

Remote Patient Monitoring – Return on Investment

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Abstract— As a result of the increasing pressure on healthcare expenditures calculations of the return on investment (ROI) have been attempted in assessing the utility of medical equipment purchases. The measurement of ROI requires an in-depth analysis of equipment cost, cost structure, and medical processes. ROI analysis in healthcare is more complicated and error-prone than in most other industries. Results may dramatically vary between different countries even for the same investment. This paper discusses general aspects of ROI in healthcare and specific issues related to remote patient monitoring.

Keywords— return on investment, medical equipment, remote patient monitoring, cost-effectiveness analysis.

I. INTRODUCTION

Under the increasing pressure on healthcare expenditure hospital administrators and healthcare professionals have been forced to focus their decision-making more and more on cost and cost effectiveness of care. Therefore, it is important not only to measure but also to forecast the amortization of investments into healthcare [1, 2, 3, 4, 5].

The terms and definitions of “return on investment” have their origins in the economic literature [6]. But if we compare the healthcare industry with other productive and service industries there are many aspects of ROI analysis that may be different. For instance, in other industries

- increasing overall revenue is one important aspect of ROI,
- hard data about the production process, costs, and retail prices are often readily available,
- easily quantifiable products are produced, and
- the rules of a free market can be applied.

In healthcare the situation is more complicated:

- There are many external restraints and most countries do not have a free healthcare market.
- There are certain quality requirements, for instance, to avoid litigation for malpractice. But this is in some way comparable to other industries [3].
- The consumer, i.e. the patient, does not always have to pay directly for the service he makes use of. Therefore, the patient may have different appreciation of healthcare services than of other, non-medical products.

- The investor may not always be the party receiving the ROI. For instance, in many regions and countries capital investments into CDOs may come from different budgets than the operating costs.
- Care delivery organizations (CDO) may not be allowed to keep their profits. Therefore, they do not have a strong incentive to make investments that may in the long run increase their profitability.

Another very important aspect in the analysis of ROI are the different reimbursement methods that generate provider revenue [7]. Even within one CDO, but always across the different healthcare systems entirely different reimbursement methods may be encountered.

It is obvious that different reimbursement methods will lead to an entirely different financial bottom-line for the same investment and the same change in the medical process. An investment that may yield a significant ROI in one healthcare environment may result in financial losses in another.

II. THE SCOPE OF ROI IN HEALTHCARE

In other industries the scope of ROI often is very clear. In healthcare different perspectives to assess ROI may include

- the individual care provider, e.g., the physician,
- the CDO, e.g., a hospital,
- a health management organization (HMO),
- an entire healthcare system, i.e., the public purse,
- the employer of the patient, or
- the individual patient.

As it is impossible to cover all perspectives of ROI analysis in healthcare in one article, this article will focus on the perspective of the CDO.

III. HOW TO GENERATE ROI IN HEALTHCARE

As in other industries also in healthcare there are two basic approaches to ROI, namely increasing the revenue of the operation or reducing the cost per production item. The differences are how likely each of these approaches can be followed in healthcare compared to other industries.

Basically, there are three ways to increase the revenue from the operation into which the investment was done.

First, the investment can be used to expand the existing market or to find new markets. This approach is extremely unlikely in regulated healthcare environments. On the other hand, it is an opportunity in non regulated settings.

Second, the investment aims at taking a market share from competitors. The likelihood of success for this approach depends on the structure of the healthcare system.

Third, the investment will be used to improve the quality of the product offered to the customer. Consecutively the customer will be charged a higher price for the better product. This approach will typically not work in most healthcare environments.

Today, in healthcare the emphasis is on cost reduction [2, 8]. The basic goal is to reduce the cost per service item, while a service item could be a specific medical procedure, e.g., an MRI study, one specific disease episode, the complete treatment for one DRG, or even the entire health coverage for a population. In principle, there are three approaches to reduce cost:

- Reduction of resource consumption, i.e., the direct cost, for an individual service item. This could be achieved by a medical device that has lower operating costs.
- Increase of the number of procedures done with the same resource, i.e., reduction of the fixed cost per service. An example could be extended operating hours for expensive imaging equipment.
- Reduction of complications for the delivered service item. This approach to reduce cost is specific for healthcare. Typically, complications are excessively expensive, as they require additional treatment, increase the length of stay, and may result in litigation. Therefore, even a small reduction of complication rates may have a significant effect on cost-effectiveness [1, 9, 10].

With reference to medical processes there are two different basic ways that the problem of cost reduction and cost-effectiveness can be tackled. On the one hand, the cost of the existing medical practice can be reduced by the investment in question without changing medical processes. Examples would be cheaper drugs or cheaper ancillary services. This is a simple approach where the prospective ROI is easy to anticipate. Therefore, it carries only a limited risk. But it typically yields only limited benefits and the effect may not be sustainable over longer periods of time.

On the other hand, an investment can be used to change the entire process of care or clearly defined subprocesses. Examples include clinical pathways or electronic physician order entry systems. Remote patient monitoring may also induce or facilitate significant process changes. These investments may help to reduce complications, medical er-

rors, or improve patient home care [2, 3, 11]. But they lead to complicated changes in the processes of healthcare delivery. They require the commitment of all healthcare professionals involved. Therefore, the actual ROI in these cases is difficult to anticipate, although many clinical studies have shown that they can have the by far largest impact on cost effectiveness [12, 13, 14, 15]. In other words, investments in changing the process of care carry a significant risk, but may lead also to a significant ROI that may be sustainable over time.

