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Disease Management System (DMS)

Hadas Lewy

Maccabi Healthcare Services, Tel-Aviv, Israel

8.1 Introduction

Parkinson's Disease is a chronic and progressive neurodegenerative disorder with a great number of motor and non-motor symptoms [2, 4, 5, 7]. The cardinal symptoms are bradykinesia, rigidity, tremor and postural instability [1, 3, 8]. However, a number of non-motor-related symptoms (e.g., sleep disturbances, depression, psychosis, autonomic and gastrointestinal dysfunction as well as dementia) may occur [3–7].

The disease is a great burden as it has a negative incidence on the quality of life, due to a gradual loss of functionality and decreasing ability to take care of oneself. For these reasons, the caring process changes along disease progressions and involves many healthcare professionals. Usually, these professionals are located in different care services and organizations (hospitals and the community), and they cover a wide range of medical care including physicians, nurses, physiotherapists, nutritionists, occupational therapists and social workers. In addition, there is a need to support the family and reduce the informal caregiver burden by providing services, information and knowledge about the treatment.

To cope with the challenging care model of PD patients, the REMPARK project contributes to the development of a Personalized Health System (PHS) with detection, response and treatment capabilities for the remote management of the disease permitting, also, the integration of the generated data with the patient's EHR (Electronic Health Record) and the integration and support of a Disease Management System (DMS), that enable the medical team to provide integrated care and support to the patient and his family.

One of the main problems in most existing systems for disease management is that the data used for treatment is collected on the system overtime

and is not updated by other systems that are used for treating the patient. For example, if the patient is treated by the neurologist for the PD and in parallel he is treated by the general physician in the community for other health conditions. Usually, no integration between data is made and there is a lack of information about the overall condition of the patient. Furthermore, there is no communication between the healthcare professionals treating the patient.

This way of delivering care results in a fragmentation, slight duplication and lack of coordination. The DMS creates an integrated environment for data and knowledge sharing for all care providers without a need to access different organizational systems by users from different organizations and thus overcomes the privacy and security barriers. The DMS also includes clinical guidelines and a decision support tool for healthcare providers that allow the clinical team to obtain accurate and reliable information and to decide about the treatment that best suits the patient for improvement of the disease management.

This tool enables treating several conditions at the same time in a coordinated way; therefore, the organization can use several experts to treat a patient (e.g. psychiatrists, urologists or neurologists) and enable integrated care between different organizations (e.g. hospital community care and welfare) which provides flexibility and efficiency treating a patient with changing conditions, without breaching security constraints of the organization.

For the patient, there is a portal in which he is able to communicate with the professionals (doctor, nurse...) and obtain information about his condition and treatment plan. The DMS communicates with the patient's interface that can be reached by a home computer, a tablet or a Smartphone, it updates the data and collects inputs from the patients, such as self-reported questionnaires, for the evaluation and decision making by the healthcare professionals. These tools give useful information to the patients and empower them for better self-management.

The system also has an interface for healthcare organizations to enable management of the treating teams such as shifts and workload at the call centre, and reports for the management teams.

This chapter describes the use of the implementations of a DMS within the REMPARK system, its ability to communicate with REMPARK sensors, intelligent layer and actuators and reviews the advantages that the DMS brings to all users involved in the system from a clinical, personal (patient), organizational and healthcare points of view. At the end of the chapter, the conclusions from using the system and the vision for its contribution of the future treatment of PD patient are described, as well as for elderly people with co-morbidities in a changing era of care models moving from reactive

to proactive treatment, empowering the patient and creating new services and relationship between the patient and the healthcare providers.

8.2 Disease Management System Application

Providing integrated care and remotely treating large populations creates a challenge for the care providers at the clinical and organizational level. Although the data provided by the sensors and analytical tools are valuable and the REMPARK system paves the way for its clinical use in the future for the automatic control of continuous infusion pumps, automatic management of external cues to guide the gait or for comprehensive and reliable analysis of changes in motor state, still the use of this type of data in clinical practice is not implemented. Clinical guidelines for remote monitoring, standardization of care and risk management of the remote monitoring and care is still not well-established and requires development of supportive tools as well as methodological approaches.

