Valuation of Online Continuing Medical Education and Telemedicine in Taiwan

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ABSTRACT
Physicians have acknowledged information technology (IT) efficiency and now utilize it in their professional practice and patient management. The benefits of IT within the health care environment has received academic attention, however existing literature currently pertains to limited areas, including the financial effects of telemedicine networks, and both the acceptability of this branch of medical care and the perceptions of patients and clinicians. Studies on welfare valuation of telecommunication health services in an economy are deficient. Based on a welfare concept valuation method, this research provides systematic as well as empirical analysis of telemedicine and finds that online CME plays a key role in enhancing the health care environment. The quantity of health services, the quality of the health care environment, as well as a consumer surplus all increased with online CME lectures. Such lectures are underprovided in telemedicine systems. Appropriate government intervention or programs, through adding physicians for local on-site visits with the electronic health care program and increasing the availability and quality of online CME, could possibly remedy the situation and establish a stable, well-structured, and effective medical care system for rural areas.

Keywords
Continuing medical education (CME), Telemedicine, Effectiveness, Welfare valuation

Introduction
Telemedicine is the use of electronic information and communication technologies to provide and support health care when distance separates the participants. Because of hyperspecialisation and multidisciplinarity, the technical medical environment has profoundly transformed in recent decades. The area of telemedicine is relevant for the treatment of ill-health and for the provision of medical consultation. Existing wisdom from decision makers and psychiatric consulters evaluates clinical applications of telemedicine, including the quality and accessibility of health care (US Congress, 1990). Two assessments contributed to the evaluation. One focuses on the acceptability of medical care and perceptions of patients and clinicians (Puig-Junoy et. al, 1998). The other concentrates on the financial effect of telemedicine in rural health care networks (Bashshur, 1995).

Research conducted by Berman & Fenaughty (2005) on rural Alaskan health services revealed that such new health care technology may increase patient benefits. Similar concerns about accessibility can be applied to Taiwan, a small heavily-populated land area with many mountains and isolated islands. Chen et al. (2001) performed a brief review of the telemedicine system in Taiwan and found that high quality medical care is difficult to access and medical resources are unequally distributed in rural areas. Due to geographic barriers, several archipelagos are deficient in specialist clinicians and medical resources are under-distributed. Primary healthcare is not emphasized and consulting a family physician is not encouraged. Telemedicine services were introduced in 1995 with a particular focus on providing healthcare in rural areas, continuing medical education (CME) for physicians in these areas, and special medical services for the elderly, the handicapped, and terminal ill patients at home. Online CME, one of the important functions of the telemedicine system, leads to a reduced sense of isolation for physicians and enhances the confidence of medical staff and patients.

Based on technically sound for society concern, Brodie et al. (2000) and Autor (2001) found that access to online services can mean better information about jobs, education, and health. This finding can also be applied to service industries, including health care, manufacturing, transportation, government and education. Health care provisions and relevant medical education through telecommunication is perhaps related to increasing social welfare and the development of new health services. Telemedicine systems offer new ways to practice medicine and “are technologically based innovative systems for the remote delivery of personal health services, continuing medical education, and patient health education.” (Bashshur, 1995, p. 22) This research then investigates the educational,
medical, and economic prosperity of government expenditure in infrastructure and health service in the context of telemedicine diffusion.

There are currently no studies that discuss the welfare concepts of telecommunication health services within the managed care environment or the influence of online CME on such health management. To address the relevant effects of access to care for rural residents, while facilitating the continuation and consolidation of positive effects on service delivery and utilization, this research makes an effort to provide an empirical base for evaluating the current operations of health care provisions, and to assess its potential replicability.

Drawing on literature from the health care and the educational technology fields, we measure and value the relevant environment and consequences from multiple perspectives. A better understanding of concerns from all affected factors will help establish the quantitative significance for possible medical interventions or programs. Investigation results serve as paradigms for selecting areas to maximize welfare in health care provisions.

