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# Perceived effectiveness of clinical pathway software: A before-after study in the Netherlands

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ABSTRACT

*Background:* Clinical pathways (CPs) increase in popularity and are known to lead to several benefits in the hospital environment. Clinical pathways can be either paper-based or software-based. It is known that paper-based CPs can result in more paperwork instead of simplifying daily routines of healthcare workers. Insufficient research has been done on the acceptance of software-based CPs by different user groups. Our aim in this study was to assess the effectiveness of the software-based CPs (CPS) from the perspective of healthcare professionals in the hospital environment as well as to investigate the differences in perceived effectiveness between user groups.

*Methods:* Using surveys and interviews, data were collected in four departments of an academic medical center. A distinction was made between decision makers (DM) and executive staff (ES). The surveys contained questions based on the Technology Acceptance Model and four objectives of the software defined by the hospital. Statistical tests were used to investigate the effectiveness of CPS and study the differences between DM and ES. Interviews were recorded and transcribed based on grounded theory principals.

*Results:* After implementation, monitoring protocol-based working was significantly improved ($p = .026$) and significantly higher efficiency on the work floor was reported ($p = .046$). ES perceived the software as less useful than expected ($Md = 3.25$ vs. $Md = 2.75$, $p = .028$) compared to DM and were less convinced of its ability to improve monitoring protocol-based working. The most important benefits of CPS as perceived by its users are the better overview of tasks it provides and facilitating documentation. Negative aspects mentioned were the lack of usability and the inflexibility of the software, and particularly ES claimed that the software did not increase their effectiveness.

*Conclusion:* Our study showed that CPS is effective from healthcare professionals' perspective due to its ability to increase monitoring of protocol-based working and by enhancing the efficiency on the work floor. However, the users also acknowledge that the software lacks usability and is not flexible enough, which results in an additional workload. Policy makers should be more focused on informing and training executive staff more thoroughly when implementing a CPS. Our results strongly suggest that executive staff members need to be convinced of its usefulness and the added value a CPS provides. Preferably, they should be involved in the design phase of the software.

## 1. Introduction

Ensuring patient safety and clinical effectiveness is a challenge healthcare is facing worldwide [1]. To tackle this challenge, many tools and strategies have been developed such as electronic decision support systems (EDSS) [2,3,26–30]. The development of clinical pathways can also be pointed out as one of these initiatives for quality improvement aimed to optimize efficiency, improving the clinical effectiveness of care processes and safety of care [4].

A clinical pathway, also known as integrated care pathway or care map, is a method for the mutual decision making and organization of care for a well-defined group of patients, during a well-defined period [5]. They detail essential steps in the care of patients with a specific clinical problem and describe the patient's expected clinical course. This methodology represents a path that a patient can undertake if her conditions are associated with a routine series of interventions [4].

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Clinical pathways offer a structured approach to implementing protocols based on evidence-based guidelines [11]. They increase in popularity and are known to lead to several benefits in the hospital environment. By standardizing and organizing the care processes for specific groups of patients, clinical pathways maximize patient outcomes and efficiency of care while at the same time controlling costs and guaranteeing the quality of care [6–8].

Clinical pathways can be either paper-based or software-based [5]. The paper-based method essentially contains large manuals often implemented as additional sheets to patient records [9]. Consequently, paper-based clinical pathways can result in more paperwork instead of simplifying daily routines of healthcare workers [10,11]. Healthcare organizations can also work with electronical clinical pathways or an electronic method to facilitate the management of paper-based clinical pathways [12]. Despite the benefits of software-based systems (clinical pathway software management systems or CPS), hospitals often still choose to work with paper-based clinical pathways due to the entailed high investments costs of the software [12–15]. Several studies provide reasons why healthcare organizations should move away from paper-based clinical pathways. According to Li et al. [11], paper-based clinical pathways are challenging for knowledge sharing, and bring burdensome paperwork which causes inefficiency and a lack of accuracy in care processes. In addition to this Du, Jiang, Diao, Ye, and Yao state that paper-based clinical pathways have a limited capacity of data recording and collection, and lack support for monitoring and handling variations [16].

CPS can include EDSS. Various studies have assessed the effectiveness of software-based clinical pathways (CPS). Wang et al. reported a reduction of the median total length of stay of 1–3 days in the patients treated according CPS in comparison to patients treated using paper-based clinical pathways [17]. In addition, the study conducted by Brignole et al. reported a statistically significant reduction in total costs per patient [18]. Also, Katzan et al. found a significant reduction in inpatient mortality [19]. Moreover, O'Connell found that the rate of major complications was significantly higher in patients not treated according to the CPS when compared to the patients treated according to the CPS [20].