The progression of the disease is individual and cannot be predicted, and the patient and their family need support at different levels and by multiple caregivers at different stages of the disease. Since the disease is usually related to elderly people, the associated symptoms may be mistakenly treated as geriatric symptoms and there is a need to diagnose the source of the symptom and provide the personalized treatment considering the overall condition of the patient. The services provided for comprehensive treatment are often provided by different organizations located in the hospital, community service and home care. Therefore, the treatment can be complex and involves several stakeholders.

For these reasons, healthcare system and the industry are interested in the implementation of technologies for remote care in healthcare. For healthcare system, the main challenge is to enable the use of these technologies by changing the model of care and sharing information. Implementation of these technologies requires collaboration of the healthcare professionals and patients not just in adoption but also in the process of development and implementation in new best practice and care pathways and open the way for sharing information from the patient (self-reported) and other sources (different organizations), capturing and analysing patient data from dispersed systems.

For the industry, the challenge is to provide solutions that will support healthcare systems considering constrains of standardization, privacy, reliability, security, existing models of care including healthcare professional workloads and workflows and adapt the solutions to the system [9]. With these

challenges in mind, it was proposed and developed the REMPARK system composed of wearable sensors, analytical layer, decision support tool and a care platform (DMS) for professional care providers, patients and family.

The DMS system provides various functionalities that **support the care** by healthcare professionals and communicate with the patient. It is also adaptable to the **organizational care pathways** and **workflows** and flexible to different clinical guidelines that are used in different countries and/or can be developed overtime. It enables to treat the PD patient in a way that changes along the development of the disease and consider co-morbidities, motor and non-motor symptoms. In addition to the workflow and/process support, the system provides the organization tools for **risk management**, **standardization** and **data reports** that enable a better understanding, control and ways to manage the treating teams.

The care models are moving from **reactive** to **proactive approach**. The treatment of PD patient involves both approaches since it combines monitoring of motor symptoms, alerting and responding, as well as overall preventive assessment and on-going treatment in a proactive way. The REMPARK system receives data transmitted from the sensors. For each patient, there is a defined range of normal and abnormal values in each monitored parameter. Any deviation from normal event creates an alert on the system and consequently there is a reactive intervention. The **alerts** can be set not only for a single event but also for a set of events overtimes. For example, a fall requires immediate response therefore a single event will create an alert. However, for the neurologist it is important to know if the drug treatment is effective; therefore, parameters such as number of dyskinesia events or FoG events in the last week will be important and indicative for the treatment. In this sense, it is possible to set an alert whenever a set of accumulative events in a defined period occurs and to present it to the neurologist.

In addition, each patient has a **personalized treatment plan** defined by the doctor that is monitored by the nurse in the centre, who has a concrete list of **tasks** to handle. The tasks will be generated automatically from the patient's treatment plan or by the doctor/coordinator of the team. This way the patient is also being treated in a proactive way by the nurse or other care team members. The nurse can also see the condition of the patient in the last week at a glance or enter his record. The proactive treatment is driven by the treatment plan that is observed and followed by all care team members. This allows an **integrated care**, team discussion and coordination in providing comprehensive care. The platform has, also, the ability to communicate between care team through messaging tool or video call.

For each patient, participating in the REMPARK pilots, according to the patient's evaluation and clinical history, medications and definition of normal ranges for every measurement, the medical team can add and update the treatment plan according to changes in condition of the patient. A change in the treatment plan can be as a result of changes in the patient's health state or patient's environment. Some items create a task for a specific medical team member according to his profession while all team members can be updated in the status and given treatment.

The strength of the system also relies on the ability to obtain, analyse and **integrate data from different sources**: sensors, patient reported data and EHR. Wearable sensors provide data monitoring of clinical data about PD patients motor condition but also behavioral data such as activity levels, type of activities and social activity. The development of these technologies that monitor different data types to yield additional information about wide range of parameters and activities including behavioral, mental and clinical data that are transmitted in order to assist the treatment process, opens new opportunities for care providers but also requires integration of care models.

