6,\ P_{22} = 0.8$$

$$N_{11} = N_{12} = N_{21} = N_{22} = 500$$

then the degree of interruption of outpatient care for each doctor in the case of solo care is

$$L_1 = 1 - P_1 = 1 - 0.7 = 0.3$$

$$L_2 = 1 - P_2 = 1 - 0.7 = 0.3$$

Therefore, we can say that both Doctor 1 and Doctor 2 cause a mismatch of 30% of all patients diagnosed. On the other hand, L_g during network practice is

$$L_g = 1 - P_g = 1 - 0.8 = 0.2$$

and mismatch occurs in 20% of patients, indicating that the possibility of interruption of hospital visits is reduced by one-third compared to solo care.

Table 4 summarizes the values of L_i and L_g for each of the cases in Tables 1 and 2.

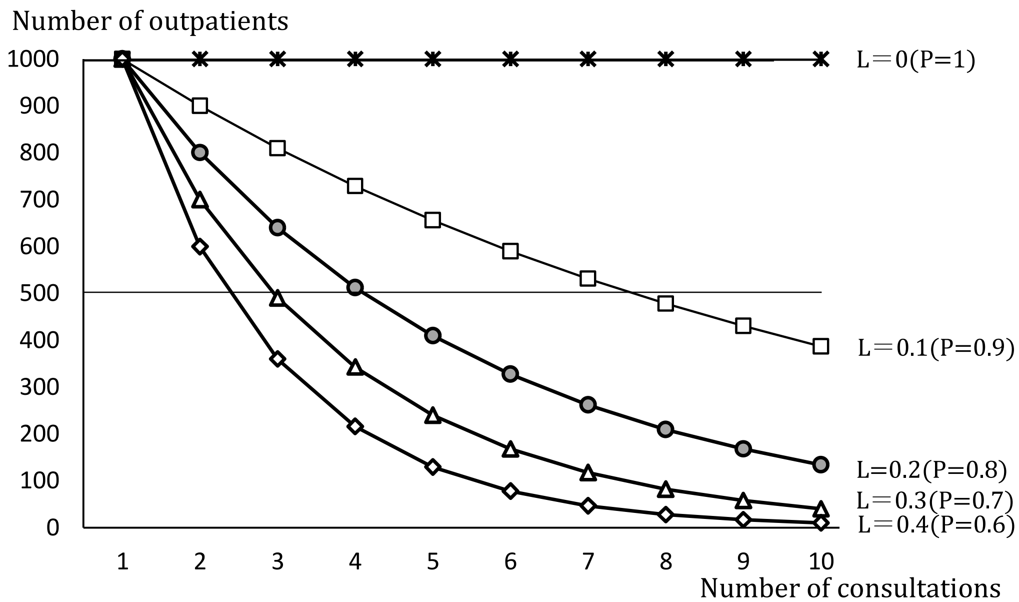
4.2 Simulation of the number of patients by the number of visits using the interruption level of outpatient care

Next, we attempted to simulate the number of patients by the number of visits using the "Outpatient Care Disruption Model" to clarify the relationship between doctor sensitivity and patient interruptions. In this study, we tentatively set the upper and lower limits of the doctor's sensitivity level to five levels in increments of 0.1, from the maximum value of 1 to 0.6. We assumed that the average number of outpatients per month in a typical clinic is 1,000, and that the number of patients who require regular visits and are mismatched to the doctor's area of practice is interrupted (reduced) with each visit. For convenience of analysis, we did not include the number of new patients. With the above parameters, we estimated how much the number of patients would decrease each time a patient visited the doctor in question. The results are shown in Figure 1.

As a result, at $P = 1$, the number of patients was steady regardless of the number of visits, because the patients and doctors were perfectly matched in their fields of practice. However, at $P = 0.9$, the number of patients was halved at the seventh visit, at $P = 0.8$ at the fourth visit, and at $P = 0.7$ and 0.6 at the third visit. Therefore, it can be interpreted that the larger these mismatches are, the greater the risk that patients will interrupt their visits.