IV. THE PROCESS OF ROI ANALYSIS

There are different approaches to ROI analysis using different models and assumptions. The discussion of all methodologies goes beyond the scope of this article. Rather than giving an in-depth theoretical discussion of models and methods this chapter will focus on five practical steps of a ROI analysis from the perspective of a CDO:

A. Analysis of the cost structure

The analysis of the cost structure needs to start with the identification of those areas in the healthcare organization that are affected by the investment. For instance, the use of a continuous blood gas analysis system substituting or supplementing the benchtop gas analyser will affect the workflow of physicians and nurses on the respective care unit, while a telemedicine system for intensive care may affect physicians and nurses working with the system, the hospital pharmacy, the accounting department, and ancillary services. All cost structures, including variable and fixed costs, need to be identified and measured.

B. What changes can be anticipated

This analysis of workflows may be an integral part of the first step. It is important to check whether the anticipated changes will actually happen. Many of the anticipated changes depend on the commitment of the healthcare professionals affected by the changes. If the expectations toward the changes are unrealistic, or changes do not materialize due to lack of commitment, the entire ROI analysis may fall apart.

C. The cost of the new investment

The cost of a new investment is composed of two components: initial investment and running cost. The initial investment typically includes the capital investment for the product that is purchased and the manpower for the imple-

mentation of the new system. This manpower often has to be provided by the CDO and may include efforts like the configuration of medical software or the training of users. The running costs include items like consumables, energy, maintenance costs, manpower to support and operate the systems or devices.

D. Estimation of potential savings

The identification of cost savings in the processes affected by the investment can be considered the most difficult step in the ROI analysis. The estimation of potential cost savings is much more uncertain and more difficult, if it has to be based on assumptions about changes in the process of care that are expected to lead to consecutive changes in outcome, e.g., better long-term outcomes from the management of chronic disease conditions with remote patient monitoring. These assumptions are typically prospective and based on studies that investigated the same or similar devices or systems that are about to be assessed in the ROI analysis in question. In general, the deeper the changes are to the process of care as a consequence of the investment, the more difficult it will be to make a reliable estimate of the prospective ROI.

E. Calculation of the return on investment

If the first four steps of the analysis lead to clear results the final step is relatively easy. In essence, at this step one has to calculate the sum of all direct and indirect savings and subtract all investment cost and running cost over a defined period of time. This is also the last chance to check again for uncertainties and errors in the previous analyses, especially for hidden cost. The final result be the return on investment. In any case the final analysis should include an assessment of the probability of the results. East gives a good overview and practical example how the methodology of probabilistic modelling can be used for ROI analyses in healthcare [16].

V. ROI FROM REMOTE PATIENT MONITORING

Assessing the ROI from monitoring technology can be difficult when the effects of monitoring on patient outcomes need to be included in this analysis. Monitoring per se cannot have direct beneficial effects on patient outcomes. Only when monitoring is translated into therapeutic action, i.e., if data and information generated by monitoring technology is used to guide or facilitates therapeutic decisions and therapy, this can result in changes of patient outcomes [17]. The only notable exception is the replacement of one monitoring

technology by another that provides the identical information at lower cost or with fewer complications. On the other hand, the use of monitoring that is not used to guide medical decision making most likely will have a negative ROI. In this respect only studies that investigate (therapeutic) interventions that are facilitated or guided by the respective monitoring technology can be considered.

Remote monitoring of critically ill patients in the context of a telemedicine system for intensive care has resulted in significant patient outcome and financial benefits [18]. In this application of remote monitoring the monitoring technologies facilitate a remote intensivist consulting service leading to a reduction of mortality and complications.

Comparable effects have been reported from home monitoring of patients with chronic conditions, such as diabetes, congestive heart failure, or obstructive lung disease. Again, in all these settings remote monitoring was employed to facilitate remote patient support which resulted in beneficial effects [19, 20]. Unfortunately, the limited quality of most studies published on remote patient monitoring in outpatient and home settings precludes a definite assessment [21].

It should be noted that in nearly all studies remote home monitoring actually constituted patient self testing where the test results were transmitted to a remote service center. Remote continuous monitoring outside the hospital has not been subjected to ROI studies thus far.

VI. DISCUSSION AND CONCLUSIONS

The increasing pressure on healthcare expenditures and cost effectiveness of care has made ROI analysis more important than ever before [2, 4, 5]. ROI analysis in healthcare should follow the same principles and use the same methods as in other industries [6]. But these methods have to be adapted to the specificities of the healthcare environment. In healthcare more intervening factors can be expected and especially more constraints.

For a purely technical investment, e.g., replacement of one device by the other, the ROI analysis is relatively simple, because the process of care as such will not be changed. As soon as the investment leads to a change in the process of care the uncertainty in the ROI analysis increases dramatically. Generally speaking in healthcare the emphasis is on cost reduction rather than on increasing revenue; an aspect that has to be included in any ROI analysis. The highest potential for cost reduction can be anticipated when investments are used to significantly change and control medical processes [1, 3, 14]. On the other hand, the more complex the changes to the processes of care are, the more difficult ROI analysis becomes. It may even be difficult to assess the ROI retrospectively.

It can be recommended to follow the five steps outlined here for the ROI analysis. Probabilistic models can be very helpful to accommodate uncertainty in the analysis [16]. Of course, the ROI requires that the anticipated changes are actually implemented consistently in daily practice.

Many analyses have to be based on assumptions derived from studies in the literature. It needs to be carefully analysed whether these assumptions are actually justified in the setting under consideration [22, 23]. Differences in the healthcare systems and in how medicine is practised may make it even impossible to transfer study results from one country to the other. A rule of thumb may be that the closer the observed changes are to the patient, i.e., the more “medical” they are, the more likely it is that the results can be applied to different healthcare systems.

In summary, ROI analysis is feasible even in highly complex healthcare settings. But even on a limited scope ROI analysis is a formidable task that carries a high level of uncertainty. But it is also a chance to learn more about the processes and cost structure of care.

VII. REFERENCES

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