The data can be further analyzed for risk assessment of stratification for timely intervention. In these cases, data entered by the patient regarding his condition is pre-defined by the care provider and used as part of the treatment and for further assessment of the patient's condition [10, 11]. However, today the data collected for chronic conditions and specifically **patient reported data** in different care programs is partially used in care and are usually not treated by physicians as clinical data in the **EHR** as part of the clinical process. (see Figure 8.1 for a shot view of a screen showing patients' data. Consider that data are not real).

The challenge of healthcare system will be to use these data providing additional information to that existing in the EHR. The REMPARK system provides a tool for implementation of this approach by using the integrated care platform to combine heterogeneous data from EHR, **sensors, analytical tools** and patients' self-reported data for **comprehensive care** of multidisciplinary teams. Furthermore, the data are continuously updated from the different sources and do not require manual update enabling all stakeholders to continue using their organizational systems without duplication of work and bringing added value to the treatment process using intelligent tools on top of their existing system. The interaction between the patient and the healthcare professionals will be enabled through the DMS platform as a result of alerts and/or treatment plan, since the nurse will be able to call the patient or message him.



Figure 8.1 View of data on a patient from a list. (All appearing data are not real).

All correspondence is registered on the system for follow-up and **risk management**. One of the useful tools presented in REMPARK system is the **clinical protocols** tool. A clinical protocol is a document with the aim of guiding decisions and criteria regarding diagnosis, management and treatment of PD. It is a set of steps allowing the medical team to make decisions according to the collected information. It is actually a set of medical instructions for every situation according to the patient's medical state.

These protocols can be easily updated or changed from time to time by the care provider according to the medical considerations or according to organizational procedures. The protocols can guide the medical team how to treat the patient and co-morbidities. For this purpose, the clinical team of REMPARK project developed a set of clinical protocols based on the best practices for the treatment of PD patients. In addition, protocol for other chronic diseases or geriatric conditions exist in the system and enable the medical team to identify the clinical situation. The protocols are adapted to the user (e.g. healthcare organization) and can be generated for doctors, nurses or/and caregivers. By using the protocols the medical team will provide a standardized treatment that is in accordance with clinical guidelines (see Figure 8.2).

The protocol is loaded automatically in case of treating a task or an alert. The clinical protocol automatically guides the medical team user to the next

Figure 8.2 Protocol screen capture for apomorphine pump alert.

point or stage according to the data, until reaching the final decision or action. Using the clinical protocol the medical team will be able to send instructions to the auditory cueing system as described in the external interfaces or make a decision about any intervention or treatment using future tools that would be connected to the system.

In order to have an overall understanding about the patient's condition the neurologist interviews the patient about their symptoms, frequencies and daily condition. The patient is usually asked to fill a diary; however, the experience shows that these diaries are only partially filled in and the information provided to the neurologist is partial. One of the ways the REMPARK system overcomes this problem relies on the data obtained and analysed by the sensors and presented to the neurologist on the DMS platform. This tool is complemented under some conditions by the use of a questionnaire.

The DMS platform provides a tool of **questionnaires** that serves as "**patient reported data sensors**". The questionnaires can be filled by the patient, relative or by a nurse calling the patient in cases the patient is unable to fill the questionnaire. In addition, some of these questionnaires can also be responded through the smartphone, which are also received by the DMS. In either case, the system presents the patient the questionnaire that has to be filled according to the treatment plan. For each questionnaire, there is a logic to calculate a score. The medical team and the patient are able to see all history of previously answered questionnaires.

The questionnaire tool is also combined with the sensors data and can ask the patient additional questions when the sensor data alerts. The information can be viewed along time to show a trend even if no alert was raised. This tool was designed to collect the patient's reported data and use it with clinical logic to create alerts and response by the medical team. It integrates the data with the clinical data in an innovative way that presents the physician the information they need and simplify the analysis of the patient's reported data for use in clinical practice. Figure 8.3 shows, as an example, a part of the questionnaires section.

