Mobile services provide value by decoupling the time and location constraints in healthcare delivery

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Abstract

eHealth solutions exist to improve outcomes, but they have the potential in improving output of service provision as well. Operations management research on eHealth interventions tends to focus solely on output efficiency and leaving the questions of output-outcome relations to clinical medicine. However with preventive eHealth interventions output-outcome relation plays a critical role in defining life-cycle long costs, outcomes and production effects of the technological intervention. Healthcare operations management can offer a valuable framework for better understanding eHealth service systems and their effects. In this paper we explore different types of efficiency implications using mobile phone based solutions as an interesting example. We discuss time and location constraints of traditional service provision and how mobile services can impact them. We conclude by defining a new approach to studying eHealth interventions from an operations management perspective.

1. Introduction

Healthcare production systems are challenged by increasing demand and the need to maintain efficiency and cost-effectiveness [1]. The increasing patient volumes are caused primarily by three factors: 1) increased treatment opportunities, 2) the epidemic increase in chronic diseases, such as diabetes and hypertension, and 3) an aging population. Increasing number of healthcare providers address the second factor by shifting parts of the responsibility for chronic disease management over to the patients and their peer groups, through the use of remote care delivery channels. It is believed that cost-efficiency can be improved by applying ICT technologies to move routine live communications to more cost-efficient channels [2]. Examples of this type of service delivery are eHealth internet services or remote patient-physician communication.

2. Implications to increased efficiency

From former studies of telemedicine technology we know that remote communication improves efficiency and effectiveness of clinical care [2-4]. Efficiency measures the relation between inputs and outputs [5]. Healthcare efficiency assessment is complicated by the difference between outputs and outcomes. Outputs refer to observable and measurable things that are done to a patient, such as surgical interventions, and hospitalizations. Outcomes refer to the things that happen to a patient, i.e. changes in medical condition.

The purpose of healthcare is to improve outcomes, not maximize the volume of output [5]. However, the relation between output and outcome is complicated by patient behavior, such as compliance, various psychosocial factors, and placebo. Therefore healthcare service providers can have a larger control over outputs than over outcomes. Health policy needs to be concerned with outcomes.

Remote communication involves both providers and patients. Therefore it can have an impact on output, i.e. how provision is organized (staffing and scheduling); and on outcomes that are subject to patients’ health behavior. Healthcare operations management tends to sidestep behavioral questions by focusing solely on output efficiency and leaving the questions of output-outcome relations to clinical medicine. However with preventive eHealth interventions output-outcome relation plays a critical role in defining life-cycle long costs and effects of the technological intervention.
There are three elements of output efficiency: technical, allocative, and economic (or productive) efficiency [5].

Technical efficiency measures the resource consumption for a given output. Since a major share of healthcare costs are personnel costs, labor time can be used as a measure of input. Thus technical efficiency measures are typically the amount of labor required for a standard output.

Economic efficiency measures the relation of monetary inputs to outcomes. The relative prices of various inputs need to be considered to produce a unit cost for each output.

Allocative efficiency refers to situations where there are two or more input types for an output. How should the input types be grouped in relation to each other? Typical issues are how much of various labor types (doctors or nurses) should be used and how service provision points (the physical location and/or interface where a service is provided to/or made accessible for a consumer) should be configured to get the best technical and economic efficiency.

From this follows two implications to the study of the impact of ICT in healthcare:
- Is the impact on outputs or outcomes or both?
- Is the impact on outputs on technical, economic or allocative efficiency, or some or all of these?

3. Services are constrained by time and location

Allocative efficiency in healthcare service production has traditionally been constrained by time and location. Service producers (e.g. doctors) and customers (patients) need to meet at a certain service provision point (SPP). It has two elements, service provision time (SPT), and service provision location (SPL).

Healthcare services usually include clinical interventions, self-administered care (e.g. taking medicines), and various information devices to record, store, guide, and follow-up care. If provider-patient communication is direct, and records are paper documents, patient information systems are also time-location constrained. All time and location – constrained service production systems face trade-off’s between three elements: access, variety, and capacity utilization rate (CUR), which to a large extent determines unit cost.

Access here means the time and trouble in getting from the location where need arises to the first contact at a SPL. Variety means the range, type, and expertise level of the service offerings available at one SPL. Variety requires a variable degree of asset specificity, that is, assets specialized to a certain service type are not easily shifted to other purposes, for technical or cost reasons. Each asset has a capacity to serve a demand volume. Unit cost efficiency requires that capacity is fully utilized. Demand, however, is related to the size of the catchment area, that is, the region from which patients come. If the specificity of assets increase, the catchment area becomes larger, this in turn reduces access. Thus, a service production system with several SPLs faces trade-offs between access, variety, and cost. If access is maximized, variety must be reduced. If variety increases to include specific assets, the catchment area grows and access suffers. If both access and variety increases, CUR decreases and unit costs grow.

ICT technologies can be used to break, amend, or twist these trade-offs by changing the relations between SPT and SPL. There are four combinations of time and location constraints:
- same time, same location (synchronous services)
- same time, different location (time-synchronous services using telephone, or other remote real-time location-to-location communication devices)
- different time, same location (location-synchronous e.g. non-urgent blood sampling and X-ray examinations)
- different time, different location (asynchronous services)

The impact of ICT solutions to service provision can be examined in two ways:
- does the solution provide a way to change the access-variety-capacity utilization rate trade-offs
- which service elements can be shifted from one to another time-location constraint type.

