The Importance of Health Informatics in Public Health during a Pandemic
J. Mantas et al. (Eds.)

doi:10.3233/SHTI200564

Model Driven Approach for Development of Person-Centred Care in Stroke Rehabilitation

Ivana OGNJANOVIĆ [a,1] Roman LEWANDOWSKI [b], Ramo ŠENDELJ [a], Dalia KRIKŠČIŪNIENĖ [c] and Jevto ERAKOVIĆ [d]
[a] *University of Donja Gorica, Montenegro*
[b] *University of Social Sciences, Lodz, Poland*
[c] *Vilnius University, Lithuania*
[d] *Clinical Centre of Montenegro, Montenegro*

Abstract. Person-centred care is known as a novel approach which contributes to wellbeing, prevention, care and support of patients. There is little evidence about practising PCC in stroke rehabilitation. In this paper, we develop a novel framework for creation of person-centred services for stroke rehabilitation which supports service configuration adapted to the requirements of each patient. The framework is elaborated over evidence from neurology department of Clinical Centre in Montenegro.

Keywords. Person-centred care, model-driven, neurology, stroke rehabilitation

1. Introduction

Person-centred care (PCC) is increasingly advocated as a new approach for delivery of care which advances partnership between a provider and a patient on the way to produce a mutually agreed treatment plan. This approach improves health outcomes and increase patient satisfaction [1]. Implementation of PCC is highly linked with the existing healthcare system (the structure, organisation, cooperation models with patients, health care delivery processes, etc.) as well as with concrete domain of care (due to specific knowledge and individualised treatment plans). The stroke rehabilitation is mostly designed based on scientific evidence gathered in the form of clinical practice guidelines (CPGs) which proves to improve patient outcomes [2]. Since stroke is a chronic condition, the recommendations have to embrace the whole cycle of recovery, from the early treatment in the acute care hospital through reintegration into the community till the long term maintenance and prevention including social reintegration, health-related quality of life, maintenance of activity, and self-efficacy (e.g. [3]). Optimally, rehabilitation should be delivered by a multidisciplinary team of healthcare professionals trained in neurology, rehabilitation, occupational speech and language therapy, psychology, psychiatry and social work [3]. In this paper, we present an innovative framework for creation and planning of PCC services for stroke rehabilitation built upon

[1] Corresponding Author, Ivana Ognjanović, University of Donja Gorica, Oktoih 1, 81000 Podgorica, Montenegro; E-mail: ivana.ognjanovic@udg.edu.me.

the well-known principle in the software engineering field, known as the model-driven approach, which allows specification of processes with included commonality and variability of the constitutive element. The framework is elaborated over evidence from neurology department of Clinical Centre in Montenegro.

2. Methods

Model-driven engineering is well exploited in the literature for creation of intensive software systems by combining processes and analysis with architecture. In this paper we use an approach which integrates the following models [5]: (i) *Feature model*- is widely used for the presentation of variability among different increments in functionality (usually presented as a *feature*) as well as their interdependencies (e.g. relations *mandatory, optional, alternative*, etc.) (see Fig.1.a); (ii) *Business process model*- gives a comprehensive view on processes in the domain, with included variations which are presented with injective mapping with corresponding feature model (see Fig.1.b). Created model is elaborated by using the database for experimental research which consists of registered stroke cases of patients (944 records of different patient, age from 13 to 96 years). The experimental research included statistical analyses and classification algorithms in order to define key factors of individualised care of stroke patients for monitoring the efficiency of rehabilitation processes, often affected by conditions of other diseases (multimorbidity), smoking habit, or necessity of assistance.

3. Results

Many studies suggest that well organized, interdisciplinary rehabilitation reduces the likelihood of long-term disability by enhancing recovery outcomes (e.g. [5]). Depending on the deprivation, rehabilitation could be delivered in inpatients or outpatients rehabilitation facilities and later in a community setting. Patients should continue in inpatient rehabilitation if they are in necessity of skilled services, for example [3]: (i) bowel and bladder impairment; (ii) impaired bed mobility; (iii) dependence for activities of daily living (ADLs); (iv) inability to manage medications; (v) high risk for nutritional deficits; (vi) pain management issues; (vii) moderate to severe motor/sensory deficits, and/or; (viii) cognitive deficits, and/or, (ix) communication deficits. There is growing evidence that other physical activities, such as aerobic exercise, treadmill, body weight–supported treadmill, is effective in improving medical outcomes [3]. Physical activity should be an important aspect of home-based rehabilitation programs, especially that both patients and family members or caregivers prefer home-based rehabilitation programs over institutionally located rehabilitation. Community-based rehabilitation reduces depression and increases participation and health-related quality of life. Some studies report problems related to patient safety, fidelity of the treatment, lack of equipment and capacity to provide home-based rehabilitation [5]. The process of stroke rehabilitation is presented on Fig.1. with integrated different treatment elements. The concrete treatment plan shall be delivered based on characteristics of each specific patient, with PCC implementation approach which relies on continual communication with patients, their family members and other relatives. Having in mind that modern ICT solutions provide support to the implementation of PCC services in the form of mobile-based solutions which continually monitor patient's behavior, biochemical parameters,

as well as other healthcare indicators, selection and configuration of such services shall include: (i) the situational analysis about disease, (ii) available resources and potentials for integration with existing health information systems, and (iii) requirements and preferences of each specific patient.