**Teleconsultation and Distance Education Network**

At least two sites were connected by a broadband network (e.g. asynchronous transfer mode) or a narrowband network (e.g. integrated service digital network). The network allows two-way or multiple-way video face-to-face teaching, learning, and audio interactive communication in real time between participants. The efficiency of CME on the information technology (IT) promised web site has been reported by Brace-Govan & Gabbott (2004). In the telemedicine context, Chen et al. (1998) have demonstrated that video-on-demand provides web-based distance learning courses and multimedia teaching materials as well as allowing physicians to attend synchronous CME or web courses at home or at the work place to obtain CME credits.

**Aims of this Study**

This study aims to implement innovative methods of blended learning strategies that include the use of new information technologies in continuing medical education. This study further aims to analyze both the impact of these strategies on social welfare improvements as well as the support the telemedicine system offers rural practitioners and teaching hospital consultants interested in the latest research information. This paper is not the first to investigate the effects of blended learning in a medical education framework. Pereira et al. (2007) and McNulty et al. (2000), among others found that the synergic combination of traditional teaching methods with online learning tactics improved academic performance, long-term knowledge and facilitated active learning. Despite the available literature, studies into the impacts of educational technology on social welfare have not considered the important factor of human-computer interactions. Utilizing our knowledge of the welfare concept valuation approach, this study will attempt to explore this distinctive and new area.

This research aligns the feasibility of an integrated approach with the economical side of an online learning system to continue medical education. The methodological goal of this study is to highlight the welfare feature of the telemedicine system and to investigate whether health services increase with online CME lectures for physicians through a telemedicine system, and to test the influences of such increases on welfare variations. Although our findings focus specifically on locations where geographical limitations may impede access to public sector health services for rural residents, our research may be equally relevant for other countries who wish to utilize an electronic health care system to improve access to health care for people living far away from medical centers with and without health insurance.

**Definitions of Relevant Terms**

In this study, relevant terms are compiled from the literature, technological products in education, production of learning environments, instructions of healthcare provisions, and economics usages. Various terms are defined in order of appearance.
Continuing medical education (CME) is required to maintain and further develop competence for continuing professional development to support rural practitioners as well as teaching hospital physicians and consultants who are seeking the latest research information. Utility means satisfaction from consuming goods or services. The demand curve is generally assumed that the lower the price of goods, the greater the quantity demanded. Consumer surplus is presented as the difference between an agent’s willingness to pay for goods and actually purchasing value of the goods. It is regarded as an increase in happiness or utilities. Welfare variation is usually presented by a change in the consumer surplus. Effectiveness analysis guides the choice for the program with the lowest cost to supply fixed units of effects.

Method

The blended learning method is generally recognized as a supporting system to off-line teaching and learning. Blended learning combines personal interaction from live class sessions with online education for greater learning flexibility (Demetriadis & Pombortsis, 2007). This study investigates the potential merits of using appropriate technology (e.g. computers combined with satellite links/wireless hotspots) to assist in fostering a sense of belonging to one supportive learning community among distance physicians (educators and learners) and improve educational, medical, and social outcomes. It presents supportive networks and technological perspectives about online continuing medical education in the healthcare provision system, while still maintaining its statistical rigor. Furthermore, based on a welfare concept valuation method approach, this study uses the demand theory to measure the value of medical care and with STATA 9.0, produces estimates based on three areas: (1) the quantity of medical services demanded of telemedicine, (2) the welfare status of a given quantity of such services, and (3) possible welfare variation, resulting from an increase in online CME lectures.

Subjects

The subject of this study is to establish a systematic framework to meet the specific health care demands in offshore archipelagoes in Taiwan. Based on the experience of rural Alaskan health services, Berman & Fenaughty (2005) revealed that such new health care technology may improve treatment for patients. Similar concerns about accessibility can be applied to Taiwan, a small heavily-populated land area with many mountains and isolated islands. High quality medical care is difficult to access and medical resources are unequally distributed in rural areas. Due to geographic barriers, several archipelagos are deficient in specialist clinicians and medical resources are under-distributed. Primary healthcare is not emphasized and consulting a family physician is not yet encouraged. Telemedicine service was introduced in 1995 particularly to facilitate medical care in remote areas and to assist physicians located in these areas in continuing their online medical education. Telemedicine Service further offers special medical services for the elderly, the handicapped and terminally ill patients at home.

