The Economics of Telerehabilitation
SREERAM DHURJATY, Ph.D.

ABSTRACT
This paper is an analysis of the economics of physical telerehabilitation, at home, in the clinic, and at work. This study was a precursor to generating a business case for manufacturing telerehabilitation systems. Pilot studies were performed and structured interviews conducted with providers, payers, patients, and employers. The data obtained were analyzed, in conjunction with published data, to understand the economics with respect to parameters such as lost opportunity costs at work, faster rehabilitation, and cost savings to patients, providers, payers, and employers. The results showed that telerehabilitation has a positive business case with respect to all the stakeholders. The ability to quantify and analyze data from patients remotely is convenient and economical to providers. Patients benefit by getting back to their normal activities faster, both at home as well as work. Telerehabilitation at work allows employees to be treated at work without having to take time to go to a clinic. Lost opportunity costs for employers are minimized when workers return to work faster and are treated on-site. The ability to measure progress quantitatively is beneficial for patients, providers, payers, and employers. Additionally, malingering can be detected and eradicated using telerehabilitation. Proper application of appropriate telerehabilitation technologies makes eminent economical sense. There is a strong business case for the application of telerehabilitation, on-site, in large corporations and therefore is profitable to medical device manufacturers.

INTRODUCTION
Both physical and cognitive telerehabilitation have been shown to be efficacious in treating patients. Compliance is enhanced by telerehabilitation resulting in positive outcomes that are faster in comparison to conventional methods. Recent papers1–3 detail some of the work done in these areas. Most of the studies have been conducted in academic settings where the main goal was to validate the efficacy of telerehabilitation. In most cases, the cost of the instrumentation and its deployment was not a determinant while conducting these studies. There are many patients that can benefit from telerehabilitation. Occupational and sports injuries account for lost productivity in industry. It is estimated in Greenleaf et al.2 that the number of workers at risk, in various occupations, is about 104 million. Table 1 contains the distribution of workers at risk in various industries. It is also estimated in Greenleaf et al.2 that there are 500,000 injuries annually, which account for absences of 3–10 days from work and another 150,000 injuries that account for 11–30 days away from work. Table 2 details median days off from work for various injuries in 1998.

For telerehabilitation to be adopted successfully, it is necessary for companies to manu-
facture, sell, and maintain appropriate technologies for applications in the clinic, home, and work. The profitability of such ventures is a major determinant for the involvement of major medical device manufacturers in telerehabilitation. Today one of the challenges is the migration from unsophisticated devices to the more sophisticated telerehabilitation systems. Dhurjaty has a discussion of such devices for telerehabilitation at home.

The economics of telerehabilitation involves a complex interplay between patients, providers, and payers. The dynamics of this often-changing relationship is crucial in understanding the economics. Government regulations add another dimension to this puzzle. The value-propositions of each of these stakeholders have to be identified and deconstructed to generate business cases that are profitable for all the stakeholders. These value-propositions are also coupled to the implementation of telerehabilitation technologies.

The purpose of this paper is to provide a framework for the various stakeholders to engage in telerehabilitation profitably. This study was conducted by Eastman Kodak Company and Greenleaf Medical Systems.

MATERIALS AND METHODS

The first part of this methodology involved a pilot study. Details of the pilot study are available in the paper by Dhurjaty. This pilot study involved 25 patients in Houston and Palo Alto with acute hand injuries. Patients were equipped with personal computers connected to range-of-motion sensors (glove), a pinch meter, and a grip meter. The system communicated remotely with a therapist over a telephone line. Exercise protocols were downloaded each day, and, as the patient performed these exercises, feedback regarding progress was given to the patient via a graphical interface. The results of these exercises were transmitted to the therapist and displayed appropriately using a personal computer. New protocols were downloaded to the patients on the basis of the results. Real-time video was also available between the patient and the therapist for live consultation.

Interviews were conducted at the end of this 6-week pilot with patients, as well as therapists and physicians. The questions were structured so as to understand parameters such as compliance, convenience, comfort, and time to return to normal activities.

The second part of the study involved interviews with providers, payers, and four large, self-insured, corporations. The questions were structured so as to understand the nature of injuries, lost time, and the cost of these injuries to these corporations. Using results from the studies, the economics of telerehabilitation have been quantified with the assumption that workers could return to work faster with telerehabilitation in comparison with existing treatments.

The questionnaires for the study were designed by Szumowski.

