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# Prospective Assessment of an innovative test for prostate cancer screening using the VITA process model framework

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**Abstract.** Healthcare innovations are crucial for enhancing patient treatment and a high-quality healthcare system. However, bringing new technologies, methods and procedures into the healthcare market is challenging. Enormous amounts of financial, personnel and organizational resources are required with no upfront certainty for the medical and economic benefit. A new and innovative approach uses interdisciplinary medical, technical and economic expertise to forecast effects of healthcare innovations already at the early research and concept phase of an idea and before major investments are made. A process model framework was developed to operationalize this structured assessment of healthcare innovations. The Visionary Iterative Tailored Approach (VITA) is based on conceptual modeling, simulation and health economics evaluation. Its application for the prospective assessment of an innovative prostate cancer screening is presented.

**Keywords.** Conceptual modeling, simulation, health economics evaluation, decision making, healthcare innovation, prostate cancer screening

## Introduction

Prospective Health Technology Assessment (ProHTA) is a new approach of so-called technology forecasting using simulation and health economics evaluation to assess healthcare innovations [1]. In order to prevent misinvestments the resource intensive development of healthcare innovations is addressed at the early concept and research stage before major investments have been made. Assessing the innovations future impact on the healthcare system supports decision making for either optimizing or early aborting development processes.

This new and innovative approach involves data and information on prevention, treatment and care next to demographic and epidemiologic information as well as costs.

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Interdisciplinary stakeholders with medical, technical, economic and entrepreneurial knowledge and expertise work closely together. The challenge is to capture this broad and vast knowledge in order to prepare data and models for the simulation. A structured approach becomes fundamental to consolidate complex settings and interdisciplinary stakeholders with different knowledge and views as well as to support service delivery for healthcare decision making.

Therefore, we developed a structured framework for the prospective assessment of healthcare innovations called the Visionary Iterative Tailored Approach (VITA). Two case studies to assess healthcare innovations, one for acute ischemic stroke treatment and one for prostate cancer screening, were used to develop the VITA framework. In the following the VITA process model framework is presented together with an exemplary application for the prospective assessment of an innovative test for prostate cancer screening.

## 1. Methods

VITA is based on process models from software engineering combined with project management principles and adjusted to the healthcare simulation context. Based on conceptual modeling to bridge the real world with the simulation model world, medical knowledge and economic figures are transformed into executable simulation scenarios. The simulation results are analyzed by health economics evaluation in order to support decision making in healthcare. It was developed in the course of a prospective assessment of mobile stroke units for acute ischemic stroke treatment [2]. An analysis and process model benchmark helped to revise and to adjust the initial approach, leading to a comprehensive process model framework. An overview of the VITA

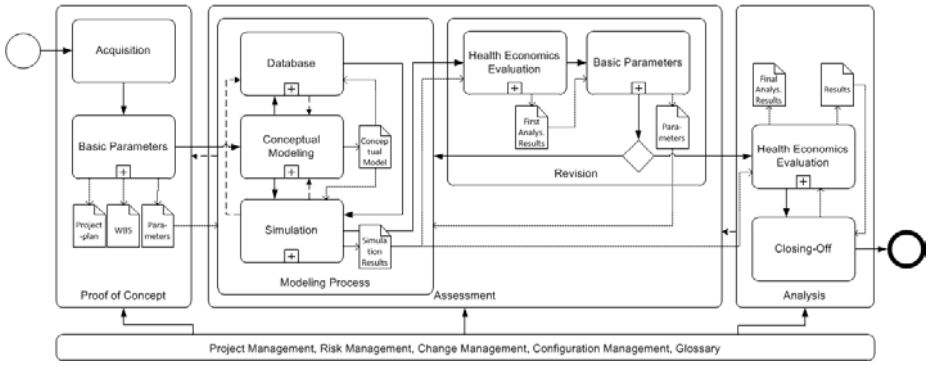


**Figure 1:** VITA process model framework

framework is given in Figure 1.

The *proof of concept phase* starts with the acquisition of an idea for a healthcare innovation, and first checks the feasibility of the assessment needs. A positive prospect triggers the *assessment phase* based on defined basic parameters such as objective, time, costs and participants. Subsequently a conceptual model is developed together with a knowledge database to prepare the simulation [3]. Based on the first simulation output a basic health economics evaluation is accomplished to check model and simulation. In case of adjustments to the basic parameters (especially input and output specifications) an iteration of the modeling process is initiated. Although more than one iteration is

possible it is not preferred due to economic reasons (time, costs and personnel). The final *analysis phase* can be accomplished, if no (further) revision is carried out. A thorough health economics evaluation of the latest simulation output is performed to achieve the assessments objective, respectively to answer the research question. The result of the analysis is thereby not a simple Yes or No in favor or against an innovation but rather a detailed evaluation and calculation of advantages, benefits and drawbacks within the healthcare context.

The whole process model framework as outlined in Figure 1 is described in narrative text with generic templates for project management (e.g. project plan, work breakdown structure), modeling (graphic notation, Word and Excel templates for data structuring) and simulation (computer code for e.g. demography) representing a comprehensive guideline. VITA supports a structured team process to ensure correctness, understandability, usefulness and applicability for all interdisciplinary stakeholders throughout the prospective assessment of a healthcare innovation.

