

Evaluation of the implementation of Value-Based Healthcare with a weekly digital follow-up of lung cancer patients in clinical practice

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# Evaluation of the implementation of Value-Based Healthcare with a weekly digital follow-up of lung cancer patients in clinical practice

## **ABSTRACT**

### **Objective**

The aim of this study was to evaluate the implementation of Value-Based Healthcare principles for lung cancer patients in a large Belgian hospital. This hospital implemented a digital platform for the collection of patient-reported outcomes and the standardization of care pathways. Also, a follow-up by the multidisciplinary care team was put in place.

### **Methods**

Evaluation was done by employing a mixed method approach with data-analysis of all included patients (n=201), a pilot study (n=30), and semi-structured interviews with the care team (n=5).

### **Results**

Overall, 95% of all lung cancer patients of two thoracic oncologists agreed to participate in the digital follow-up during the period January 2018–September 2020 (201 participating patients). The response rates of those patients were high: 92% of the weekly questionnaires and 90% of the 6-weekly ICHOM questionnaires were responded. Based on the pilot study, we conclude that questions are clear and the platform is user-friendly for 90% of patients in the pilot. The interviews revealed that the weekly follow-up has a positive impact on the patient–provider communication and makes it easier to discuss psychological and palliative care needs.

### **Conclusion**

This study shows a successful implementation of Value Based Healthcare with weekly digital follow-up.

### **Key words**

Lung Cancer – Quality of life – Quality of care – Needs Assessment – Patient Reported Outcome Measures

## **Introduction**

Lung cancer is a serious and common type of cancer that has very low survival rates. Both in Belgium and in Europe overall, lung cancer was the most frequent cancer-related cause of death in 2016. Patients with lung cancer often face a high burden, with disease- and treatment-related symptoms that have a high impact on their quality of life. Both physical and psychosocial problems are often under-recognized by physicians or not expressed by patients (Laugsand, Sprangers et al. 2010, Ugalde, Ugalde et al. 2012, Atkinson, Ryan et al. 2016).

Patient-reported outcome (PRO) measures are increasingly used in clinical practice to detect those physical and psychosocial problems, to improve symptom control, to track patient progress and to enhance communication with patients (Chan, Edwards et al. 2019). A PRO can be defined as “a

measurement based on a report that comes directly from the patient about the status of a patient's health condition, without amendment or interpretation of the patient's response by a clinician or anyone else" (FDA 2009). In a randomized controlled trial on symptom monitoring with PROs during routine cancer treatment including lung cancer, the weekly collection of PROs resulted in an improved health-related quality of life, a reduction in emergency room admissions and hospitalizations and quality-adjusted survival (Basch, 2016). Furthermore, multiple systematic reviews have provided strong evidence that the use of PROs improves symptom control (Kotronoulas, Kearney et al. 2014), patient-provider communication (Chen, Ou et al. 2013), and patient satisfaction (Chen, Ou et al. 2013) (Kotronoulas, Kearney et al. 2014). PROs are often collected by a digital health solution. Research shows that the benefits of PROs are not only obtained by the assessment of outcomes, but also by the appropriate management of the responses. Therefore, these digital health solutions need to be integrated into healthcare team practices (Aapro, Bossi et al. 2020).

Value-Based Healthcare (VBHC) aims to maximize the value for patients by achieving the best outcomes at the lowest cost (Porter and Lee 2013). Cossio-Gil, Omara et al. (2021) see 4 important areas in the roadmap for implementing Value-Based Healthcare: (1) Organize care pathways, (2) collect a set of outcomes, including clinical outcomes and PROs, (3) build an information platform and (4) actively use short-term and long-term outcomes for clinical decision and for improving care. Inspired by the principles of VBHC, a large Belgian hospital decided to optimize the care delivery for lung cancer patients. Therefore, they focused on those 4 areas and standardized care pathways, defined outcomes and implemented a digital platform for the collection of clinical outcomes and PROs. Also, a follow-up of the PROs by the multidisciplinary care team was put in place.

Recent reviews concluded that future research should assess the applicability of PROs in routine clinical practice (Aapro, Bossi et al. 2020, Cavanna, Citterio et al. 2020). Therefore, the present article presents the results of a study conducted to evaluate the digital collection and follow-up of PROs. The aim of this research is to improve the knowledge on optimizing the care delivery by using PROs in routine clinical practice.