Based on the systematic framework, regression analysis is undertaken. The sample covers the period from 1995-2004. Five teleconsultation medical centers, all funded by the Department of Health were surveyed, including National Taiwan University Hospital, Veterans General Hospital Taipei, National Cheng Kung University Hospital, Tri-Service General Hospital, and Buddhist Tsu-Chi General Hospital. This is also regarded as a national sample.

Systematic Framework

Economic assessment provides a systematic framework to make decisions regarding known costs and the positive effects on health care. Drummond et al. (1997) indicated that economic evaluation should offer an analysis of courses of action in terms of costs and consequences, including direct, indirect and intangible factors. Bashshur (1995) precisely defined the telemedicine system and offered guidelines for the successful assessment of such a regime. Brent (2003) was sure that all resource allocation should provide the highest satisfaction. Henderson (2005) regarded improving the health of a given population as the primary goal of the health policy and believed that the preferred measure of health benefits, being the health outcomes themselves, should not be limited to a dollar value. This research, inspired by Bashshur (1995), intends to assign values to human health and puts the analysis on the willingness-to-pay basis that is so fruitful in other contexts (e. g. environmental studies). The framework examines
the central result of the welfare status responding to changes in the quantities of continuing medical education (CME) lectures through the educational technology system.

No matter how ingenious the investigator, some benefits and costs are impossible to value. The tools of cost-benefit analysis can be used to force planners to reveal limits on how they value intangibles. A program is admissible if the measured costs are less than the measured benefits. Using the tools of demand theory, we investigated the incremental (marginal) value consumers attach to additional consumption of medical care at any level of consumption observed. This is the willingness-to-pay interpretation of a demand curve. As mentioned by Phelps (2003), willingness-to-pay slopes downward for two reasons: (1) diminishing marginal productivity of health care and (2) the decreasing marginal utility of health care itself in producing utility. The key lesson from this work is that individual patients’ preferences differ regarding the various aspects of health, and to assume otherwise leads to a loss in utility. Health is composed of many measurable components. The maximizing utility problem is written as:

\[
\begin{align*}
\max_{T,O} & \ U(O, T, Q) \\
\text{s.t.} & \ I = O + RT
\end{align*}
\]

Where \( O \) is the unit price of goods other than medical care, being normalized to unity, \( T \) is the quantity of consumption on telemedicine health services, \( Q \) is the quality of health care environment, \( I \) is personal income, and \( R \) is the monetized cost for accessing the medical services. Consumer objectives are to maximize their utility from consuming telemedicine health care and other goods while being protected by the quality of an electronic health care environment, presented by equation (1), but limited by income and by prices, presented by equation (2). Solving equations (1) and (2), we express the demand function for telemedicine of the representative consumer as:

\[
T^* = T^*(R, I, Q)
\]

The demand curve is depicted in Figure 1. A consumer surplus is the value of an electronic health service minus the price paid for it, summed over the quantity bought and supplied. The area is equal to the shaded area, the base of the triangle multiplied by the height of the triangle divided by 2.