## 2. Results

In the following, the application of VITA for the assessment of an innovative biomarker for prostate cancer (PCa) screening is described. PCa is the second most frequently diagnosed cancer in men worldwide [4]. The prognosis of the cancer, i.e. the patient's outcome, depends on the tumor stage at diagnosis. Thus, early detection is crucial for prostate cancer therapy. But PCa screening based on the prostate specific antigen (PSA) is a controversial issue [5]. Due to a high sensitivity but low specificity of the PSA test, prostate cancer screening became infamous for overdiagnosis and overtreatment next to increasing costs of care [6]. A PSA-complementary test with high specificity could help to increase screening benefits (early tumor detection) beyond harms (painful interventions and adverse effects).

The initial objective of our PCa case study was defined as: "What specificity is required of a PSA-complementary test in order to facilitate comprehensive and evidence-based statutory PCa screening in Germany?" The proof of concept phase revealed, that this initial question was too general. PCa treatment is complex and data and information on the various treatment options are insufficient or not available. Therefore, the objective was refined to differentiate between overdiagnosis and overtreatment, first of all concentrating on early PCa diagnosis to the point of prostate biopsy. The revised objective was defined as follows: "What are the cost savings that can be achieved by reducing the number of false positive biopsies in combination with avoided complications, depending on the variable specificity of an innovative PSA-complementary test when PSA $\geq$ 4 ng/ml?" In order to answer this question, a hypothetical prostate cancer screening workflow developed. It is based on prostate cancer prevention in Germany [7] and extended with an innovative PSA-complementary test.

Within the assessment phase, the conceptual model was derived from clinical guidelines and medical journals predominantly listed in PubMed. Scientific information and data for prostate cancer diagnosis as well as expert knowledge on patient behavior is supplemented by information on screening programs, statistical data and health related costs. Epidemiologic as well as demographic data on men aged between 45 and 80 years is received from the Federal Statistical Office in Germany [8]. Costs considering medical examinations and biopsy diagnosis are calculated referring

to the doctor's fee scale from the German National Association of Statutory Health Insurance Physicians [9]. Costs of follow-up treatment due to medical complications of biopsies were calculated considering literature from the review.

Sensitivity, specificity and costs of the innovative test are variable input parameters to the simulation scenarios. As output parameters we defined the number of prostate biopsies together with total costs for PCa screening including the innovative test. Thereby the number of biopsies are on the one hand calculated for solely PSA-based screening and on the other hand for the innovative screening supplemented with the PSA-complementary test. Regarding costs, savings due to avoided biopsies and biopsy complications are calculated together with additional costs for the innovative test.

The simulation is implemented as hybrid system-dynamic and discrete-event simulation. Executing the simulation with the innovative screening program for 10 years in Germany and studying three different specificities of the innovative test (70%, 80% and 90%) as well as three different costs (20€, 50€ and 100€) revealed cost neutrality of the innovative screening (compare Figure 2).

The analysis phase showed that the innovative prostate cancer screening is cost-effective at costs of 20 Euro and a specificity of at least 70% for the innovative test. For costs of 50 Euro a specificity of 80% is needed to be at least cost-neutral and with costs of 100 Euro the innovative screening would not be cost-effective even with a specificity of 90%. Higher specificity values are assumed to be not realistic. Further health economics evaluations can be calculated based on the simulation results.

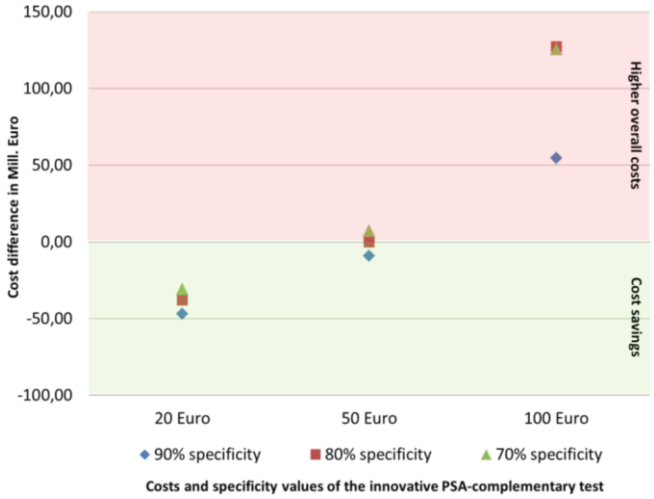


**Figure 2:** Results of the prostate cancer case study

## 3. Discussion

Our simulation showed that it is possible to improve screening results by complementing PSA-testing with an additional, innovative test. However, to support screening evidence, also the impact of an innovative PSA-complementary test on overtreatment needs to be assessed. Therefore an extension of the scenario towards staging and therapy is required. Nevertheless, a PSA-complementary test could help to

support evidence for prostate cancer screening by showing that unnecessary (false positive) biopsies can be reduced and thus costs can be saved.

Using the Visionary Iterative Tailored Approach enabled us to successfully consolidate an interdisciplinary team for the prospective assessment of a healthcare innovation. The VITA framework supported our close collaboration with different expertise and views on data, models, simulation and health economics evaluation throughout the process. Future research will now concentrate on assessing further case studies in cardiology and breast cancer treatment to use and improve the VITA process model framework. Furthermore, a thorough business plan for the prospective assessment of healthcare innovations is underway to optimize service delivery in healthcare decision making.

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