4. Mobile phones – another channel for care delivery

With the availability of ICT and the emergence of technology -savvy patients, healthcare providers are facing the challenge of implementing and coordinating several service delivery channels. The internet and email break the location constraint requiring patients to travel to an SPP. With fixed-line communication they, however, are constrained by the location of the device. Mobile communications removes this constraint further as patients can carry a communication device on their person.

Increasing numbers of patients use mobile phones in their daily lives for various purposes. As user interface for healthcare applications, mobile phones have unique advantages. As they follow patients
everywhere they can deliver reminders, lab results, messages and advice, straight to the patient’s pocket.

Mobile phone applications can be used to decouple some elements of healthcare provision time and location constraints. Providers and patients can interact at times of their choosing, in locations of their choosing.

5. Effects on output and outcome

Mobile communications offer value propositions in two primary categories: 1) tackling inefficiencies in output provision by decoupling the SPP from the time and location constraints, as well as improving communication, and 2) improving outcomes of healthcare and the risk of more serious complications through improved self management etc. These two categories offer a framework for understanding the different kinds of value propositions mobile solutions potentially have.

5.1. Tackling inefficiencies in output provision

Mobile solutions can have a significant role in tackling inefficiencies in service output provision by improving communication between providers and users, e.g. by
1. Decreasing missed appointments
2. Keeping patient on schedule/routine
3. Communication to hard to reach populations such as teenagers

Text messaging offers the easiest value proposition in mobile technologies that improve communication. Using text messages to boost efficiency is not rocket science. Text messaging is easy to adopt because it is device independent and can therefore be sent to a mobile phone of any brand or model.

The ‘one-to-many’ feature of SMS systems means that messages can be sent to many recipients simultaneously and potentially in several different languages [7]. This kind of automation has the potential to improve both the technical efficiency, as well as the economic efficiency, as less labor (less cost) is used to reach an output, there.

“Trials have found that the use of text-messaging reminders reduces the number of missed appointments with family doctors by 26-39%, for example, and the number of missed hospital appointments by 33-50%”. [7]. Decreasing missed appointments has a direct economic implications by improving the productive efficiency of the provider [9], as missed appointments carry a cost for the provider by decreasing the CUR. In addition, missed appointments will usually have to be rescheduled, thus taking up an additional appointment slot.

SMS messages usually reach the recipient within seconds, allowing for an immediate response, and a delivery receipt can be added to the message to confirm that delivery has taken place.

SMS is the fastest form of communication, if measured by actual communication throughput, including instances such as the counterpart not being able to take a call, being out of radio coverage, listening to voicemail, put on hold etc. SMS at its worst is a few seconds slower than a direct voice call or wireless e-mail etc, but in the best case is faster by hours or even days than any other form of communication. SMS messages tend to be read within 30 minutes where an email message tends to be read in 48 hours. This has the potential to reduce the throughput time of a care process, something which is regarded to decrease cost, and improve economic efficiency [8].

5.2. Improving the outcomes of healthcare

Mobile applications have potential to improve the outcomes of healthcare and decrease the risk of more serious complications, through improved self management and monitoring of patients with chronic conditions, e.g. by:
1. Enabling better communication between healthcare providers and patients that can be very mobile
2. Move the service provision forward in time – patients may access a service remotely at a time of their own choosing
3. Gathering diagnostic data through mobile platform based biometric monitoring devices (e.g. EKG), enable the gathering of data over a longer period of time, which can help healthcare providers make better care decisions

As complications often constitute the majority of the costs of care in many chronic diseases, such as diabetes, avoiding complications will have a positive impact on the economic efficiency. The mobile phones unique value is especially apparent when it is used as a platform for remote monitoring. Mobile phones enable patients to take smaller Bluetooth enabled measuring devices with them and send results automatically over the cell phone network. Many technology providers are starting to offer solutions where patients can measure multiple critical values such as glucose, pressure and heart rate on the go with very small kits. Mobile phones can also offer added intelligence in interpretation of results and therefore provide deeper understanding of the coinciding effects.
6. Conclusions

The paper presented ways in which mobile technology can be used to decouple traditional time and location constraints in healthcare. This decoupling may lead to increased output efficiency for service providers, as well as improved outcomes through changes in health behavior for patients. That is, ICT impacts both outputs and outcomes.

From this follows two implications to the study of the impact of information and communication technologies (ICT) in healthcare:

- Is the impact on outputs or outcomes or both?
- Is the impact on outputs on technical, economic or allocative efficiency, or some or all of these?

The impact of ICT solutions to service provision can be examined in two ways:

- does the solution provide a way to change the access-variety-capacity utilization rate trade-offs
- which service elements can be shifted from one to another time-location constraint type.

When attempting to improve healthcare provision efficiency through the use of ICT solutions, it is important to figure out which trade-offs one wants to impact, and how a change may affect the balance between access, variety and CUR.

We believe this approach provides a valuable framework for future research to build on. This approach highlights an operations management view and should be supported by not only traditional intervention study design, but other innovative interdisciplinary approaches as well.

7. References