## **METHODS**

In this section we will first discuss the methods used for the evaluation of the digital follow-up of lung cancer patients in a large Belgian hospital, and then elaborate on the implementation process that has been evaluated.

### **A. Methods used for the evaluation of the digital follow-up of lung cancer patients**

For the evaluation, we used the Framework for Implementation Outcomes Proctor, Silmere et al. (2011), which is composed of eight types of Implementation Outcomes: feasibility, acceptability, adoption, appropriateness, fidelity, implementation cost, penetration, and sustainability.

### **Study design**

The evaluation was conducted employing a mixed method approach by: (1) data analysis of all included patients in the digital platform for the period January 2018–September 2020, (2) a pilot study on the feasibility and (3) semi-structured interviews with the care team.

#### **1. Data analysis of all included patients**

The digital collection and follow-up of PROs started in January 2018 for all lung cancer patients treated by the two thoracic oncologists working on the main campus of the hospital. To evaluate the

implementation, data on response rates, alerts, and patient characteristics were collected of all included patients during the period January 2018–September 2020.

## 2. Pilot study

A pilot study for 30 patients was set up during the period from February to December 2019 to evaluate the feasibility of the digital weekly follow up of PROs. For reasons of comparison and consistency, only patients at the start of their Stage IV treatment were recruited in this pilot. The study period lasted six months, from the start of the Stage IV treatment. Patients at the start of their Stage IV treatment were asked by the oncology nurse to participate. Patients were eligible if they were diagnosed with Stage IV lung cancer, spoke sufficient Dutch, and were willing to participate. Patients were randomly assigned to two arms by simple randomization. In the intervention arm, 15 patients received a weekly questionnaire. Alerts were sent to the multidisciplinary care team, who undertook follow-up actions. In the control arm, 15 patients received the standard care pathway without weekly questionnaires and without automatic alerts to the care team. The standard care pathways and the care team were the same in both groups.

In this pilot study, the weekly follow-up was evaluated in three different ways to ensure that all the relevant information was gathered through various channels. (1) At the beginning and end of the study period, patients in the intervention arm received a validation questionnaire. (2) In addition, five patients in the intervention arm were interviewed in a semi-structured way in June 2019. (3) The care team in the hospital registered the workload of the team for all included patients in the pilot study during these six months. They registered all contacts with the included patients, such as phone calls, consultations, multidisciplinary team meetings, and emails and the time spent on every contact in both arms.

## 3. Semi-structured interviews care team

Subsequently, one researcher conducted semi-structured interviews with five members of the multidisciplinary care team in June 2020 – namely, an MD thoracic oncologist, oncology nurse, psychologist, palliative support, and dietician. This way, a breadth of professional perspectives was included in the interviews. The questions of the interviews are included in the supplementary information.

## Data analysis

The outcomes were analyzed using descriptive statistics and calculations were performed in Excel. Subsequently, Stata was used to analyze the correlation between the response rates and alerts generated and the patient characteristics.

## Ethics

The study protocol was approved by the Medical Ethical Committee of the hospital. Participants in the pilot study provided written informed consent. The dataset for the analysis of the response rates during the period January 2018–September 2020 only contained pseudonomized data.

## B. Implementation process of VBHC with weekly digital follow-up of PROs

The implementation process consisted of three important milestones. First, in January 2017, a multidisciplinary care team was set up and standard care pathways were defined for every stage of the disease and type of treatment. Second, in January 2018, the care team started to use a digital platform for the collection of PROs and the standardization of care pathways. Third, in February 2019, the care team started with the adapted version of the weekly questionnaire based on the international standard PRO-CTCAE.

Figure 1 provides an overview of the implementation milestones and the sequencing of the activities performed to evaluate the implementation.