When it comes to the implementation and effectiveness of CPS, healthcare professionals play an important role. As Berg [15] already stated: "Whether or not a system is successful or not is decided on the work floor". Without the acceptance of CPS by the healthcare professionals it will not reach its full potential and it will thus lose (a part of) its effectiveness. Previous studies have argued that the satisfaction of healthcare workers is positively affected by the use of clinical pathway management software (CPS) [21,22]. Aarnoutse et al. [5] state that CPS leads to an increased efficient workload due to prefilled orders and letters, less forgotten tasks, and a better overview of tasks for the department which results in a better understanding between healthcare professionals. However, some correspondents experienced the CPS to be not flexible enough. Some studies have implicated that CPS might be less effective for nursing staff when compared to physicians [10,23]. However, research investigating the differences in (perceived) effectiveness between user groups is lacking.

Thus, although there is evidence that CPS could improve healthcare for patients, it may also increase the workload for healthcare staff. Insufficient research has been conducted on the acceptance of CPS by different user groups. The objective of this study was therefore twofold: to assess the effectiveness of the CPS from the perspective of healthcare professionals in the hospital environment as well as to investigate the differences in perceived effectiveness between user groups. In this study we focused on perceived effectiveness, and not on measured clinical effectiveness to determine the effect on clinical outcome, nor did we study the measured efficiency such as time taken or steps needed to complete a task.

## 2. Method

### 2.1. Study design and setting

We performed a study using a mixed-method design in a large academic hospital in Utrecht, the Netherlands. Since 2011 the hospital has been using a commercial Hospital Information System (HIS), (EZIS, Chipsoft, Amsterdam, the Netherlands). This HIS runs on the Microsoft Windows platform and includes a home-grown order management system called Check-It. All orders are entered directly into the computer by physicians or nurses. The objectives of Check-It were defined by the hospital as follows:

1) To improve protocol-based working.
2) To improve the monitoring of this protocol-based working.
3) To ease administrative workload.
4) To reach a more efficient workflow (e.g. reducing consultation preparation time)

The hospital hypothesized that these objectives not only lead to more uniform care quality, but also to better collaboration between healthcare professionals within and between departments. Check-It does not only document how care should be delivered for a client in a particular pathway, but also whether that client actually received the care. It organizes and visualizes what is done, and what should be done next. It enables healthcare professionals to navigate between the care path activities of past, present and the future. To clarify this, two screenshots are shown below. To start a procedure for a patient, a pathway should be initiated. The healthcare professionals is presented with a list of standard clinical pathway activities, and can deselect activities if they do not apply for that particular patient. This is shown in Fig. 1. When the activities are approved, they are added as a separate tab in the patient's dossier. Check-It shows an overview of the clinical pathway activities for a certain patient at a specific time (see Fig. 2).

This system was piloted in six departments, of which four departments accepted to participate in our study, namely the departments of Pediatric Pulmonology, Vascular Surgery, Dermatology & Allergology, and Ophthalmology (Table 1). The departments of Pediatric Pulmonology and Vascular Surgery had not begun using Check-It yet at the