As healthcare moves towards proactive treatment there is a need for changes in relationship between the care provider and the patient. The proactive concept that involve the patients in self-care requires **patient empowerment**. The patient becomes an active partner in care and makes his own decisions about his health and disease. In order to do so the patient has to be educated about his disease, aware of the clinical options and learn how to cope with the disease. Patients who participate in their care process, cope better with their disease, live healthier lifestyle, have higher quality

8.2 Disease Management System Application 167

The screenshot shows the 'DMA SYSTEM' interface. At the top, there are navigation links: 'My Tasks', 'Supervisor', 'Reports', and 'Admin'. Below this is a 'Disease follow-up' section with a 'Change User' link and a search bar. The 'Disease follow-up' section includes a 'Last 7 days state' field and an 'Update' button. Below this is a 'Patient Details' section with tabs for 'Patient Details', 'Scheduler & Treatment plan', 'Measurements', 'History', 'Questionnaire', and 'Load Protocol'. The 'Questionnaire' tab is active, showing a 'PQ39' section. The 'PQ39' section contains eight questions, each with a 1-5 Likert scale. The questions are: 'Had difficulty doing the leisure activities which you would like to do?' (score 3), 'Had difficulty looking after your home, e.g. DIY, housework, cooking?' (score 2), 'Had difficulty carrying bags of shopping?' (score 1), 'Had problems walking half a mile?' (score 4), 'Had problems walking 100 yards?' (score 3), 'Had problems getting around the house as easily as you would like?' (score 2), 'Had difficulty getting around in public?' (score 3), and 'Needed someone else to accompany you when you went out?' (score 1). At the bottom of the questionnaire, there is a 'Your Score: 3 pt' field and a 'Save' button. The date '10/07/12' is displayed at the bottom left.

Figure 8.3 Questionnaire's section detail.

of life and better clinical outcomes [9]. For these reasons, the REMPARK system adopted this approach and developed a web portal and smartphone interface for the patient.

Electronic correspondence between the patient and the medical team is bi-directional. The correspondence can be triggered from the patient (using the patient web site or the smartphone) or from the medical team or any DMS user. The patient interface is designed to enable the patient receiving all the information about his condition. They can view all sensor's data, questionnaires and correspondence and perform actions required for the treatment such as filling questionnaires and for correspondence with their carers (healthcare providers). The patient is able to add activities into the treatment plan. The patient's web interface is used, among the above, to communicate with the patient either by global message to every person registered to the REMPARK system or messaging a specific patient/medical team member. This way the message is personalized to a patient or can be addressed to a group of patients with the same clinical condition or need.

An emphasis was made on **patient empowerment** and **education**. Educational materials are sent to the patient according to their condition, need, and disease progression such as articles regarding PD, new treatments and medications or any links to external internet pages and support groups. Figure 8.4 is showing how it looks the patient's interface presenting the personal treatment plan.

The REMPARK system provides additional organizational tools for management of the care team. The DMS includes a **shift management** module that manage the tasks and users that are at each shift. The shift manager can see the workload and type of activities done in the centre for efficient management of the care process. They can also receive reports about activities done on the system.

The above description of the REMPARK system provides an insight not only to the workflow application but also to the **care approach of REMPARK project** for PD patients. The system supports the care approach and enables the care provider to effectively manage the delivery of integrated care. The **uniqueness of REMPARK system** is that it includes a wide