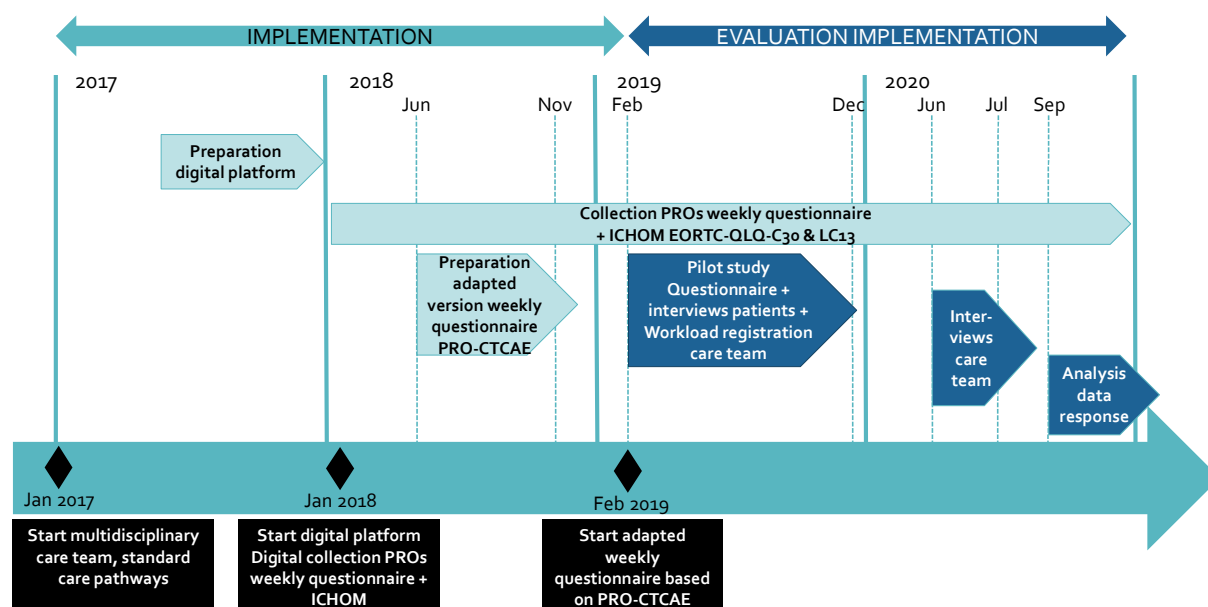


Figure 1: Implementation milestones and overview of methods for evaluation

#### Multidisciplinary care team and standard care pathways

A multidisciplinary care team was introduced for the follow-up of the treatment. This care team consists of two MD thoracic oncologists, a dietician, a psychologist, a dedicated lung cancer oncology nurse, two nurse unit managers and pastoral, palliative, and social support. During weekly team meetings, every new diagnosis, as well as specific cases or messages from the weekly digital follow-up of PROs that need attention, are discussed.

The care team defined standard care pathways for every stage and type of treatment in 2017. Figure 2 shows an extraction from these standard care pathways. Agreements were made about the sequencing of activities: appointments with different physicians (thoracic oncologist, general practitioner (GP), surgeon, radiotherapist, etc.), diagnostics, registration of clinical outcomes, digital questionnaires, etc. Also, the role of the GP was made clearer in the care process. Previously, the role of the GP had not been clearly defined and patients always contacted the hospital in case of questions. Now, in the overview of care activities, patients can see when they need to visit the GP. Also, patients are advised to contact the GP first in case of adverse events; in this way, the GP is involved in the whole care process of lung cancer patients.