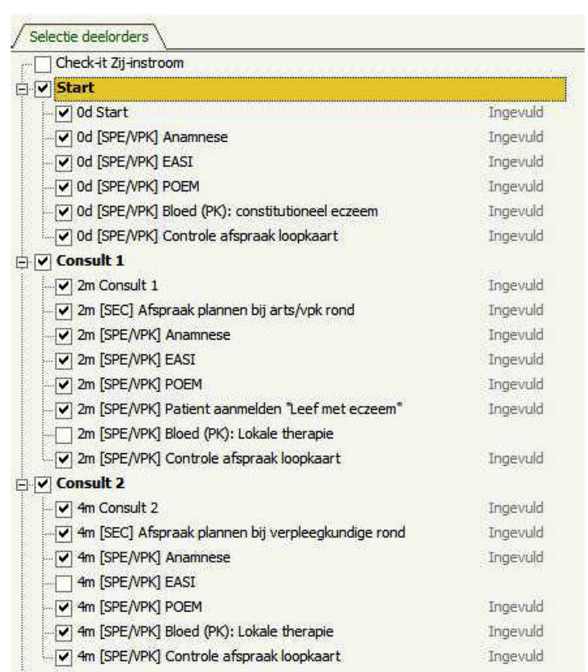


**Fig. 1.** Getting started in Check-It (© UMCU, ChipSoft).


**Fig. 2.** Check-It (© UMCU, ChipSoft) shows an overview of the clinical pathway activities for a specific patient at a specific time. At the top, the different moments of contact are shown. "Actueel" (current) lists all pending activities, '3 maanden' (3 months) lists the activities to be accomplished in the first appointment after a patient started in this pathway, after 3 months. This holds for '6 maanden' (6 months); '9 maanden' (9 months) and' 12 maanden' (12 months). The patient in this particular clinical pathway should come back every 3 months for the duration of a year. The '(V)' before 3,and 6 means that all activities are already completed.

time data were collected, which allowed for a baseline to be obtained (pretest). Four months after implementation, another data collection moment was realized for these departments, in which the departments of Dermatology & Allergology and Ophthalmology also participated (posttest). The four departments that were object of study together with their test timeline are shown in Fig. 3.

The healthcare professionals participating in this study have different functions throughout the hospital. As we aimed to assess the differences in perceived effectiveness per user group, we made a distinction between two user groups. The two user groups can be formulated as decision makers (physicians, medical specialists and nurse specialists) and executive staff (general nurses, paramedics and medical support personnel).

### 2.2. Data collection

Both the pre- and posttest included a survey and an interview acquired among employees who work with Check-It. Analyzing and synthesizing both methods allowed for a more comprehensive insight to be obtained by linking the numerical data to the opinions and motivations of healthcare professionals who work with the software program. Whereas the pretest measured the baseline opinions and expectations of the healthcare professionals, the posttest evaluated the implementation of the CPS. The survey that was administered is available as an appendix.

We used the survey to collect demographic data such as age, gender, profession, and years of experience. Additionally, the survey contained questions regarding the objectives of Check-It as well as questions based on the Technology Acceptance Model (TAM) as proposed by Wu, Li and Fu [24].

The part regarding the objectives of Check-It contained questions in which the participants had to grade their department based on to what extent the objectives of Check-It have been met (scale 1–10). These objectives were related respectively to working according to protocol, monitoring protocol-based working, efficiency of the process of care, and ease of working with patient records. In the pretest, these questions assessed to what extent the objectives of Check-It had been met before the implementation as a baseline. The same questions were repeated four months after implementation, to detect differences with the baseline.

As mentioned before, the survey also contained a standardized TAM questionnaire. The TAM concerns the acceptance of technology by the people who ought to use it and consisted of statements that can be scored on a Likert scale. The constructs in the TAM model as proposed by Wu, Li, and Fu [24] were grouped in three clusters for the analysis in our study. Each cluster is proven to have an influence on each other and/or the constructs in the next phase. Cluster one consisted of Perceived Service Availability (PSA), Perceived Ease Of Use (PEOU) and Personal Innovativeness in IT (PIIT). Cluster two consisted of Personal Usefulness (PU), Attitude (ATT), Perceived Behavioral Control (PBC), and Subjective Norm (SN). Behavioral Intention (BI) was the only construct in the last cluster. This construct can be seen as the most important construct of the TAM model, as it directly indicates the acceptance of technology by indicating to what extent the healthcare professionals are intending to use a system. The elements of each cluster were measured using a 5-point Likert scale, in both the pretest as well as the posttest.

The interview questions were conducted in Dutch and were posed in a semi-structured interview format, and asked the participant about the positive or negative expectations and effects of Check-It individually. The interviews were recorded on a mobile device and transcribed based on grounded theory principals and steps. By using open coding, names were identified and phenomena were categorized in the text. After relevant chunks of data were labelled, the codes as well as the labeled categories were related using axial coding. The results of the interviews, in tables, were presenting the positive and negative statements mentioned by the healthcare professionals per user group. The statements that were mentioned by five or more participants in total were taken into account in our analysis.

### 2.3. Analyses

#### 2.3.1. Objectives of Check-It

The differences between the pretest and posttest were analyzed using the Wilcoxon Signed Rank test. For this test, no distinction between user groups was made to assess whether or not the overall situations within the departments concerning the objectives of Check-It had changed after implementation. In addition, the differences between the pretest and posttest were also analyzed for each user group separately using the Wilcoxon Signed Rank test as well. To compare the two user groups, no distinction between departments was made and the data were combined.