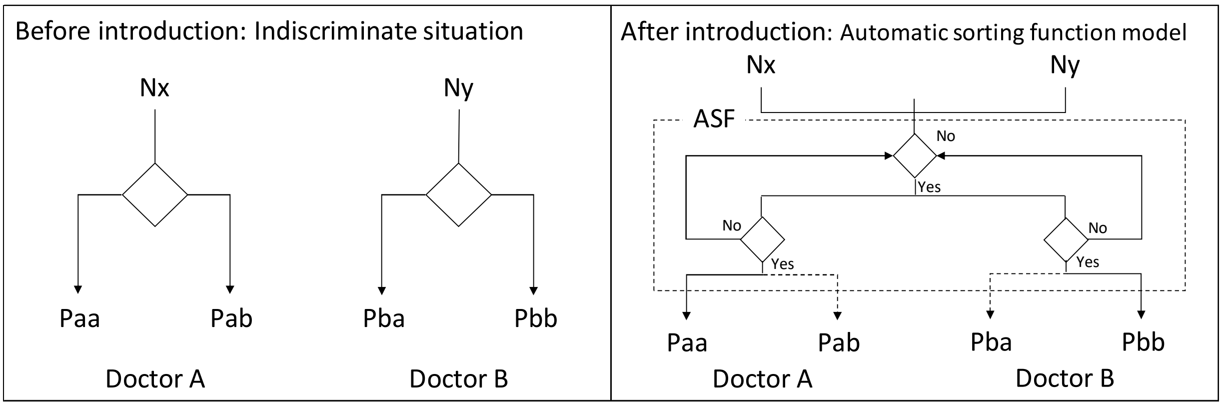
5 Possibility of matching clinical areas in patients and doctors by introducing automatic sorting function

Finally, what about the case where patients



Source: Created by the author.

Figure 1 Estimated number of outpatients by expected loss



Note： $N_x = N_y = (N_a + N_b)$, $N_a : N_b = 1 : 1$

Source: Created by the author.

Figure 2 Automatic sorting function model

can select appropriate specialists and departments before visiting a medical institution? It is empirically known that, in general, the purpose and function of specialty hospitals are more clearly defined than those of general hospitals, which makes it easier for patients to identify specialists and departments and to match patients and doctors in their fields of practice. This situation is naturally expected to be a signaling to patients in medical malls that are composed mainly of specialists. In particular, to increase the effectiveness of networked medical care, if artificial intelligence (AI)-equipped questionnaires are introduced at the general counter of medical malls and reflected in patients' medical choices, efficient matching by patients and doctors can be achieved (Petkus and Hoogewerf et al., 2020). Let us look at Figure 3 now. The left-hand side shows a situation where the automatic selection function has not yet been introduced, that is., in an indiscriminate manner, Doctor A is treating patient group N_x and Doctor B is treating patient group N_y solo. Here

Patient group in Clinical Area A: N_a

Patient group in Clinical Area B: N_b

$$N_x = N_y = N_a + N_b$$

$$N_a : N_b = 1:1$$

and assume that the patients are evenly distributed in the Treatment Areas A and B.

On the other hand, the sensitivities of Doctors A and B are

-Sensitivity of Doctor A's area of Practice A: P_{aa}

-Sensitivity of Doctor A's area of Practice B: P_{ab}

-Sensitivity of Doctor B's area of Practice A: P_{ba}

-Sensitivity of Doctor B's area of Practice B: P_{bb}

Let us assume that here, we have

- $P_{aa} \geq P_{ab}$
- $P_{bb} \geq P_{ba}$
- $P_{aa} \geq P_{ba}$
- $P_{bb} \geq P_{ab}$

then Doctor A is dominant in Practice Area A, and Doctor B is dominant in Practice Area B, meaning that they are complementary.

At this time, it is optimal for N_a to see Doctor A and N_b to see Doctor B. However, as long as N_a and N_b see doctors indiscriminately without taking into account the expertise of the two doctors, that is, the superiority of their areas of practice, half of the patients will theoretically experience a mismatch.

However, the right side of Fig. 2 shows a situation in which a medical questionnaire with AI can be used to automatically select a Doctor

A or Doctor B that matches the medical fields of N_a and N_b. For example, by having N_a and N_b answer this questionnaire in advance at the general counter, one of the two doctors with high sensitivity can be appropriately selected. This will reduce the mismatch between the patient and the doctor in the area of medical care to the maximum value of the doctor's sensitivity, and also reduce the risk of patient interruption.

(3) Discussion

In this study, we examined the conditions for the establishment of a network practice, focusing on the sensitivity of doctors to realize an alliance in a medical mall. As a result, it was found that in addition to "ensuring a high level of sensitivity of the partner doctors," "complementary relationships" would have the effect of increasing the sensitivity of the entire practice. Therefore, if the above two conditions are met, networked medical care can be established, and benefits that cannot be demonstrated by individual doctors can be provided to both doctors and patients. In other words, this conclusion means that a medical mall alliance will not be realized by blindly gathering doctors without taking these two conditions into consideration.

Furthermore, to increase the feasibility of alliances, we must make full use of information network technology. This is because the effective use of such technology will make it easier to reduce transaction costs between doctors and eliminate mismatches between patients and doctors without placing an undue burden on the medical field. However, in recent policy debates, the argument for limiting free access has been accelerated because many people perceive that allowing free access has led to patients' preference for large hospitals and the problem of excessive medical care known as doctor shopping. However, the premise of this debate is undesirable because it may divide the relationship between patients and medical professionals. Certainly, the problem of overmedication should not be left unaddressed, but it is an oversimplification to interpret this as unreasonable demands or lack of health literacy on the part of patients.