## Care pathway Thoracic Oncology – 1<sup>st</sup> line treatment

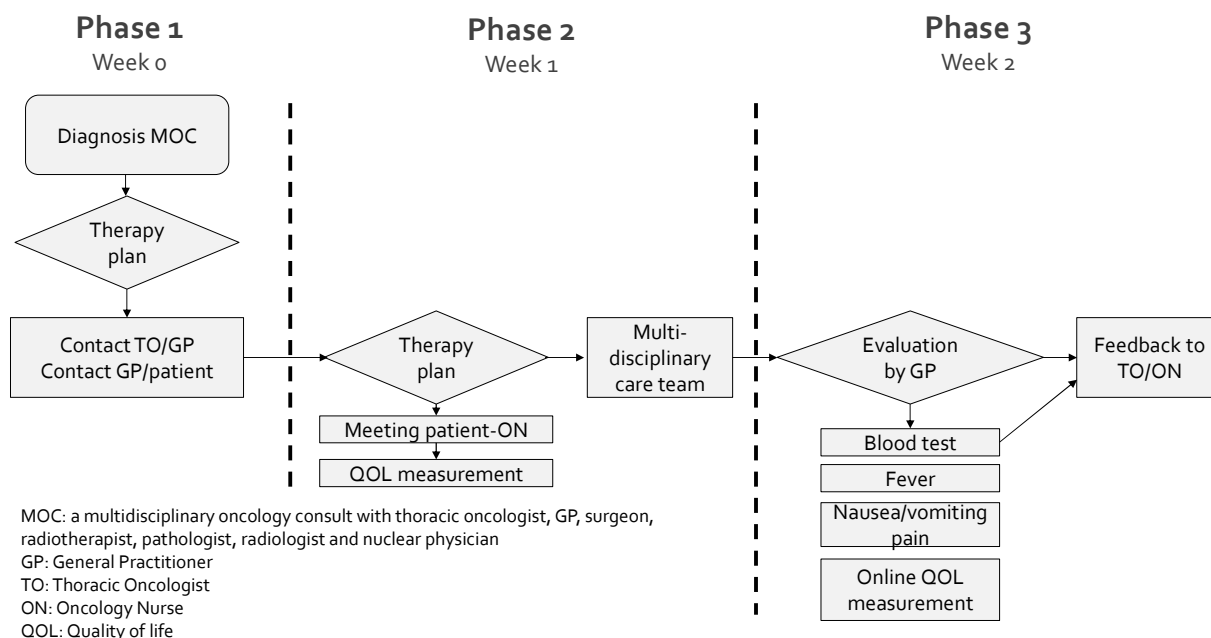


Figure 2: Extraction from the standard care pathways

### Digital collection of PROs

#### Method of data collection

Since 2018, the standard care pathways are supported by a digital platform developed by a private company (Awell Health). This platform enables the digitalization of care pathways and the collection of PROs by e-mail. The oncology nurse provides a personal introduction to every patient at the start of the treatment. A telephone follow-up by the oncology nurse is also in place in case of non-response.

#### Content of data collection

##### WEEKLY DIGITAL QUESTIONNAIRE: ADVERSE EVENTS AND PSYCHOSOCIAL CARE NEEDS

At the start of the digital follow-up (January 2018), the care team implemented a weekly questionnaire based on their own experience with lung cancer care. As time passed, they decided to adapt the questionnaire and to use an internationally validated instrument. Based on a literature search, the researchers decided to use the PRO-CTCAE, a library that represents 78 symptomatic toxicities for weekly symptom monitoring of patients with cancer. The reasons for this choice were: international use, validation per item performed, and scientific evidence for improvement (Basch, Deal et al. 2016, Denis, Basch et al. 2019).

The adapted weekly questionnaire was developed by the authors of the manuscript, three of which are working at the hospital and was implemented in February 2019. The selection of the items of the PRO-CTCAE was based on a literature search on the most common or threatening events for lung cancer (Mok, Wu et al. 2009, Reck, Rodríguez-Abreu et al. 2016, Soria, Ohe et al. 2018). The selected items were: mouth/throat, nausea, vomiting, constipation, diarrhea, shortness of breath, cough, rash, general pain, fatigue, anxious, discouraged state, and sadness.

As patients suffer from psychological, spiritual, palliative, social, family-related and financial needs (Temel, Greer et al. 2010, Maguire, Papadopoulou et al. 2012, Ugalde, Ugalde et al. 2012), the care team decided to add some extra questions on these topics. The list of all questions and alerts generated is integrated in the supplementary information.

#### ICHOM LUNG CANCER OUTCOME SETS

The care team also collects the ICHOM outcome data for lung cancer. The PROs in the ICHOM standard set for lung cancer (ICHOM 2017) are tracked by EORTC QLQ-C30 and its lung cancer-specific module EORTC QLQ-LC13. The EORTC questionnaires are collected by other hospitals in Belgium as well as abroad. The goal of the care team is to benchmark these results with other hospitals.

#### Follow-up of PROs

A follow-up is in place for the weekly questionnaire. The digital platform generates alerts by e-mail to the appropriate caregivers based on the responses of the patient. For every item, a threshold was defined to trigger an alert to the care team (see supplementary information). Along with the alerts, the care team has a visual overview of the weekly responses in the digital platform. Alerts are discussed on the weekly multidisciplinary team meetings and patients are contacted by phone or visited at the day care center during their visit by the appropriate care giver to follow up on the alerts. Also, the oncology nurse discusses the responses on the weekly questions with patients at every visit to the daycare clinic.

In Belgium, there is a e-health hub in place for the electronic exchange of messages between care givers (<https://www.cozo.be/ehealth>). The GPs receive the alerts of their patients within this e-health messaging system, next to all other messages of their patients, like blood results. These alert messages also include which therapy the patient receives and the possible side effects.