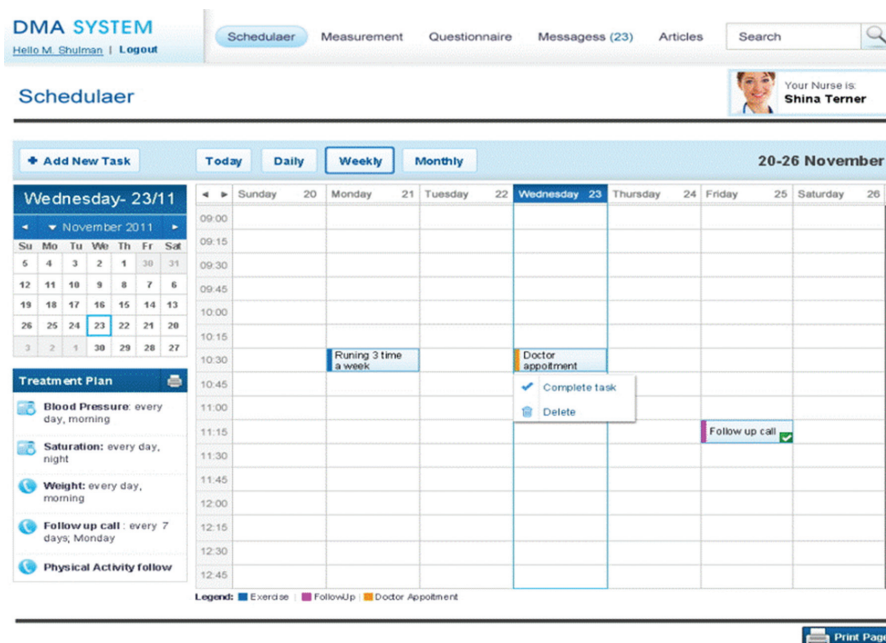


Figure 8.4 Treatment Plan. A patient's interface view.

range of functionalities for delivering comprehensive customizable integrated care by multidisciplinary team, but it also enables the treating physician to maintain a supervision of the patient throughout the journey; from patient disease diagnosis, through treatment plan definition, customizing specific protocols.

Moving from reactive to proactive treatment, involving all care providers, requires a change in interaction and mode of delivery the care under the physician coordination. Here, the care is delivered under his supervision enabling to effectively leverage other providers to pursue a consistent treatment approach and objective. It establishes a way for patient's personalized treatment. The application interfaces with the EHR, and the physician receives on-going alerts, updates and patient's data. The care team operates as a supporting envelope to the physician, and maintain constant touch with the patients according to the treatment plan, protocols and alerts received from the system.

8.3 DMS Functional Organization

For the already presented functionality, the DMS platform will communicate with the mobile gateway in both directions through the REMPARK server. This way, two types of information are distinguished:

- Incoming data: contains the patient's parameters as they have been measured by the sensors or/and patient processed information from the Rule Engine. Furthermore, the DMS will get information from the Rule Engine through the REMPARK server too.
- Outgoing data: contains updates for the patient's treatment according to the patient's pump or any other command from the auditory cueing system. These data are sent from the DMS.

The system architecture allows that all the data are stored at the REMPARK server, so the interaction between the different parts of the system will be with the REMPARK server. Figure 8.5 shows the main role that the REMPARK server has in the communications process. This is the only interaction point between the REMPARK's server to the Medical Application – DMS system.

In general terms, there are two types of communications: telemonitoring of motor symptoms and another related to patient management issues. These flows were implemented by sending and receiving different services between the server and the DMS system. In case of the tele-monitoring of motor

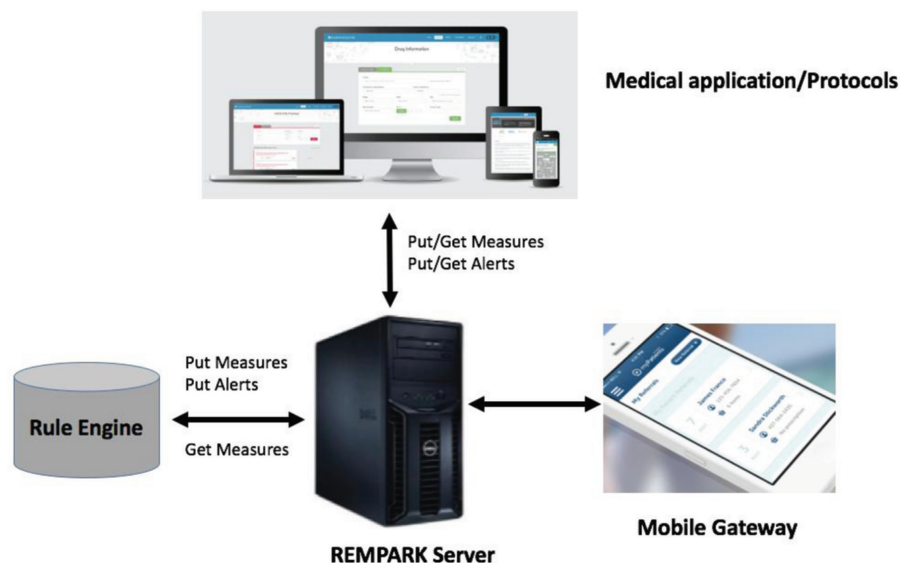


Figure 8.5 The server acting as a communication hub interfacing the DMA System.

symptoms, the DMS system will receive measures and alerts immediately from the REMPARK server. On the other hand, regarding the patient’s management communication, the DMS system will send events regarding the medication, questionnaires and clinical agenda of the patient.

