

# Influence of NYHA Classification of Heart Failure Patients for Assessing Telemedical Applications and Services by Using a Discrete Event Model

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**Abstract.** The double aging effect causes new challenges to public health care systems. New solutions in health care such as telemedical applications and services can be essential for reducing the future financial burden. However these intervention programs have to be evaluated. For that reason a detailed discrete event model has been developed, which allows to compare medical outcome and incurred costs of different interventions for heart failure patients. The model takes account of outpatient care as well as inpatient care to analyze costs, mortality and attribution to NYHA class of the patients. Based on this, different scenarios can be simulated and analyzed to develop sustainable health care solutions. The results show that telemedical care and disease management have the potential of cost savings.

## 1 Introduction

The demographic development shows that the proportion of people over the age of 60 increases enormously, which challenges public health care systems. Even the prevalence of patients with the clinical syndrome of heart failure (HF) will rise considerably in the next years. Moreover epidemiological data shows that heart failure is the leading cause for hospitalizations regarding patients older than 65 years [1]. It is clear that new strategies for patient management or new methods of medical care such as the possibility of telemedical treatment can be essential for the reduction of the future financial burden. For that reason a simulation model was developed, which allows to compare medical outcome and incurred costs of conventional medical care and different interventions, like disease management programs or telemedical treatment of heart failure patients.

## 2 Methods

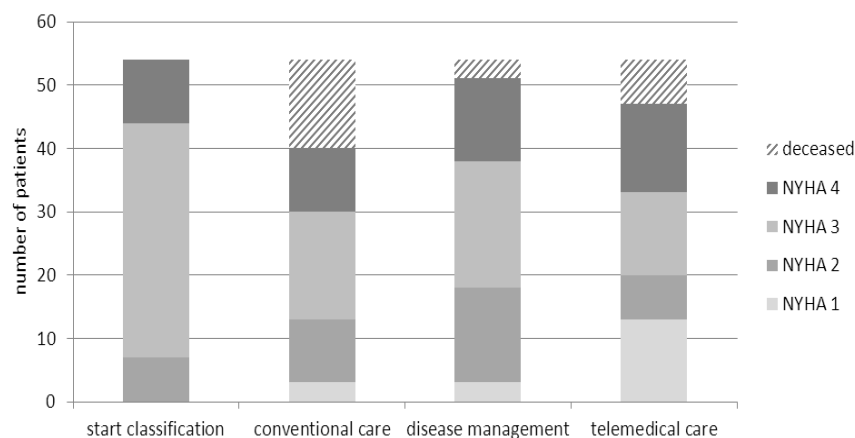
For modeling the discrete event technique was used, where objects and resources are utilized to describe the treatment procedures. The model takes account of outpatient care as well as inpatient care to analyze total costs, mortality and attribution to

NYHA (New York Heart Association) class of the patients. The concept is based on four modules, whereas patients are treated in one of the 4 implemented NYHA classes [2]. Depending on the NYHA class of the patient, the implemented probabilities for decisions regarding different events in the model change. The more severe the heart failure is, the higher the chances for negative events are. Three different scenarios were simulated. A disease management program with care of a physician and additional costs for patient education, a telemedical care model and finally the conventional medical care were compared in this work. The simulation time was 5 years and the simulated study group contained 54 patients based on previous scenarios.

The validation of the model was performed using the “V-model” development process. In the verification phase it was proven that implementations in each module represent the predefined specifications. The validation process of determining to which degree the simulation results represent real study results was based on the MOBITEL study [3]. Therefore the study group for the validation scenario contained 54 patients classified with different NYHA groups (13% NYHA 2, 69% NYHA 3, 18% NYHA 4), which fitted exactly the study group of this clinical study.

### 3 Results

The simulated scenarios show that conventional medical care appears not to be the most expensive treatment. However telemedical care and disease management have the potential of cost savings, which strongly correlate to the assumptions in the model, like the distribution of NYHA patients at the beginning and their probability of improving or worsening health status during interventions, which is indicated by changing the NYHA class.



**Fig. 1.** Distribution of the patients regarding their NYHA class after 5 years of simulation time referred to the distribution of the patients at the beginning of the simulation (left bar).

Fig. 1 shows the distribution of the patients regarding their NYHA class after 5 years of simulation time referred to the distribution of the patients at the beginning of the simulation (start classification on the left). It can be seen that the simulated study group ends up with completely different distributions, for example both interventions show higher survival rates compared to the conventional treatment. These results have to be further investigated especially with regard to the overall treatment expenses

## 4 Conclusions

The developed model provides the opportunity to simulate various scenarios, whereby cost estimations for future health care solutions can be compared with each other. For the first time not only the occurring total costs, but also the distribution of the patients in regard to their NYHA classification after the intervention were observed and analyzed, which is essential to develop sustainable health care solutions considering the severity of symptoms.

## References

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