### **RESULTS**

#### **Patient characteristics**

Table 1 provides an overview of the patient characteristics of the patients included in the two arms of the pilot and of the other patients included in the digital platform. In all subgroups, the majority of patients are male (total = 79%) and the average age is around 70 years. Most patients have a high school diploma (total = 56%). Almost all patients have a WHO performance score of 0 (Able to carry out all normal activity without restrictions) or 1 (Restricted in physically strenuous activity but ambulatory and able to carry out light work). Most patients in all subgroups are diagnosed with a Non-small-cell lung carcinoma (total = 77%). At the start of the disease, most patients were diagnosed with Stage IV disease at outset or diagnosed with de novo metastatic disease (total = 50%). The majority were treated with chemotherapy or a combination of chemotherapy and immunotherapy.

**Table 1: Patient characteristics of included patients in the platform during the period January 2018–September 2020.**

	Pilot		Patients included in the platform, excl. pilot n=171 (%)	Total n=201 (%)
	Weekly questionnaire n=15 (%)	No weekly questionnaire n=15 (%)		
Gender				
Male	10 (67%)	13 (87%)	135 (79%)	158 (79%)
Female	5 (33%)	2 (13%)	36 (21%)	43 (21%)
Age				
Average (range)	67 (34-86)	70 (54-84)	69 (38-90)	69 (34–90)
30–39	1 (7%)	0 (0%)	1 (1%)	2 (1%)
40–49	0 (0%)	0 (0%)	7 (4%)	7 (3%)
50–59	2 (13%)	2 (13%)	21 (12%)	25 (12%)
60–69	5 (33%)	5 (33%)	60 (35%)	70 (35%)
70–79	5 (33%)	7 (47%)	59 (35%)	71 (35%)
80–90	2 (13%)	1 (7%)	23 (13%)	26 (13%)
Diploma				
Primary school	3 (20%)	3 (20%)	42 (25%)	48 (24%)
High school	10 (67%)	7 (47%)	96 (56%)	113 (56%)
Bachelor or higher	2 (13%)	1 (7%)	28 (16%)	31 (15%)
Unknown	0 (0%)	4 (27%)	5 (3%)	9 (4%)
WHO score (1)				
0	3 (20%)	2 (13%)	8 (5%)	13 (6%)
1	12 (80%)	13 (87%)	151 (88%)	176 (88%)
2	0 (0%)	0 (0%)	6 (4%)	6 (3%)
3	0 (0%)	0 (0%)	1 (1%)	1 (0%)
4	0 (0%)	0 (0%)	2 (1%)	2 (1%)
Unknown	0 (0%)	0 (0%)	3 (2%)	3 (1%)
Type of cancer (2)				
NSCLC	12 (80%)	9 (60%)	134 (78%)	155 (77%)
SCLC	3 (20%)	5 (33%)	32 (19%)	40 (20%)
Other	0 (0%)	1 (7%)	5 (3%)	6 (3%)
Stage of the disease at the start of the treatment (not the current stage)				
Stage I	3 (20%)	1 (7%)	9 (5%)	13 (6%)
Stage II	0 (0%)	1 (7%)	17 (10%)	18 (9%)
Stage III	2 (13%)	2 (13%)	59 (35%)	63 (31%)
Stage IV	10 (67%)	11 (73%)	80 (47%)	100 (50%)
Unknown	0 (0%)	0 (0%)	6 (4%)	7 (3%)
Type of systemic therapy received				
Chemotherapy	0 (0%)	8 (53%)	63 (37%)	71 (35%)
Immunotherapy	1 (7%)	0 (0%)	17 (10%)	18 (9%)
Chemo-immunotherapy	12 (80%)	5 (33%)	79 (46%)	96 (48%)
TKI	1 (7%)	0 (0%)	5 (3%)	6 (3%)
Combination of treatments (Chemo/Immuno/TKI)	1 (7%)	2 (13%)	7 (4%)	10 (5%)

(1) WHO- performance score:

0 – Able to carry out all normal activity without restrictions.

1 – Restricted in physically strenuous activity but ambulatory and able to carry out light work.

2 – Ambulatory and capable of all self-care but unable to carry out any work; up and more than 50% of waking hours.