Figure 8.6 presents the implemented architecture for the Internet interface, including a web server and a data base server (can be a physical or virtual server).

8.4 Advantages Using the Disease Management System (DMS)

8.4.1 Advantages for the Clinical Team

Nowadays, Healthcare delivery systems face problems such as the prevailing inequities in access to care, resulting from services with availability problems in different geographic areas, socioeconomic and cultural disparities. In addition, the system is usually fragmented and a comprehensive patient-centred care is almost impossible to be delivered with existing systems and care models. Therefore, even if services exist, it is very complicated for the clinician to provide the services to many patients that are not located in the geographical environment and even for these patients, there is a need of coordination between service provider’s.

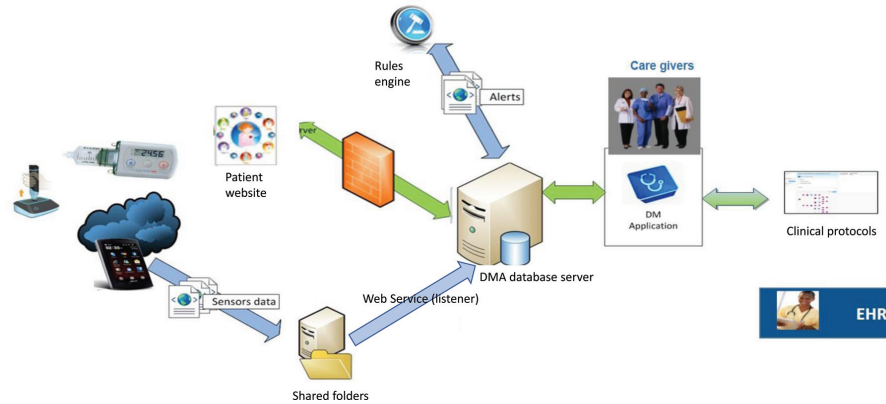


Figure 8.6 The Web interface architecture.

The main health dimensions are described in the SHARE document [14] and they can be listed as:

- Physical health measured by self-reports on general health, functional limitations, ADLs, IADLs, diseases symptoms, and health behaviour
- Healthcare use
- Cognitive function test, literacy, numeracy, memory, verbal fluency
- Mental health
- Physical performance measures

The inefficiencies, limited coordination and integration of complex healthcare systems further complicate the treatment and uneven adherence of patients to evidence-based medicine becomes a major barrier in treatment efficacy.

The care of PD patients is complex and requires a coordinated care team. It is possible to consider two approaches for delivering disease management programs: integrated and non-integrated care. Disease management programs based on the integrated care model with primary care have shown the most valuable and effective care and promising results. An integrated approach requires much deeper involvement from providers, and patients throughout the process and many health plans are starting to use in-house nurses with data analytics [12].

New models of integrated health management address member needs across the organization, offering value and transparency in all member interactions with the health plan. In order to provide such services there is a need in predictive modelling health risk assessment, utilization management and coordination of care. The care delivery model includes capturing and

analysing patient data from dispersed systems, involving and engaging all stakeholders, especially primary care providers that are typically left out. An optimal identification and stratification of patient population is, also, derived from data integration and physician engagement challenges.

The REMPARK system supports the referred care approach and enables the clinical team to effectively manage the patient's disease. The advantage is that different healthcare professionals can use the same platform without changing their own system. The data are updated and the workflow is maintained. It serves for Information and knowledge sharing between all caregivers of the patient. The REMPARK system provides the care team a way to overcome the barriers of fragmented care service, overcome organizational and inter-organizational limitations and focus on patient's clinical needs for diagnosis to most advanced conditions, better management of care and replacement of some of the home visits by remote evaluations as well as better management of visit scheduling according to need instead of the periodic visits usually done.

