Prototypical Implementation of a Decision-supporting System for Operative Breast Cancer Therapy

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Abstract: Based on the current edition of the German guideline on Screening, Diagnosis, Treatment and Follow-up of breast cancer, we created a patient journey modelled in BPMN (Business Process Model and Notation V2) serving as template for the development of a patient centered decision support system. This approach resulted in two prototypical devices represented by a web-based information platform and a mobile application, intended to support the decision support at the point of care. These early prototypes were discussed with a clinical expert and the members of a regional breast cancer self-help group. The information gained by this approach will be integrated in the further user centered design of the devices.

1 INTRODUCTION

The advent of computer assisted clinical decision support goes back to the early 1960s (Shortliffe, 2018). Since then scientists and clinicians have undertaken numerous efforts to create various systems in order to improve the quality of clinical decisions, enhance their transparency and increase the number of guideline conform decisions, resulting not only in patient centered decisions but also enabling patients to engage in the process of shared decision making (Middleton 2016, Beeler, 2014). Despite these efforts, decision support systems are failing to be introduced into daily routine for a number of reasons. Among other reasons, a suspected negative influence on the physician-patient relationship, the extra time spent to utilize the system or that the system could not be integrated into the routine workflow, were named (Kilsdonk, 2017). On the other hand, factors in favor of using computerized decision support systems are seen in systems that e.g. fit with routine care and provide recommendations at the point of care (Kilsdonk, 2017). In order to address at least some of these requirements we analyzed the current guideline on Screening, Diagnosis, Treatment and Follow-up of breast cancer of the German Cancer Society (Wöckel, 2018). Based on our results we developed an early prototype of a clinical decision support system, which should not only serve clinicians but also support patients and their relatives.

2 METHODS

On the basis of the German S3 guideline on Screening, Diagnosis, Treatment and Follow-up of Breast Cancer, a patient journey as a process model for breast cancer was extracted and modelled in BPMN (Business Process and Model Version 2.0) as described previously (Andrzejewski, 2015, Andrzejewski, 2017). This resulted in the definition of several important decision nodes, which were then examined for their specific, decision relevant parameters. These factors consisted of the Tumor seize, axillary lymph nodes involved (N-status), distant metastasis present or absent (M-status), the tumor grading, the (clinical) breast to tumor relation, estrogen and progesterone receptor status, the HER-2 status, the Ki-67 status and finally whether the patient was pre- or postmenopausal (Fig. 1). In contrast to our previous work, Ki-67 was newly introduced as relevant decision factor in the 2018 edition of the guideline, which forced us to redesign our process models. The aforementioned factors were then used

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to create a decision matrix, which however resulted in more than 140,000 individual combinations.

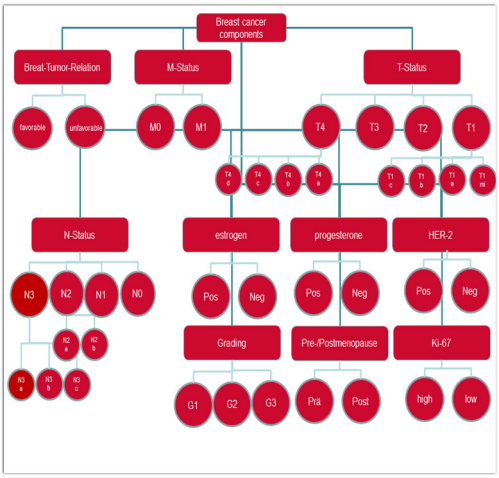

Figure 1: Factors in the treatment of breast cancer.

We thus restricted our preliminary efforts to re-generate our computer-based decision support system to the factors necessary to make a transparent decision concerning surgical treatment only. Tumor size and the clinical breast to tumor-relation were identified as the two essential factors concerning decisions on surgical treatment. In the following short matrix, the possible outcomes for four of the eight different possible combinations are shown.

Table 1: Decision matrix for the surgical treatment.

T-Status	T1	T2	T3	T4
BTR	G	G	G	G
Neo	-	-	Opt	+
Treat	BCT	BCT	BCT	BCT / (Mast)
Radio	+	+	+	+ /Opt
Adju	+	+	+	+

The abbreviations in the table in order of appearance are: T-Status: the size of the tumour;
BTR: Brest-Tumor-Relation, the size of the breast in relation to the tumour;
G: good or rather favourable;
Neo: neoadjuvant system therapy;
Opt: optional;
Treat: surgical treatment;
BCT: breast conserving surgical therapy;
Mast: mastectomy;
Radio: radio therapy;
Adju: adjuvant system therapy.

Based on these combinations and the resulting actions to be recommended, we created a prototype of a rule-based decision support system. A decision support system is defined by Keen und Scott-Morton (Keen, 1978) as:

"Decision Support Systems (DSS) represent a point of view on the role of the computer in the management decision-making process. Decision support implies the use of computers to:

- Assist (managers) in their decision processes in semi structured tasks
- Support, rather than replace, (managerial) judgement
- Improve the effectiveness of decision-making rather than its efficiency".

Our decision support system is aimed to assist patients in a complex process of medical decisions by delivering recommendations with very little input. This rule-based system was primarily implemented as an app, which advocates the respective operative intervention, once the relevant factors are entered. The app was built with the MIT App Inventor as a fast prototype and to use with the treating doctor for a shared decision making in a consultation meeting. Also, a website with the same functions, built in JavaScript and HTML was designed. After the development of these prototypes, they were presented to a health care professional and a former breast cancer patient for a preliminary evaluation of the system. As a second step, we presented the application and the website at the annual meeting of the regional cancer self-help group Berlin/Brandenburg.