3 – Capable of only limited self-care; confined to bed or chair more than 50% of waking hours.

4 – Completely disabled; cannot carry on any self-care; totally confined to bed or chair.

(2) NSCLC = Non-small-cell lung carcinoma; SCLC = Small-cell lung carcinoma (SCLC)



**Table 2: Analysis of response rates and retention of included patients in the platform during the period January 2018–September 2020.**

Feasibility	Administrative data (all patients, excluding pilot arm without weekly questionnaires), period January 2018–September 2020, n=186
Response on weekly questionnaires	
Weekly questionnaires sent (in total)	3,028
Weekly questionnaires responded (in total)	2,835
Percentage of questionnaires responded	92%
Response rates per patient: % of questionnaires responded per patient	
100% of questionnaires responded, n (%)	66 (35%)
90–99% of questionnaires responded, n (%)	44 (24%)
80–89% of questionnaires responded, n (%)	28 (15%)
70–79% of questionnaires responded, n (%)	13 (7%)
60–69% of questionnaires responded, n (%)	12 (6%)
50–59% of questionnaires responded, n (%)	9 (5%)
<50%, n (%)	3 (2%)
0%, n (%)	11 (6%)
Total, n (%)	186 (100%)
Average response rate/patient (%)	83%
Retention: average response rate per number of questionnaires sent/patient, in %:	
1 questionnaire sent (n = 10, 5% of patients)	30%
2–4 questionnaires sent (n = 42, 23% of patients)	70%
5–9 questionnaires sent (n = 41, 22% of patients)	88%
10–24 questionnaires sent (n = 53, 28% of patients)	90%
25–50 questionnaires sent (n = 29, 16% of patients)	92%
50–100 questionnaires sent (n = 11, 6% of patients)	98%
Response rates on EORTC questionnaires	
EORTC questionnaires sent (in total)	932
EORTC questionnaires responded (in total)	835
Percentage of questionnaires responded	90%
Average response rate / patient	88%

### Evaluation of outcomes

For the evaluation, we used the Framework for Implementation Outcomes (Proctor, Silmere et al. 2011) composed of eight types of Implementation Outcomes: feasibility, acceptability, adoption, appropriateness, fidelity, implementation cost, penetration, and sustainability. The feasibility was evaluated through (1) data analysis of all included patients in the digital platform for the period January 2018–September 2020, (2) a pilot study on the feasibility and (3) semi-structured interviews with the care team. The other implementation outcomes were evaluated through the interviews with the care team.

#### 1. Feasibility

We examined whether it is feasible for patients to participate in the weekly digital follow-up. Overall, 95% of all lung cancer patients of the two participating thoracic oncologists agreed to participate in the digital follow-up during the period January 2018–September 2020 (201 participating patients). For the analysis of the response rates (see Table 2), patients in the pilot arm without weekly questionnaire (n=15) were excluded. In total, for 186 patients, 3,028 weekly questionnaires were sent. 92% of these weekly questionnaires were responded by patients. These response rates are high for patients included during a long period in the digital platform (>90%). The response rates are lower for patients when only

a few questionnaires were sent. The researchers evaluated the patients with fewer than five questionnaires sent (n=52) to explain the low response rates of these patients. In this group, 28 patients had response rates lower than 75%. Reasons for the lower response rates were decrease of patient shortly after the start of the digital pathway (n=16), pause of the treatment (n=3) and recent start of the care pathway (n=3). For the 7 other patients the reason was unclear, 3 of them unsubscribed to the questionnaires. The response rates on the EORTC questionnaires are also high: 88% of the EORTC questionnaires are responded by patients. We investigated whether the patient characteristics (gender, age, diploma, WHO score, type of cancer, stage and treatment) were correlated with the response rates. None of them had a significant correlation ( $p>0.05$ ).

In the pilot study, patients filled in a validation questionnaire. Ten out of 15 patients filled in the questionnaire at the beginning of the study period and five at the end. Four patients passed away during the study period, which explains the lower response rate at the end of the study period. The majority (90%) of patients felt that this online system is easy to use. Most patients did not need support to answer the questions. In the validation questionnaire, two out of 10 patients stated that they needed help (see Table 3). The overall response rates of these two patients in the pilot study were 67% and 77%, which is lower than the overall average response rate of 83% (see Table 2). According to patients in the pilot study, the questions were relevant (70%) or moderately relevant (30%), and the questions were clear (90 %) and not difficult (80%).