Furthermore, the Mann-Whitney *U* test was used to analyze the differences between the two user groups in the pretest as well as in the posttest separately.

#### 2.3.2. TAM

The Wilcoxon Signed Rank test was used to assess the differences

**Table 1**
Characteristics of participating departments and participants.

| | Vascular Surgery | Pediatric Pulmonology | Dermatology & Allergology | Ophthalmology | Total |
|---|---|---|---|---|---|
| Decision makers | 2 | 5 | 3 | 3 | 13 |
| Executive staff | 8 | 3 | 6 | 11 | 28 |
| Average age | 40–50 years | 30–40 years | 30–40 years | 40–50 years | 30–40 years |
| Average job experience | 5–15 years | 5–15 years | 5–15 years | 5–15 years | 5–15 years |
| Focus clinical pathway | Abdominal aortic aneurysm | Children with Cystic fibrosis | Atopic dermatitis | Uveitis | – |
| Total (n = 41) | 10 | 8 | 9 | 14 | 41 |

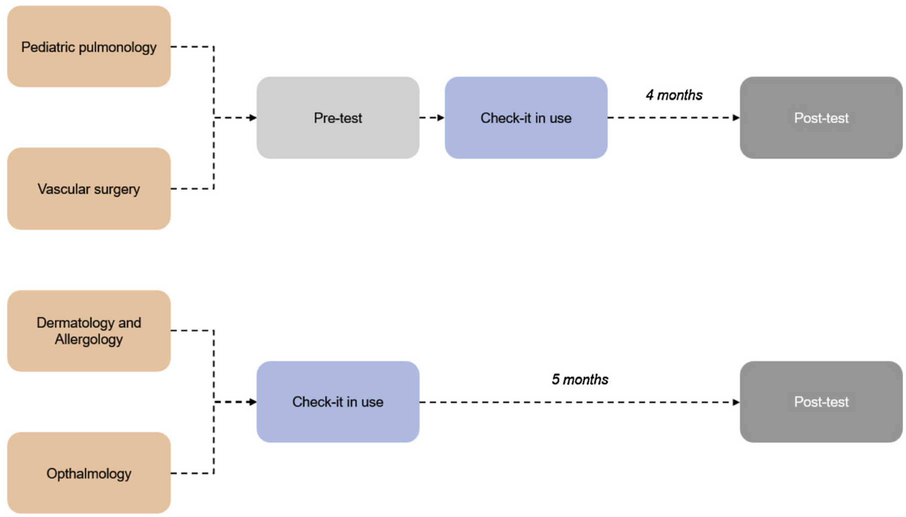


**Fig. 3.** Test timelines of the participating departments.

between the pretest and posttest per user group. This analysis was also done per cluster, as well as per construct. In addition, the differences between the two user groups in the posttest were analyzed using the Mann-Whitney *U* test per cluster of the TAM as well as per construct.

### 2.3.3. Interviews

The interviews were transcribed based on grounded theory principals and steps. Open coding was used to identify names and categorize phenomena in the text. After labeling all the relevant chunks of data, we used axial coding to relate the codes, and to relate the labeled categories to each other. In the final phase, all the created categories were reviewed to choose an adequate wording. The results were demonstrated using percentages per user group (decision makers vs. executives). The statements that were mentioned by five or more participants were taken into account.

Demographic data were calculated using percentages, mean and standard deviation (SD). Analyses were performed using SPSS and $p < .05$ was considered statistically significant.

## 3. Results

### 3.1. Characteristics of participants

In total, 41 healthcare professionals participated in this study. From the 41 participants of four departments, 14.6 % (n = 6) were male and 85.4 % (n = 35) were female. The average age was 30–40 years and the average job experience was 5–15 years. On average the users have worked with Check-It for approximately 30–40 patients. When it comes to the distinction between user groups, 31.7 % (n = 13) of the participating healthcare professionals belonged to the group of decision makers (referred to as user group 1), and 68.3 % (n = 28) belonged to the executive staff (referred to as user group 2). An overview of the characteristics of participants per department is presented in Table 1.