3 RESULTS

To generate the best decision support for breast cancer patients, the precise diagnosis and all relevant clinical and personal factors which may affect the choice of treatment should be known. A newly diagnosed patient, who in our view is most likely in need of a decision support system, will not necessarily be aware of all these data. By focusing on the factors mentioned above which were derived from the S3 guideline we created the prototype of an evidence-based decision support platform. Our aim was to test if it was possible to translate the medical guideline into a digital rule-based system, which is able to create relevant suggestions based on the information given by a patient. In Fig. 2 the patient journey, starting with the decision conflict between a mastectomy or a breast-conserving operation as initial surgical step, is visualized. In the first instance the tumor size is used to define the disease as early stage cancer or locally advanced tumor. Combined with the factor “breast to tumor relation”, this results either in a strait forward decision concerning the type

of surgical intervention or raises the question of a primary (neo-adjuvant) Chemotherapy. The latter could be applied in cases of locally advanced tumors or in early breast cancer with an unfavorable breast to tumor relation.

These respective decisions are based on the decision matrix shown in Tab. 1. The further process model then describes the consecutive steps of adjuvant chemo and/or radiation therapy once the operative intervention was carried out.

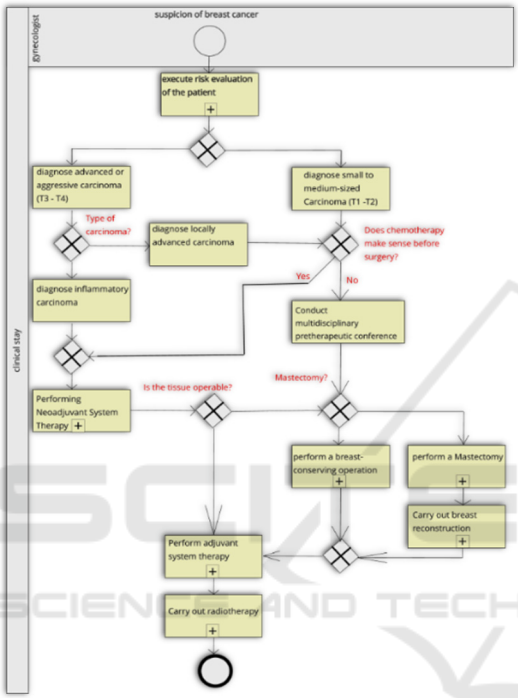

Figure 2: Process of the breast cancer treatment.

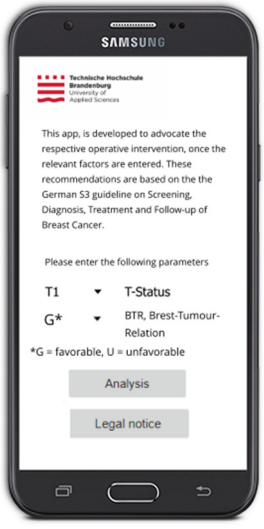

Figure 3: Screenshot of the app.

Most of the modelled tasks like the "perform breast-conserving therapy" are further detailed in various sub-processes, which however for the sake of clarity are not shown.

Based on these models and the previously mentioned decision matrix, two prototypes of a decision support system were developed. Figure 3 shows the app. The app was primarily designed in order to serve as a mobile device available for the evidence-based decision support at the point of care.

4 EVALUATION

In order to improve these first iterations of the applications, two interviews were conducted with a medical expert and a person affected by breast cancer. The recommendations extracted from these interviews were applied to further improve the prototypes before we presented them on the annual meeting of the regional cancer self-help group Berlin/Brandenburg. While the website was assessed as appropriate for making an informed decision, the app however raised major concerns. The approach to have a fast and mobile decision support system at hand, was viewed as a useful development. However, it was stated, that without a consultation with the treatment overseeing physician or another health care professional, the information given by the system could lead to confusion and insecurities, which would counteract to the expected result.

5 CONCLUSIONS

Based on the various tasks and decision nodes extracted from the S3 guideline on Diagnosis, Treatment and Aftercare of Breast Cancer we were able to map the complete clinical process, starting with the first suspicious findings and ending with the completion of adjuvant treatment utilizing BPMN. The complexity of the information provided in the guideline, however, constrained us in the first instance to restrict our efforts in developing a computer-based decision support system to the tasks related to the decisions concerning the operative intervention. Utilizing the TNM classification and the breast-to-tumor relation, we created a decision matrix. Based on these rather preliminary results, two applications were developed in parallel, a website that serves as a breast cancer information platform and an app that represents only the decision matrix. The website contains not only information about breast

cancer, but also user-controlled information paths that allow patients to navigate freely according to their individual information needs and thus receiving specific, patient centered information. These pathways lead the users to the decision matrix in which they can enter their individual clinical data resulting in a suitable recommendation.

In summary, we developed two prototypical systems, which were designed to support the decision-making process in breast cancer. These prototypes, however, will have to be tested by independent experts on the basis of a larger number of realistic case reports. By applying the best available evidence for the diagnosis and treatment of breast cancer, represented by the S3 guideline we are convinced, that our systems could not only help to increase the number of guideline conform decisions in the near future, but could also help to improve the patients knowledge and thus assist in shared decision making.

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