**Table 3: Results from the patient validation questionnaire**

Question	At the beginning of the study period (n=10)		At the end of the study period (n=5)	
	N	%	N	%
How was your experience with the online system?				
Very difficult/difficult	0	0%	0	0%
Moderate difficult	1	10%	0	0%
Easy/very easy	9	90%	5	100%
Did you need help with filling in the questionnaire?				
Yes	2	20%	0	0%
Did you receive the help you need? (n=2): yes				
From whom? (n=2): friends and family				
No	8	80%	5	100%
How relevant did you find the questions?				
Totally not relevant/not relevant	0	0%	0	0%
Moderate relevant	3	30%	2	40%
Highly relevant/relevant	7	70%	3	60%
How clear did you find the questions?				
Very unclear/unclear	0	0%	0	0%
Moderately clear	1	10%	1	20%
Very clear/clear	9	90%	4	80%
How difficult did you find the questions?				
Very difficult/difficult	1	10%	0	0%
Moderately difficult	1	10%	0	0%
Not difficult at all/not difficult	8	80%	5	100%
Did you have other symptoms you wanted to report?				
Yes	3	30%	0	0%
Which symptoms? Arthralgia and myalgia (n=1), varying defecation (n=1), dry mouth (n=1)				
No	7	70%	5	100%

These findings were confirmed in the interviews with the care team. A small proportion of patients do not have the digital skills to fill in the questionnaires themselves. In this situation, a family member usually fills in the questionnaire. The oncology nurse estimates that in 15% of the cases a family member (partner/child) fills in the questionnaire. Those patients are often older (80+) and/or do not have access to the internet.

## 2. Appropriateness

We also evaluated the appropriateness of the digital health solution. In the interviews the multidisciplinary lung cancer care team stated that the defined standard care pathways are clear for the care team and that it makes planning of care activities easier. One improvement suggestion mentioned by the palliative support is that this support is not included in the standard sequencing of activities. Therefore, palliative support is often brought up only at a late stage of the disease. This could be improved by entering a standard moment in every care pathway where the care team needs to evaluate whether palliative support can be offered to patients. Furthermore, the caregivers mentioned that for some patients, the question on end of life and palliative concerns is confronting. Based on this feedback, the formulation of this question will be adapted.

## 3. Acceptability

All of the interviewed caregivers stated that the PROs facilitated the communication between the patient and the caregiver. In particular, the interviewed psychologist and palliative nurse declared that alerts are an important trigger to start a conversation on psychological and palliative support. In the pilot study, seven patients in the intervention arm with a weekly digital questionnaire had contact with the psychologist; four of them had more than one contact. In the standard care arm, only two patients had contact with the psychologist. This is an interesting finding and warrants further research with a larger sample. For palliative support, we could not see any difference between the standard care and the intervention arm in the pilot study.

## 4. Adoption

Most patients respond positively to the digital care pathway. Throughout the entire period (January 2018–August 2020), 95% of targeted patients are included in the digital platform and only 3 patients unsubscribed to the questionnaires.

## 5. Fidelity

During the implementation, some small adaptations were made to the questionnaire. A question was added so that patients could indicate if they did not want to be contacted by the care team. Also, an extra open field was added for patients to add remarks or other adverse events.

## 6. Implementation cost

Unfortunately, the lung cancer care team did not register the time spent for the implementation of VBHC with weekly follow-up. In the interviews, the care team members declared that they gained efficiency by the digital follow-up: consultations and visits can proceed in a more efficient and focused manner. Also, there was no expansion of the team because of the digital follow-up.

## 7. Penetration

Since 2021, the digital platform has also been implemented in the other campuses of the hospital for lung cancer patients. Also, the surgery care pathway for lung cancer patients was implemented. In

addition, the digital platform was also implemented for other pathologies in the hospital, namely COPD, breast cancer, IBD and prostate cancer.

#### 8. Sustainability

The thoracic oncologists were the driving forces behind the installation of the multidisciplinary care team, standard care pathways, and the implementation of the digital platform. In the interviews, this was appointed as a key success factor in the implementation process. The engagement of all members of the care team, especially the oncology nurse, from the start of the development process was also essential for successful implementation.