### 3.2. Objectives of check-it

To determine the overall impact Check-It has had on achieving its objectives, an overall analysis was done without making a distinction between user groups. A Wilcoxon Signed Rank test revealed statistically significant increases of “Monitoring protocol based working” (z = -2.33, p = 0.026) and “Efficiency” (z = -2.00, p = 0.046). However, the median scores remained the same for both objectives in pre- and post-phase (Md = 7.00). The results of this test are shown in Table 2. The Wilcoxon Signed Rank test was performed to assess the differences

**Table 2**
Check-It Objectives grades in departments: Pre vs. post, no distinction between groups.

| Objective | Pretest | Posttest | Test statistics* |
|---|---|---|---|
| Protocol-based working | 8.00 | 8.00 | Z = −1.34, p = 0.180 |
| Monitoring protocol-based working | 7.00 | 7.00 | Z = −2.33, p = 0.026 |
| Ease of administrative workload | 7.00 | 7.50 | Z = -1.34, p = 0.180 |
| Efficiency | 7.00 | 7.00 | Z = -2.00, p = 0.046 |

Variables are denoted as median.
* Pre-post differences were tested with the Wilcoxon Signed Rank test.

between the pretest and the posttest per user group separately, only revealed a statistical significant increase of “Monitoring protocol-based working” among decision makers (z = -2.04, p = 0.041). The median score increased from pre-implementation (Md = 6.00) to post-implementation (md = 8.00).

The Mann-Whitney *U* test performed in the pre-implementation phase revealed a significant difference in the second objective of Check-It, “Monitoring protocol-based working”, of executive staff (Md = 6.00) and decision makers (Md = 6.00), U = 12, z = -1.47, p = 0.021. This test revealed no significant differences in the other three objectives of Check-It between the two user groups. The results of this test are shown in Table 3. It can be stated before the pilot program had begun, the perception of the executive staff differed significantly from the perception of the decision makers when it came to monitoring protocol-based working in the departments.

In the post-implementation phase, again a difference was only found in “Monitoring protocol-based working” between the two user groups. However, this time the decision makers (Md = 8.00) scored the performance of their departments higher than the executive staff (Md = 6.50), U = 41, z = -2.69, p = 0.007. The results of this test are shown in Table 3. Thus, after implementation of Check-It, the performance of the departments were given a significant higher score by the decision makers in comparison to the executive staff.

### 3.3. TAM-scores

Table 4 shows the median scores of the TAM constructs and clusters per user group, comparing the pretest to the posttest. The Wilcoxon Signed Rank test revealed a statistically significant reduction of Perceived Usefulness (PU, Cluster Two) among executive staff following the implementation of Check-It (z = −2.20, p = 0.028). The median score of PU decreased from pre-implementation (Md = 3.25) to post-implementation (Md = 2.75). The test revealed no additional

**Table 3**
Check-It Objectives grades in departments: Decision makers (referred to as' user group 1′) vs. Executive staff, Pretest and Posttest. Scale.1–10.

| Objective | Pretest | | | Posttest | | |
|---|---|---|---|---|---|---|
| | User group 1 | User group 2 | Test statistics* | User group 1 | User group 2 | Test statistics* |
| Protocol-based working | 7.00 | 8.00 | U = 21, Z = −1.47, p = 0.141 | 8.00 | 7.75 | U = 90, Z = −0.43, p = 0.665 |
| Monitoring protocol-based working | 6.00 | 7.00 | U = 12, Z = −2.309, p = 0.021 | 8.00 | 6.50 | U = 41, Z = −2.69, p = 0.007 |
| Ease of administrative workload | 7.00 | 7.50 | U = 25, Z = −1.01, p = 0.312 | 7.00 | 8.00 | U = 65.5, Z = −1.39, p = 0.163 |
| Efficiency | 7.00 | 7.00 | U = 28.5, Z = −0.69, p = 0.488 | 8.00 | 7.00 | U = 68, Z = −1.63, p = 0.102 |

Variables are denoted as median.
* Group differences were tested with the Mann-Whitney *U* test.

significant results.

A Mann-Whitney *U* test comparing the two user groups regarding the TAM-questions in the posttest showed a significant difference in the construct of Perceived Usefulness (PU, Cluster Two) of decision makers (Md = 3.75) and executive staff (Md = 2.75), U = 45, z = −2.57, p = 0.01. No further significant results were revealed in this test. The results are shown in Table 5.

### 3.4. Interviews

#### 3.4.1. Pre-implementation

Pre-implementation interviews were held with 23 healthcare professionals of the departments of Vascular Surgery (13, 57 %) and Pediatric Pulmonology (10, 43 %), of which 8 (35 %) were decision makers, and 15 (65 %) were members of the executive staff. The average age of the decision makers and executive staff was respectively 40–50 years and 30–40 years. The average job experience was 5–15 years in both groups. The combined results of the positive and negative statements mentioned by five or more participants within a user group are presented in Table 6.