In this paper, to explore the relationship between the mismatch of medical fields and patients' interruption of outpatient care, we tried a simulation and found that the higher the sensitivity of the doctor, the lower the risk of interruption (Figure 2). In light of this fact, it may rather be due to the mismatch between patients and doctors in their areas of practice. To prevent fragmentation and unnecessary confusion between patients and medical professionals, and to maintain a good relationship between both parties, we should seek to solve the problem through technical assistance, while allowing free access whenever possible. Nevertheless, these efforts are fragile in the medical field. This paper is novel because it proposes the conditions for the establishment of network practice as one of the solutions to these problems.

In this study, we proposed the automatic sorting function model as a mechanism to match patients and doctors at the initial stage of their visit to a medical mall. When a patient visits the general information desk of a medical mall for the first time, a medical questionnaire with AI can be used to efficiently select an appropriate specialist and department (Figure 3). This is a problem that can be realized using modern ICT, and it is not a difficult method. However, conventional discussions have lacked the perspective of problem solving using the latest technology. Therefore, a model that would match doctors and patients by applying information network technology is novel in this study. The question is, however, why is it that these models are not widely used in the medical field? The issue of concern here is that the initial cost of EHRs is unusually high, regardless of the country, and this is hindering the spread of the technology (The Commonwealth Fund, 2020; Nakamura, 2006). The Japanese government has been injecting huge subsidies to medical institutions to compensate for the high initial costs in an effort to improve this situation, but the introduction of this technology on the premise of subsidies in the absence of appropriate prices in the field has caused problems that have in turn induced cost increases. Hence, if these technologies do not spread due to the adverse effects of such price hikes, it may be difficult to realize alliances and increase the effectiveness of networked medical care, and further discussion is needed in the future. However, since the aforementioned conditions of establishment have been met in medical malls, which have in fact established the network practice with their own financial resources, it is believed that there is potential for application (Ito, 2017).

Finally, there are several limitations to this study. First, since the sensitivity analysis of doctors employed in this study is only a model analysis with certain constraints, a methodological study on specific measurement and evaluation is needed. In conjunction with this, verification of the relationship between doctor sensitivity and interruptions in patient outpatient care is required. Additionally, the issue of transaction costs occurring in medical malls needs to be investigated and verified in more detail. For example, computer simulations are required to verify the effectiveness of this model when applied to medical malls. Furthermore, this analysis did not take into account the relationship between network practice and doctor capacity. In this study, the discussion was based on the assumption that Ni = 1 or higher, but when considering the doctor capacity issue, it may be possible even for doctors with low sensitivity to participate in network practice. Therefore, it is expected that these research issues will be further discussed in the future. However, I would like to emphasize that the contribution of this study is that it focused on the issue of alliances, which has been a concern in medical malls for some time and led to a method to increase the feasibility of alliances by satisfying the conditions for the establishment of a network practice. This method has value that can be applied to the management of medical malls.

(4) Conclusion

To realize an alliance in a medical mall, the choice of partners is extremely important, and a network practice must be established under the appropriate partners. Therefore, the following two conditions must be met to establish a network practice:

1. The sensitivity of the doctors must be at a high level.
2. Doctors must have a complementary relationship with each other.

The importance of alliances has long been touted among medical professionals, but to make them a reality, it is essential that the doctors themselves are qualified and have a specialty in which they excel, in other words, that they have an advantage over other doctors. In addition, since alliances always involve transaction costs, these costs should be covered by actively utilizing information network technology. Furthermore, by making full use of information network technology, transaction costs can be reduced, and matching of patients and doctors in their areas of practice can be achieved. Therefore, to realize alliances in medical malls, further efforts are expected to be made to lower prices to the electronic medical record industry side, while promoting active investment in information technology by the clinics' own funds, rather than assuming subsidies.

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References

Ahna, T., Ryu, S., and Han, I. (2004). The impact of the online and offline features on the user acceptance of Internet shopping malls, *Electronic Commerce Research and Applications*, 3(4), pp. 405-420.

Albers, S., Wohlgezogen, F., and Zajac, J.E. (2013). Strategic alliance structures: An organization design perspective, *Journal of Management*, 42(3), pp. 582-614.

Bernardo, M., Valls, J., and Casadesus, M. (2012). Strategic alliances: An analysis of Catalan hospitals [Alianzas estratégicas: un análisis de los hospitales catalanes], *Pan American Journal of Public Health*, 31(1), pp. 40-47.