At the PD management level, the system provides information that does not exist today enabling the neurologist to have better assessment of the patient's condition and treatment effectiveness with online information. The pilot studies done in REMPARK project provided clinical outcomes for the motor symptom detection. Further studies should be done for assessment of overall clinical outcomes of the new treatment approach on the PD patients. However, from previous experience with other chronic disease patients treated in Maccabi healthcare services, in Israel, using this approach, the following significant clinical outcomes can be found:

- Significant improvements in the patient's well-being measured by QoL.
- Patients maintained a healthy lifestyle: diet, physical activity...
- The mental condition of these patients (reported depression) dropped from 24% before to 15% following the intervention using DMS.
- Patients reported that they have better ability to cope with their disease.

At the level of physicians there was a high satisfaction from the service which they found very helpful in the treatment process since the system supports Healthcare professionals in their routine work.

8.4.2 Advantages for the Patients

Daily communication with caregivers, better understanding of the disease, education and awareness about the disease progression, symptoms and possible treatments are crucial for PD patients and their ability to cope with

the disease. At early stages of the disease, there is a need to support the patient with educational materials and follow-ups, and at more advanced stages there exists a difficulty of the patient to arrive to the clinic as often as needed, to adjust the medical treatment, provide additional treatments (physiotherapy and cognitive treatment, for instance) and perform a correct on-going assessment and intervention of the disease.

The REMPARK system monitors and provides care for PD patients considering their overall clinical condition including co-morbidities. The patients are treated by their doctor and do not have to move visiting different doctors and care providers for the treatment of different conditions. The care coordination is done within the program and provides them a clear treatment plan and one contact point. The system aims to enable the patients preserve/enhance of their physical and mental QoL, performance scores, compliance rates and satisfaction. It also enables to empower the patients and support them and their family in the care process.

In summary, the REMPARK system brings an innovative solution to the patients by involving them in the care process. They are actively participating in the assessment through the questionnaires and are able to view and follow their clinical condition. The neurologist can make a remote visit and assessment of the motor condition (administering the UPDRS scale, as demonstrated during the REMPARK project pilot in Israel) through video conference and save the need to go to the hospital, especially for patients that are living in rural areas or have motor symptoms and disabilities at advanced stages of the disease.

From the cumulated experiences with chronic disease patients adopting the DMS system approach at Maccabi in Tel-Aviv (Israel), the presented system clearly helps the patient in all the mentioned aspects. Patients seem less worried regarding their condition; feel they have the information for the treatment, for drug regimen and for self-management. It also helps to preserve/enhance their physical and mental QoL (as measured by PHQ9).

The treatment increases their performance scores and satisfaction, decrease reported depression and increase healthy behaviour. The effects were shown also on the whole treatment perception, self-management and treatment burden. Healthy lifestyle was assessed by the frequency of self-care activities of the patient.

- Concerning the diet, physical activity and drug regime, there was a significant improvement due to the intervention (satisfaction with the service is very high and is rated 6 in a scale of 1–7).

- Use of a DMS based service results in a better empowerment of the patient and caregivers support of the care process. An increase of compliance and adherence to treatment is also detected.
- Remote- UPDRS was performed in PD patients as part of the pilot.

8.4.3 Advantages for the Organization

It is very well-known that the prevalence of chronic diseases is increasing around the world, and 50–80% of all global health spending is related to chronic diseases. Patients suffering from Parkinson's Disease are part of this population, since in most cases, PD patients suffer from more than one chronic disease.

The care of PD patients is complex and the correct treatment should be handled jointly by General Practitioners (GPs), and the specialized health service (hospitals or clinics): specialists (geriatrics and neurologist), general physicians, nurses, physiotherapists, nutritionists, occupational therapists, social workers, that may be affiliated to different organizations. Rehabilitation and self-management support should be handled in cooperation with GPs [13].