*3.4.1.1. Positive statements*. In total, 8 different positive statements were mentioned by five or more participants from one or both user groups. Of the participants, 52 % (50 % of the decision makers and 53 % of the executive staff) agreed that the implementation of Check-It would increase their effectiveness on the work floor. Other positive statements that were mentioned by the different user groups somewhat equally, were that Check-It would result in less forgotten tasks, increased protocol insight, and increased quality of patient care.

Not all statements mentioned in the pre-implementation interviews were equally mentioned by both user groups, as three positive statements were brought up by particularly executive staff members. Whereas 33 % of the executive staff indicate that they will benefit from Check-It in terms of pre-filled orders and letters it involves, this was stated by none of the decision makers (0 %). Also, 47 % of the executive staff members expected to obtain a better overview of tasks, while this was stated by 25 % of the decision makers. Lastly, 60 % of the executive staff believed that Check-It would improve protocol-based working, against 38 % of the decision makers.

*3.4.1.2. Negative statements*. One negative statement was mentioned during the pre-implementation interviews. 33 % of the interviewed executive staff believed that Check-It would only grant advantages for the decision makers, and would perhaps even result in more work for them. As an example, an executive staff member stated: ***"Protocol-based working is good of course, especially that you know that everyone is really working conform the protocol. However, the advantage that I fail to see is that the implementation of Check-It will benefit me in any way. I believe that it will result in more work for us and yield only benefits for the physicians."***

#### 3.4.2. Post implementation

In total, post-implementation interviews were held with 36 healthcare professionals, of which 13 (36 %) decision makers, and 23 (64 %) members of the executive staff. The average age and job

**Table 4**
TAM-scores: Pre vs. Post per user group.

| | | User group | Pre | Post | Test statistics* |
|---|---|---|---|---|---|
| Cluster one | PSA | 1 | 5.00 | 4.00 | Z = −1.26, p = 0.206 |
| | | 2 | 4.00 | 4.00 | Z = −1.00, p = 0.319 |
| | PEOU | 1 | 4.33 | 4.00 | Z = −1.30, p = 0.194 |
| | | 2 | 3.33 | 3.33 | Z = −1.34, p = 0.179 |
| | PITT | 1 | 4.40 | 3.60 | Z = −1.61, p = 0.107 |
| | | 2 | 3.00 | 3.20 | Z = −1.04, p = 0.301 |
| | **TOTAL** | 1 | 4.20(3.69) | 3.93(3.74) | Z = −1.50, p = 0.133 |
| | | 2 | 3.51(3.44) | 3.51(3.55) | Z = −0.93, p = 0.354 |
| Cluster two | PU | 1 | 4.25 | 3.75 | Z = −1.14, p = 0.254 |
| | | 2 | 3.25 | 2.75 | Z = −2.20, p = 0.028 |
| | ATT | 1 | 4.33 | 4.00 | Z = −1.44, p = 0.151 |
| | | 2 | 3.67 | 3.50 | Z = −1.64, p = 0.102 |
| | PBC | 1 | 4.67 | 3.67 | Z = −1.49, p = 0.136 |
| | | 2 | 3.33 | 3.33 | Z = −1.09, p = 0.277 |
| | SN | 1 | 4.00 | 3.00 | Z = −1.42, p = 0.154 |
| | | 2 | 3.00 | 3.00 | Z = −1.49, p = 0.137 |
| | **TOTAL** | 1 | 3.83(3.50) | 3.58(3.49) | Z = −1.43, p = 0.152 |
| | | 2 | 3.33(3.29) | 2.97(3.01) | Z = −2.00, p = 0.045 |
| Cluster three | BI | 1 | 5.00 | 4.00 | Z = −1.34, p = 0.180 |
| | | 2 | 3.00 | 3.00 | Z = −1.43, p = 0.152 |

Variables are denoted as median. Scale 1–5. Total scores per clusters are denoted as median (mean).
* Pre-post differences were tested with the Wilcoxon Signed Rank test. User group 1 = decision makers, User group 2 = executive staff. PSA: Perceived Service Availability —PEOU: Perceived Ease Of Use — PIIT: Personal Innovativeness in IT — PU: Personal Usefulness — ATT: Attitude — PBC: Perceived Behavioral Control — SN: Subjective Norm — BI: Behavioral Intention.