The Commonwealth Fund. (2020). Cost is biggest barrier to electronic medical records implementation, study finds, https://www.commonwealthfund.org/publications/newsletter-article/cost-biggest-barrier-electronic-medical-records-implementation (accessed on November 27, 2020).

Epstein, J. (2016). Going to the medical mall: A patient retention strategy not to be confused with storefront clinics, *Becker's Hospital Review*, https://www.beckershospitalreview.com/hr/going-to-the-medical-mall-a-patient-retention-strategy-not-to-be-confused-with-storefront-clinics.html (accessed on November 27, 2020).

Gulati, R. (1998). Alliances and networks, *Strategic Management Journal*, 19(4), pp. 293-317.

Hajli, M.N., Shanmugam, M., Hajli, A., et al. (2014). Health care development: Integrating transaction cost theory with social support theory. *Informatics for Health and Social Care*, 40(4), pp. 334-344.

Hashimoto, H., Ikegami, N., Shibuya, K., et al. (2011). Cost containment and quality of care in Japan: Is there a trade-off? *The Lancet*, 378, pp. 1174-1182.

Hitt, A.M, Dacin, M.T., Levitas, E., et al. (2000). Partner selection in emerging and developed market contexts: Resource-based and organizational learning perspectives, *Academy of Management Journal*, 43(3), pp. 449-467.

Ito, A. (2016). Medical mall founders' satisfaction and integrated management requirement, *International Journal of Health Planning and Management*, 32(4), pp. 449-466.

Ito, A. (2017). Verification of the efficacy of the functional unit integration system, *Sustainable Primary Care Provision System in Japan*, Nippon Hyoron Sha, pp. 165-261.

Ito, A. (2020_a). Strategy and management behavior of medical malls: Focusing on competition over location and clinical departments, *Journal of Japanese Management*, 5(1), pp. 1-17.

Ito, A. (2020 b). Identifying motivational factors to visit a medical mall by conjoint analysis, *International Journal of Japan Academic Society of Hospitality Management*, 6(1), pp.1-10.

Josi, R. and Pietro, C. (2019). Skill mix in Swiss primary care group practices—a nationwide online survey, *BMC Family Practice*, 20(39), pp. 1-11.

Kinderis, R. and Jucevičius, G. (2015). Strategic Alliances Their Definition and Formation, *Latgale National Economy Research*, pp. 106-128.

Macmillan, P. (2009). Growing shopping malls and behaviour of urban shoppers, *Journal of Retail & Leisure Property*, 8(2), pp. 99–118.

McSweeney-Feld, M.H., Discenza, S., and Defeis, L.G. (2010). Strategic alliances & customer impact: A case study of community hospitals, *Journal of Business & Economics Research*, 8(9), pp. 13-21.

Ministry of Health, Labour and Welfare. (2015). *2015 Edition Annual Health, Labour and Welfare Report,* https://www.mhlw.go.jp/english/wp/wphw9/dl/summary.pdf (accessed on December 23, 2020).

Ministry of Health, Labour and Welfare. (2016). *2016 Edition Annual Health, Labour and Welfare Report*, https://www.mhlw.go.jp/english/wp/wp-hw10/dl/summary.pdf (accessed on December 23, 2020).

Nakamura, M. (2006). Current status of electronic medical recording in Japan and issues involved, *JMA Journal*, 49(2), pp. 70-80.

National Federation of Health Insurance Societies. (2017). Public Attitude Survey Report on Medical and Health Care Systems,https://www.kenporen.com/include/press/2017/20170925_8.pdf (accessed on November 27, 2020).

Petkus, H., Hoogewerf, J., and Wyatt, C.J. (2020). What do senior physicians think about AI and clinical decision support systems: Quantitative and qualitative analysis of data from specialty societies, *Clinical Medicine Journal*, 20(3), pp. 324-328.

Stuart, E.T. (2000). Interorganizational alliances and the performance of firms: A study of growth and innovation rates in a high-technology industry. *Strategic Management Journal*, 21, pp. 791-811.

Tanaka, H. (2007). Current status of electronic health record dissemination in Japan. *JMA Journal*, 50(5), pp. 399-404.

Vattikoti, K. and Razak, A. (2018). An empirical study on strategic alliances of multi-national companies in the Modern Global Era-A Select Case Study, *Academy of Strategic Management Journal*, 17(4), pp. 1-13.

Varadarajan, P.R. and Cunningham H.M. (1995). Strategic alliances: A synthesis of conceptual foundations, *Journal of the Academy of Marketing Science*, 23(4), pp. 282-296.

World Health Organization. (2018). Japan health system review, *Health Systems in Transition*, 8(1), https://apps.who.int/iris/bitstream/handle/10665/259941/9789290226260eng.pdf;jsessionid=0ED2FEF3351BE5134E3DF8CA78445C83?sequence=1 (accessed on December 23, 2020).

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