As a large part of the study was conducted in 2020, the COVID-19 pandemic had an impact on the digital follow-up. During the first COVID wave (March-April 2020), there was a high workload in the nursing department. As a result, the oncology nurse responsible for the digital follow-up was scheduled on a hospital ward. For this reason, alerts were not followed up properly and patients felt left on their own. In May 2020, the hospital decided to relieve all oncology nurses from extra duties and the follow-up could be reinstated.

### **DISCUSSION**

The aim of this study was to evaluate the implementation of value-based healthcare principles for lung cancer patients with the weekly follow-up of PROs. Our results provide several important lessons.

First, the digital health solution needs to be integrated into healthcare team practices, and responses should be appropriately managed, as was also recommended by Aapro, Bossi et al. (2020). In our case study, the care team evaluates the alerts during weekly team meetings and the appropriate members of the care team take relevant actions. Also, the thoracic oncologists use the PROs during consultations and the oncology nurse discusses the responses at every visit to the daycare clinic. This cycle of continuous feedback between patients and their care teams, guided by the digital PROs, seems to be crucial for successful implementation. In contrast to existing literature, the response rates in our study remain high (>90%) for the entire care process and we found no significant difference between patient characteristics (gender, age, diploma, WHO score, type of cancer, stage, and treatment) (Børøsund, Cvancarova et al. 2013, Berry, Blonquist et al. 2015, Cavanna, Citterio et al. 2020). Also, digital healthcare increased rapidly due to COVID-19 (Seixas, Olaye et al. 2021). In our case study, as the system was already implemented before COVID-19, the follow-up during the COVID-19 pandemic could be continued more easily in a digital way. The teleconsultations, introduced as a consequence of COVID, were structured around the responses on the digital platform.

Second, it is important that a multidisciplinary care team is put in place to respond to patients' clinical, psychological, palliative, financial, and family-related concerns. Our case study involved not only thoracic oncologists and nurses, but also a psychologist, a palliative care nurse, a nutrition specialist, and social services. This leads to a more holistic approach of patient care, rather than just focusing on the pure medical problems. We saw that the possibility to digitally report psychological problems, end-of-life discussions, and palliative needs led to a higher uptake of these issues. Also, Porter and Lee (2013) viewed this multidisciplinary team as an essential step in implementing VBHC. Furthermore, Prades, Remue et al. (2015) concluded that multidisciplinary team meetings (MDTs) resulted in better clinical and process outcomes for cancer patients, with evidence of improved survival, also for lung cancer patients.

Third, leadership is an important enabler in the implementation process (Cossio-Gil, Omara et al. 2021). In our study, the thoracic oncologists were the driving forces of the implementation. They convinced both the multidisciplinary care team and the patients of the potential benefits, by taking small steps and allowing time and space for adaptation and feedback. Support by the management of the hospital was also an important enabler.

Fourth, we recommend using a digital tool, rather than reporting PROs on paper. Such a tool should enable (1) the collection of PROs and clinical outcomes, (2) the visualization of these data using dashboards, and (3) the provision of feedback to clinical teams and patients, as also recommended by Aapro, Bossi et al. (2020) and Cossio-Gil, Omara et al. (2021). Moreover, the digitally reported data can be used for further research, quality evaluation of the care process, and improvement cycles.

Our findings are limited by the fact that the study was a single-center study. Also, we have no information about whether the patient or a family member responded to the questionnaire. This meant we could not investigate the influence of questionnaires completed by an informal caregiver versus patient completed questionnaires. Also, we did not collect information on the time spent on the implementation. As a result, we were not able to evaluate the implementation costs, which is an outcome measure in the Framework for Implementation Outcomes (Proctor, Silmere et al. 2011). Another limitation is the small number of patients with small-cell lung cancer, which is often a rapidly progressive disease, and patients on targeted therapies who may have stable disease with limited symptoms.

We did not investigate the clinical implications and the responses to the questionnaires. This topic requires attention in further research. Also, we did not investigate the extent to which the GPs use the results and the impact of their level of experience with lung cancer and engagement, so this would be interesting for further research.

## **CONCLUSION**

This study has shown that it is feasible to implement a weekly digital follow-up of PROs in routine clinical practice for lung cancer patients. The digital platform is user-friendly, questions are clear and the follow-up of PROs is integrated in the multidisciplinary care delivery. As a result, the response rates are high and the weekly follow-up had a positive impact on the patient–provider communication and makes it easier to discuss psychological and palliative care needs.

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