**Table 5**
TAM-scores: User group 1 (decision makers)vs. User group 2 (executive staff), posttest. Scale.1–5.

| | | User group 1 | User group 2 | Test statistics* |
|---|---|---|---|---|
| Cluster one | PSA | 4.00 | 4.00 | U = 93.5, Z= −0.54, p = 0.586 |
| | PEOU | 4.00 | 3.33 | U = 57, Z= −1.76, p = 0.079 |
| | PIIT | 3.40 | 3.20 | U = 95.5, Z= −0.39, p = 0.697 |
| | TOTAL | 3.91(3.74) | 3.51(3.55) | U = 78, Z= −0.73, p = 0.466 |
| Cluster two | PU | 3.75 | 2.75 | U = 45, Z= −2.57, p = 0.010 |
| | ATT | 3.67 | 3.50 | U = 66, Z= −0.72, p = 0.472 |
| | PBC | 3.33 | 3.33 | U = 88, Z= −0.21, p = 0.472 |
| | SN | 3.00 | 3.00 | U = 94.5, Z= −0.21, p = 0.835 |
| | TOTAL | 3.54(3.49) | 2.97(3.01) | U = 59, Z= −1.80, p = 0.072 |
| Cluster three | BI | 4.00 | 3.00 | U = 80.5, Z= −1.07, p = 0.284 |

Variables are denoted as median. Total scores per clusters are denoted as median (mean).

* Group differences were tested with the Mann-Whitney *U* test. PSA: Perceived Service Availability —PEOU: Perceived Ease Of Use — PIIT: Personal Innovativeness in IT — PU: Personal Usefulness — ATT: Attitude — PBC: Perceived Behavioral Control — SN: Subjective Norm — BI: Behavioral Intention.

experience were respectively 30–40 years and 5–15 years in both user groups. These interviews were held approximately 4–5 months after the implementation of Check-It, with healthcare professionals from all four departments who participated in this study (Vascular Surgery (6, 17 %), Pediatric Pulmonology (6, 17 %), Dermatology & Allergology (9, 25 %), and Ophthalmology (15, 42 %). The combined results of the positive and negative statements mentioned by five or more participants within a user group are presented in Table 7.

*3.4.2.1. Positive statements*. A positive aspect of Check-It which was mentioned the most during the interviews is the better overview of tasks it provides, as it was stated by 42 % of the participants. It's clearer which tasks have to be done, by whom and when.

This positive aspect was stated by 62 % of the interviewed decision makers, and 30 % of the executive staff members that were interviewed.

*3.4.2.2. Negative statements*. In total, 5 different negative statements were mentioned by the interviewed healthcare professionals in the post-implementation phase. 25 % of the participants (23 % and 26 % of respectively the decision makers and the executive staff), argued that Check-It was not flexible enough; it was difficult to properly use the software when not working according to the protocol due to exceptions. In addition, 31 % of the participants specifically mentioned that Check-It lacked usability; 39 % of the decision makers and 26 % of the executive staff thought that Check-It itself was difficult to use and unclear. Moreover, 23 % of the decision makers and 22 % of the executive staff stated that Check-It was not being used enough. The remainder of the negative statements were notably not equally mentioned per user group. Particularly interesting, is the fact that of the participants (33 %) who claimed that Check-It had not increased their effectivity on the work floor, 15 % belonged to the group of the decision makers and 44 % were members of the executive staff. Another dissimilarity worth mentioning is the fact that 26 % of the executive staff and 8 % of the decision makers claimed that after the implementation, the amount of work was higher and/or more time was needed for documentation.

## 4. Discussion

### 4.1. Main findings

In this study, we investigated the perceived effectiveness of clinical pathway software. Our general results showed that using CPS significantly increased the software's objectives "Monitoring protocol-based working" and "Efficiency on the work floor". The participants acknowledged that the CPS resulted in a better overview of tasks. According to our findings, protocol-based working and the ease of administrative workload were not affected by the implementation of the CPS.

Regarding the differences between the user groups, our results showed that in the pre-implementation phase the executive staff scored their departments significantly higher regarding the software's objective "Monitoring protocol-based working", compared to decision makers. However, we found that after implementation, the decision makers scored the departments significantly higher than the executive staff on this same objective. A shift from the executive staff in the pretest towards the decision makers in the post-test has been detected. This shift was also recognized in the results of the interviews regarding the overall expectation of the software. Our interview results also revealed that 44 % of the executive staff compared to 15 % of the decision makers claimed that Check-It had not increased their effectiveness on the work floor. This notable difference confirms that the executive staff did not perceive the software as effective after all.