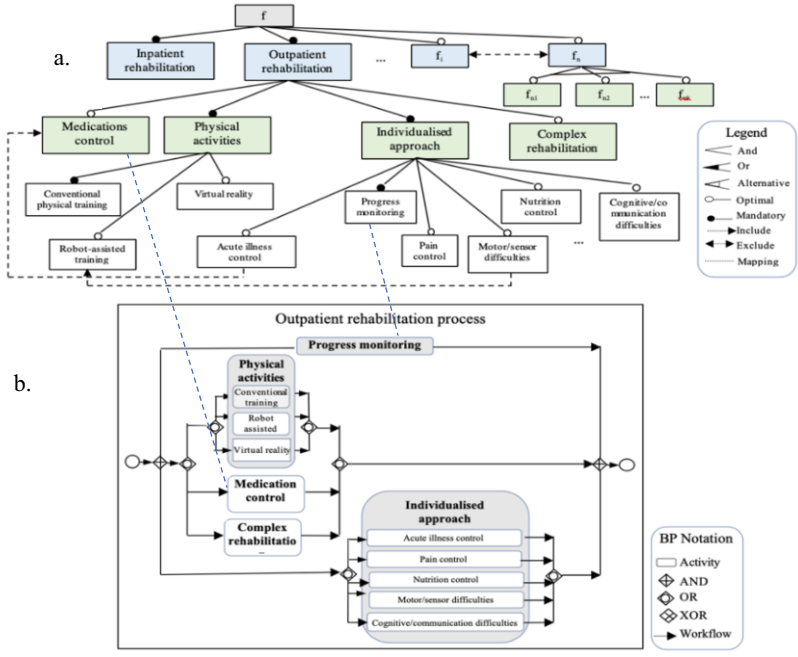

Figure 1. PCC services for stroke patients: a. feature model, b. corresponding outpatient rehabilitation business process model

The database applied for the experimental research consists of the registered stroke cases of the neurology department of Clinical Centre in Montenegro (structured records of 944 different patients, 58 variables, where 50 of them coded as scale values of [1,2,3] denoting "Yes, No, Unspecified" conditions, and 8 variables consisting of the demographic data, dates of admission and discharge from hospital). The experimental analysis aims to explore and provide insights for designing individualised PCC-approach based outpatient rehabilitation processes of the proposed model (Fig.1). The researched conditions, as prioritized by the experts of the medical centre, include outpatient rehabilitation monitoring, medication consumption control, and effect of smoking on health status of the stroke patients. The Spearman rank order correlation value of 0.39 suggests that significant number of patients are unable to perform prescribed physical therapy due to neurological effects of stroke. Therefore, the rehabilitation process planning has to be redesigned by inclusion assistance of medical workers, family or community members. The analysis for potential of IT-based control of regular medication consumption highlighted the age-related trend, e.g. 64,64% of patients using anticoagulant medication belong to highest age group (>70 years). The high risk of low acceptance of technologies in this segment reveals urgency of IT-based personalized monitoring process redesign. Due to the observed differences in recovering patterns of stroke patients, the neural network (NN) analysis is applied for the classification of the smoking and non-smoking segment (48.13% of cases) in relation to 13 variables of the

patient record, commonly applied for health monitoring. In Fig.2 the best NN models are reached classification precision of 70% in testing performance.

Select Models | Options

Index	Profile	Train Perf.	Select Perf.	Test Perf.
1	MLP 15:36-14-3:1	0,845666	0,697872	0,634043
2	RBF 14:35-68-3:1	0,742072	0,719149	0,689362
3	Linear 15:36-3:1	0,706131	0,744681	0,697872
4	MLP 15:36-14-3:1	0,866808	0,693617	0,617021
5	PNN 16:37-473-3:1	0,894292	0,651064	0,642553
6	RBF 13:34-45-3:1	0,767442	0,710638	0,702128

Figure 2. Neural network performance for classification of "smoke" and "not smoke" segments

The sensitivity analysis ranked the variables by their influence to classification: 1)Past stroke 2)Stroke type SAH, 3)Age group, 4)Stroke type HEM, 5)multimorbidity condition high cholesterol, 6)neurological condition of speech disorder, 7)Stroke type ISHEM 8) Stroke type UNSP, 9)Days at hospital, 10) Paresis, 11) Atrial fibrillation, 12) Hypertension, 13) Deep vein thrombosis. The relatively low influence of the variables (max ratio value 1.08) revealed necessity of detecting more powerful indicators, able to detect risk effects of smoking and to be consistently captured with the help of IT .

4. Discussions

The presented research provides basis for personalised health monitoring of stroke patients in Montenegro, which enables prioritization and redesign of the suggested PCC services (Fig.1). The advantages if the suggested model-driven approach include: (i) re-use of the model for PCC service design in different institutions, (ii) measure changes over time due to the factors, having impact to the delivery of care (iii) measure impacts to quality of care and delivery of services to stroke patients, (iv) respecting patient's and family's opinion about his/her health and suggested health services.

5. Conclusions

In this paper, we have explored the impact of the model-driven approach for applying concept of PCC for ensuring quality of care in stroke rehabilitation. The experimental research provided insights for process redesign based on individualised health monitoring. However, the future work for the implementation of the suggested concept in real settings is planned for comprehensive evaluation and refining the model.

References

[1] Ekman I et al., Person-centred care- Ready for prime time, European Journal of Cardiovascular Nursing 10 (2011), 248-251.
[2] Hubbard IJ et.al., Adherence to Clinical Guidelines Improves Patient Outcomes in Australian Audit of Stroke Rehabilitation Practice, Archives of Physical Medicine and Rehabilitation 93 (2012), 965–971.
[3] Winstein CJ et al., Guidelines for Adult Stroke Rehabilitation and Recovery: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association, Stroke 47 (2016).
[4] Šendelj R, Ognjanović I, Multi-criteria Decision Making for Optimal Configuration of Business Process Model Families, Information technology and control 47 (2018), 532-563.
[5] Reed MC et.al., Developing stroke rehabilitation and community services: A meta-synthesis of qualitative literature, Disability and Rehabilitation 34 (2012), 553–563.