Disease management programs focus on patient monitoring and intervention. These shift healthcare expenses to less invasive and expensive care, thus, disease management programs are meant to strive to achieve two seemingly conflicting goals:

- Improving patient outcomes
- Optimizing resource utilization

In parallel to the increase of the prevalence in chronic diseases, there is a decrease in number of healthcare professionals. Since the early 1980s there is a decrease in number of physicians per capita from ~ 3 to ~ 2 doctors per 1000 people in average in the OECD countries. The number of nurses per 1000 people decreased from 7.5 in the mid-1980s to 5.5 in 2004 in average in the OECD countries. This trend increases the workload on physicians and nurses as well as on other healthcare professionals which limit the system in providing all the services needed.

The healthcare system structure is fragmented and in order to treat PD and other chronic patients, it is needed to receive services from several stakeholders. There is a limited accessibility and availability and lack of treatment uniformity in different areas according to healthcare professionals and service availability. There is a continuous rise in national healthcare costs and as a result, the economic stress is rising.

Nowadays, the healthcare systems face huge challenges. At the level of the care process there is a need for capturing and analysing patient data from dispersed systems, involving and engaging all the related stakeholders, especially primary care providers that are typically left out. Optimal identification and stratification of patient population derives also from data integration and physician engagement challenges. Service should be equal to all patients regardless of their living area (rural or large cities) and involve care teams and case managers. At the organizational level, there is a need to establish the process/workflow, the clinical guidelines and protocols for remote treatment, risk management and cost control.

As it has been already explained, the integrated care workflow application considered in REMPARK includes built-in alerts, clinical protocols, guidelines and treatment plans. The application interfaces with remote monitoring devices and can be integrated with EHR and other medical systems. The advantage is that the system does not change the routine work of the healthcare professional and support them in their work and decisions, enabling knowledge sharing, online assessment, intervention and follow-up. Using this approach on PD patients, in REMPARK project, it was received a high level of satisfaction from both patients and doctors, however it was detected a real need to drive towards the implementation of the service and to study the success measurements as it has been already done in other chronic disease patients populations.

The system is composed of several modules that provide a number of tools and functionalities to the organization:

- Risk management.
- Control of large teams providing services 24H/7D.
- Management of a large groups of patients that will enable scaling up to large population management.
- Treating heterogeneous data coming from different monitoring device, including patient reporting data.
- Ability to treat different conditions from well-being, clinical cognitive and mental conditions.
- Keep more than one care organization in the loop by sharing data and knowledge.
- The support of several care models/workflow and therefore the minimization of the number of systems that the organization has to use and implement.

8.5 Conclusions, Discussion and Vision

As the healthcare services changes and moves from hospitals to community care, there is a need to address the need of coordination between the services provided by specialists in the hospital, such as neurologists, and healthcare providers in the community and to create a system that will enable continuity of care, global coordination and integrated care. Furthermore, the treatment of actual complex patients includes also social care organizations, municipalities and sometimes private care providers, thus making their care quite complex, fragmented and with difficulties for sharing relevant information.

On the other hand, the interaction and relationship between patients and care providers is changing and is moving towards collaboration schemes and the active involvement of the patient in his care process, including self-management. This absolutely requires new tools and a different approach for patient empowerment, guidance and timely response by the care provider.

The REMPARK project developed and experienced a system that aims to address the challenges of the future model of care for the PD community. The different levels of sensors, data analytics, decision support tools, integrated care platform and actuators as well as tools for the patient, demonstrate the process and care pathway for treating PD patients and chronic patients at home.

The success of the system relies on its ability to adapt to different organizational and national systems as demonstrated in 3 pilot sites (Spain, Ireland and Italy) in which the main care of PD is provided by hospitals and in Israel in which the main treatment is provided in the community. The reliability of the system also at the level of data analysis provides a powerful tool when combined with clinical and organizational guidelines and thus pave the way to treat large populations with different and changing conditions in a personalized way.

The main barrier in implementing such systems is the need of integration with organizational systems, which is a slow and partial process. Therefore, the main challenge of healthcare system is to implement such systems at large scale and to use them as part of the existing workflows, sharing information with other organizations, patient and family and to develop methodologies for interactive treatment.

Healthcare organizations will use these technologies by changing the model of care, sharing information and advancing the research and development of systems that will bring additional information and knowledge to that already exist, in order to find the best way to use it in practice to improve care quality. This will also change the clinical practice and patient involvement in self-care and decision making.

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