![Figure 1. The demand curve and consumer surplus of telemedicine health services](image)

**Empirical Tests**

After constructing the research model, we conducted an empirical test on the appropriate allocation of health care expenditure to provide health services in accordance with the demands of residents. Our primary interest is whether the health care system of telemedicine leads to consumer surplus and what factors bring welfare improvement in rural Taiwan.
Specifications and Data Descriptions

From the sustainability evaluation of the demonstrated program, the demand function for health care through the development of telecommunication system is specified as:

\[ \text{Quantity} = f (\text{Tel. Exp. per service, GDP per capita, NHE per capita, OLCME lectures}) \]  \hspace{1cm} (4)

As the demand theory demonstrated, the quantity demanded for health services is the number of times a patient plans to access the health care during a given time period at a particular price. In Taiwan, health services are provided by the consolidated health sector in the National Health Insurance system which began in 1995. The quantity of health services (Quantity) and telemedicine expenditure per health service (Tel. Exp. per service) respectively present the quantity demanded and price in such a regime. Following Bashshur (1995), when optimizing the effectiveness and efficiency of telemedicine, online CME is suggested. From empirical specifications, this research attempts to examine whether online CME plays a key role in minimizing incremental costs per unit of incremental health effect, defined as effectiveness, and providing the medical services that we value mostly highly, defined as efficiency in the telemedicine system.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Observations</th>
<th>Average</th>
<th>Std. Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
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<td>437.07</td>
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<td>Tel. Exp. per service</td>
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<td>13545</td>
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<td>12488</td>
<td>14633</td>
</tr>
<tr>
<td>NHE per capita</td>
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<td>730.55</td>
<td>63.56</td>
<td>636.36</td>
<td>848.00</td>
</tr>
<tr>
<td>OLCME lectures</td>
<td>10</td>
<td>1344.5</td>
<td>1221.05</td>
<td>100</td>
<td>3066</td>
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</table>

<table>
<thead>
<tr>
<th>Variables</th>
<th>Quantity</th>
<th>Tel. Exp. per service</th>
<th>GDP per capita</th>
<th>NHE per capita</th>
<th>OLCME lectures</th>
</tr>
</thead>
<tbody>
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<td>-0.8</td>
<td>0.62</td>
<td>0.69</td>
<td>0.55</td>
</tr>
<tr>
<td>Tel. Exp. per service</td>
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<td>-0.38</td>
<td>-0.48</td>
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<tr>
<td>GDP per capita</td>
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<td>0.16</td>
<td>0.74</td>
<td></td>
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<tr>
<td>OLCME lectures</td>
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<td>-0.33</td>
<td>1</td>
<td></td>
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</tbody>
</table>

Quality indices of the telemedicine health care environment, represented by effectiveness and efficiency, involve more than one indicator. The quality of the health care environment in rural Taiwan is composed of national health expenditure per capita (NHE per capita), provided by the consolidated health sector, and online CME lectures (OLCME lectures). The data of the above variables are taken from Bureau of Nursing and Health Service Department and Bureau of National Health Insurance, Taiwan (2005). The explanatory variable GDP per capita, published by the Council for Economic Planning and Development, Taiwan (2005), presents the income status of the consumers. This indicator is verified by Pritchett & Summer (1996) and Olsen & Dahl (2007), indicating that GDP per capita is strongly associated with better health in a richer economy. The sample covers the period of 1995-2004 and 5 medical centers founded by the Department of Health in the telemedicine system. Tables 1 and 2 respectively display the summary statistics and the correlation matrix between variables of the implementation for the entire period.

Regression Results

Regressions of medical services on selected variables are presented in Table 3. Empirical evidence from Taiwan experiences conveys a wealth of information. The coefficient on telemedicine expenditure per health service (Tel. Exp. per service) indicates that raising the cost of per service in telemedicine significantly decreases the quantity demanded of such health care. An increase in the cost of 0.10 reduces the quantity of services to around 0.08. A 0.1 increase in GDP per capita significantly increases the health services by 0.06. Increasing NHE per capita is associated with lower medical care quantities, whereas increasing online CME lectures for physicians (OLCME lectures) leads to a rise in the quantity of health services.
Table 3. Regressions of quantity in telemedicine health services on selected variables

| Quantity              | Coef. | Std.Err. | t     | P>|t|   | 95% Conf. Interval |
|-----------------------|-------|----------|-------|-------|------------------|
| Tel. Exp. per service | -0.76 | .18      | -4.15 | 0.009*** | -1.23 -0.29      |
| GDP per capita        | 0.61  | 0.22     | 3.07  | 0.028**  | 0.11 1.26        |
| NHE per capita        | -8.10 | 3.61     | -2.24 | 0.075*   | -17.38 1.19      |
| OLCME lectures        | 0.38  | 0.13     | 2.94  | 0.032**  | 0.05 0.71        |