RESULTS

Some of the results of this study are described in this section with respect to patients, providers, payers, and corporations.
Patients
Telerehabilitation provides patients immediate visual feedback with respect to performance. Engaging graphics provided distraction from pain, helping compliance. Online collaboration between therapist and patient was viewed as a positive experience, and reduced travel time and the associated cost were attractive to the respondents.

Providers
Faster outcomes allow more patients to be seen in the case of capitated patients in addition to controlling clinic overuse. In the case of noncapitated patients the services could be expanded to rural areas.

The ability to analyze data from multiple patients, in one sitting, conveniently and remotely was very attractive to all of the respondents. The ability to integrate telerehabilitation data into existing hospital information systems was also seen as increasing productivity.

Quantitative measures allow tailoring of treatment plans to the individuals patients in addition to the detection of malingering. Reduced travel time allows for lower travel costs and better time-management and scheduling.

Payers
Fewer patient visits are less expensive. Lower amounts of pain medication are needed, reducing costs. Quantitative data vis-à-vis compliance and patient progress helps with rationalization of payments.

Corporations
Table 3 details the cost of injuries in four large corporations. The lost-opportunity costs for these companies are substantial. People return to work faster resulting in improved productivity, rehabilitation on the job saves travel time. The training costs for replacement workers is reduced, which also may have a positive impact on quality.

DISCUSSION
The challenge to widespread acceptance of telerehabilitation hinges on the business case. The value proposition for each stakeholder along with the economic impact will be considered in this section and strategies will be outlined. Features in the instrumentation and work flows will be considered.

The introduction of telerehabilitation at home is a challenge due to the cost of capital investment. Dhurjaty has discussed, in detail, the challenges of telerehabilitation in the home environment. Telemedicine system manufacturers incorporating inexpensive, disposable devices into existing telemedicine systems will facilitate the introduction of telerehabilitation at home. The rest of this section concentrates on the economics of telerehabilitation where corporations provide these facilities for on-site rehabilitation.

Examination of Table 3 reveals that the lost productivity to the large retail corporation (1.14 million employees) is about $3.8 billion. Returning employees to work faster, by about 25%, would save the corporation $954 million. The cumulative savings for just the four corporations would exceed $1.6 billion. There is a viable business case for a manufacturer to team up with a provider such as Kaiser Permanente, Health South, and the VA hospital system to penetrate the market and share revenue. This case assumes that both upper and lower extremities in addition to back injuries are candidates for telerehabilitation.

<table>
<thead>
<tr>
<th>Type of business</th>
<th>Number of employees</th>
<th>Annual lost productivity due to injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail corporation</td>
<td>1,140,000</td>
<td>$3.716 billion</td>
</tr>
<tr>
<td>Automotive manufacturer</td>
<td>388,000</td>
<td>$1.3 billion</td>
</tr>
<tr>
<td>Parcel and package service</td>
<td>344,000</td>
<td>$1.3 billion</td>
</tr>
<tr>
<td>Consumer goods manufacturer</td>
<td>30,000</td>
<td>$96 million</td>
</tr>
</tbody>
</table>
**TELEREHABILITATION ECONOMICS**

**Instrumentation**

The instrumentation should possess, at least, the following features:

1. Should be rugged and reliable for use by multiple patients.
2. Should cater to extremities as well as other body parts.
3. Should have engaging graphics associated with each of the exercises.
4. Should be capable of different programmable effort levels for range of motion and forces inclusive of negative force to assist patients.
5. Should have accurate range-of-motion sensing.
6. Should use a fast network connection with the provider to have high-quality video communications, in real time, as well as interface with a hospital information system.
7. Should communicate over the network using standard and secure protocols to ensure patient privacy.
8. Should be easy to clean/sterilize between patients.

**Workflow**

Two broad scenarios are defined here. In the first, a patient may return to work after surgery after two or three PT/OT sessions and then continue for a few more sessions, using telerehabilitation under the remote supervision of a PT/OT.

In the second scenario an injured patient may, with the supervision of a therapist, engage in telerehabilitation before surgery. After the surgery, the patient may return to work and then follow the first scenario. In this scenario, the patient could benefit from rehabilitation, pre-surgery, which could facilitate a faster return to work. Existing current procedural terminology (CPT) codes, for reimbursement, may be used in both of the above scenarios.

**CONCLUSION**

Telerehabilitation systems that are marketed to large corporations in conjunction with large providers make sense economically and have the following incentives:

**Providers**

- Improved patient outcomes, therapeutic accountability, therapist productivity, and clinician efficiency would be resulting incentives.

**Employers**

- Improved productivity would be coupled with accountability with respect to workers compensation.

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**REFERENCES**

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