*: significant at 10%; **: significant at 5%; ***: significant at 1%

In Taiwan, under government support, most of the medical centers participate in the integrated delivery system and dispatch additional specialist clinicians. Air-transport transfers are adopted for the remote delivery of health services, increasing with the level of NHE per capita, and in turn decreasing with outpatients through telemedicine systems. However, to enhance the confidence of medical staff and patients and to reduce a sense of isolation for physicians, the archipelagos in Taiwan are covered by the telemedicine program for medical consultation and OLCME. The quality of the health care environment through telemedicine increases with online lectures of CME for physicians.

The positive relationship between health services, the health of a nation and its economic prosperity is well recognized (Pritchett & Summers, 1996; Olsen & Dahl, 2007). Patients in a telemedicine system are positively affected by the level of GDP per capita in the economy. Our primary interest is whether the adoption of a telemedicine system improves the welfare status of the economy. Ruling out trivial cases and using the demand curve to measure value of such care, influences of environment and income status in the systematic framework are then averagely specified in the constant term. The demand curve to be estimated is:

$$\text{Quantity} = 2855.9 - 0.76 \times \text{Tel. Exp. per service}$$

(5)

Substituting the means value of Tel. Exp. per service, 954.9 from statistics presented by Table 1, into equation (5), the demand curve for telemedicine health care is depicted by Figure 2. In addition, we predict that adopting a telemedicine system leads to a consumer surplus of US$777517.75, as indicated by the triangle abc. The measured benefit or willingness-to-pay is greater than the measured cost or telemedicine expenditure per service. According to the guideline of cost-benefit analysis, the program is admissible. The consumer surplus increases with the quantity of health care services provided by the telemedicine system.

![Figure 2. A welfare concept valuation of telemedicine systems](image-url)
Discussions

Increasing online CME lectures, assuming no change in other factors, shifts the demand curve outwards to account for the improvement in the quality of medical care. These increases led to a reduction in feelings of isolation for physicians and enhanced the confidence of medical staff and patients. A sizeable amount of transfers can then be reduced and through the telemedicine system, health services will increase and improve. As a result, the consumer surplus in the economy rises, which increases by rectangle $bcde$ in Figure 2. The implication is clear: the system underprovides online CME lectures. Appropriate intervention or program could possibly remedy this situation. Of course, all the difficulties in measuring the quantity and value of the health care still remain.

In the same spirit, there have been many studies on the value of a life. Viscusi & Aldy (2003) estimate the value of a life is between $4 million and $10 million. When considering this value and considering the difficulties in putting a price on saving lives, the quality of health care currently available in rural areas and online CME lectures offered to rural health-care staff are deficient and inadequate. Furthermore, the telemedicine program resulted in a reduction in the time health-care personnel devoted to traveling to their referral centre. The monetary value of the saved time is important. From the restricted budgetary perspective, the results demonstrated that the benefits from welfare improvement by increased expenditure introduced by the telemedicine system are bigger than the costs from an increase in the direct national health expenditure within the traditional health-care network, as the fourth row of Table 3 indicates.

The interconnectedness is noticeably being adopted and improved in recent international efforts in healthcare reform. In the future, telemedicine systems are expected to connect hospitals, insurance organizations, public health administrations, and finally, to extend to every household. The satisfaction of health-care staff and households with online educational programs and medical consultations seems to be assured.

Despite the strengths, like all tools it must be used appropriately. Pallof & Pratt (2001, p. 26) emphasized that effective collaboration can enhance the learning experience and can therefore be considered as one of the determining factors in measuring the success and quality of any online course. Kidney & Puckett (2003) has highlighted the presence of problems similar to those detected in the application of e-learning strategies in distance learning courses. The principle aim of the application of telecommunication techniques is to decrease clinicians’ effort and time in continuing medical education. From our analytical results, increases in CME lectures raise the health care environment. If so, that would be another, possibly much more important, source of welfare improvement derived from a policy to promote telemedicine.

Hazemi & Hailes (2002) indicated that educational institutions are now compelled to integrate technological and electronic pedagogy into their traditional education product line. Information and communication technologies in other areas of educational study received our attention. The impact of modern technology on the advancement of telemedicine depends on the works of different bandwidths for tele-consultation and distance education programs. With the appropriate technology (e.g. computers combined with satellite links or wireless hotspots), continuing professional development is required to maintain and further develop competence. Rural practitioners and teaching hospital consultants use this technology to carry out the latest research information and transmit the knowledge to where it is needed. However, the inability of web-based systems to fully deal with learning diversity and the high cost of developing new systems might weaken the effectiveness of blended learning in an operational capacity (Nasseh, 2000). This paper is limited to the analysis imposed by assuming that the effectiveness of asynchronous distance education is exogenous. This limitation is not intractable, but requires the use of appropriate surveys to ensure that the results we obtained are not influenced by improper assumptions of exogenous effective conduction in analytical and empirical examinations.

Conclusions

Physicians have acknowledged information technology (IT) efficiency and now utilize it in their professional practice and patient management. The benefits of IT within the health care environment has received academic attention, however existing literature currently pertains to limited areas, including the financial effects of telemedicine networks, and both the acceptability of this branch of medical care and the perceptions of patients and clinicians. Studies on welfare valuation of telecommunication health services with online learning systems in an
economy are deficient. Based on a welfare concept valuation method approach, this research provides positive analysis of telemedicine.

Many factors, including NHE per capita, GDP per capita, online CME lectures, and telemedicine expenditure per health service among others affect the demand for health services through telemedicine systems. The cost per service strongly and negatively affects the quantity demanded. The demand curve in the price and quantity space slopes negatively. Rising NHE per capita always results from a lack of confidence felt by patients or practitioners requesting air-transport transfers. The relationship between electronic health services and NHE per capita is negative. GDP per capita is significantly associated with more health services, including telemedicine and other medical care. Online CME plays a key role in enhancing the electronic health care environment. Quantity of health services, quality of health care environment, and consumer surplus increase with online CME lectures. This may draw attention to any issues that might need to be considered when introducing online CME, though the sample is limited to ten years. Furthermore, this regime can be designed not only for improving the quality of consultation and referral in the rural areas but also strengthening the confidence of patients and practitioners, both CME and referral. Then hospitals can concentrate on its core missions, providing inpatient services.

The use of multimedia in educational contexts is based on the assumption that interactive learning provides greater educational benefits. This study applies traditional teaching and computer-assisted learning to provide evidence of how teaching hospital consultants approach healthcare policy making, development, and evaluation as they relate to the quality assurance of continuing medical education and learning management systems. Based on educational issues related to quality assurance, a welfare evaluation approach reveals that they tend to have better enhancement in the electronic health care environment. The investigation has guided physicians, medical educators, patients, and practitioners to address key areas in order to reliably assure the quality of consultation and referral in the rural areas supported by learning management systems.

We linked the quality of a telemedicine environment with effectiveness and efficiency, which is one of Bashshur’s (1995) key concerns. The increase in online CME lectures efficiently allocates medical resources while raising consumer surplus. It further serves to improve the health condition of rural residents by raising incremental health services without increasing the cost per health service. These findings suggest that for improving the quality of the health care environment for rural residents, the system currently underprovides online CME lectures. Appropriate government interventions or programs through adding physicians for local on-site visits with telemedicine program and online CME lectures can remedy this situation. Establishing a stable, well-structured, and effective medical care system for rural areas is anticipated. Potential replicability of relevant evaluation is applicable for other countries to improve access to health care for people living in remote areas.

References