In addition, a significant reduction (from Md = 3.25 to Md = 2.75 on a five-point Likert scale) of perceived usefulness among the executive staff was revealed when the post-test was compared to the pre-test. Apparently, the software was not perceived as useful as the executive staff expected in the pre-test. As the decision makers scored significantly higher on perceived usefulness compared to the executive staff in the post-test (Md = 3.75 vs. Md = 2.75), the aforementioned

**Table 6**
Interview results per user group and in total, pre-implementation. Percentages are rounded and given per user group and in total. Statements are categorized as positive (+) or negative (−).

| +/- | Statement | Decision makers (n = 8) | Executive staff (n = 15) | Total (n = 23) |
|---|---|---|---|---|
| + | Increased effectiveness | 4 (50 %) | 8 (53 %) | 12 (52 %) |
| + | Improved protocol-based working | 3 (38 %) | 9 (60 %) | 12 (52 %) |
| + | Better overview of tasks | 2 (25 %) | 7 (47 %) | 9 (39 %) |
| + | Less forgotten tasks | 3 (38 %) | 6 (40 %) | 9 (39 %) |
| + | Increased protocol insight | 2 (25 %) | 5 (33 %) | 7 (30 %) |
| + | Pre-filled orders and letters | 0 (0 %) | 5 (33 %) | 5 (22 %) |
| + | Increased quality of patient care | 2 (25 %) | 3 (20 %) | 5 (22 %) |
| + | More accurate administration | 2 (25 %) | 3 (20 %) | 5 (22 %) |
| – | Check-It will only be advantageous for decision makers | 0 (0 %) | 5 (33 %) | 5 (22 %) |

**Table 7**
Interview results per user group and in total, post-implementation. Percentages are rounded and given per user group and in total. Statements are categorized as positive (+) or negative (-).

| +/− | Statement | Decision makers (n = 13) | Executive staff (n = 23) | Total (n = 36) |
|---|---|---|---|---|
| + | Better overview of tasks | 8 (62 %) | 7 (30 %) | 15 (42 %) |
| – | Did not increase effectivity | 2 (15 %) | 10 (44 %) | 12 (33 %) |
| – | Lack of usability / unclear | 5 (39 %) | 6 (26 %) | 11 (31 %) |
| – | Difficult when not according to protocol / not flexible | 3 (23 %) | 6 (26 %) | 9 (25 %) |
| – | Lack of use | 3 (23 %) | 5 (22 %) | 8 (22 %) |
| – | More work / more time needed for documentation | 1 (8 %) | 6 (26 %) | 7 (19 %) |

shift is again confirmed. Lastly, 26 % of the executive staff versus 8 % of the decision makers claimed that after the implementation, the amount of work was higher and/or more time was needed for documentation. Clearly, the two user groups do not share the same opinion when it comes to the perceived effects of the CPS.

The results of the interviews provide underlying reasons why the executive staff did not perceive Check-It to be as useful as the decision makers and why their perceived usefulness score declined significantly after implementation. In the pretest, some executive staff members already mentioned their concern that the implementation of Check-It would only yield benefits for the decision makers and would only result in more work for them. After the implementation, this concern has been confirmed as executive staff members mentioned that Check-It resulted in even more work for them, while our post-implementation interview results showed that the decision makers were quite satisfied with the software.

In general, participants argued that the CPS lacked usability and flexibility, and resulted in more work. This contradicts the expectations of the participants in the pre-implementation phase, as more than 50 % of the participants expected the CPS to increase their effectiveness. Other expectations that were not satisfied at the end were for example that the CPS would result in less forgotten tasks, increased protocol insight and a more accurate administration. The fact that a lot of expectations turned out not to be righteous after all, could possibly be explained by the fact that some participants indicated that the software was not being used enough. Also, the lack of usability and the inflexibility of the software, as indicated by 31 % of the users, could help explain the disappointment among the users.

## 5. Comparison with other studies

The study conducted by Schuld et al. showed that approximately 40 % of the nurses perceived the CPS to be an additional workload for them [21]. This finding is directly in line with our study. Furthermore, standardization and process facilitation were in their study reported as more important for medical doctors than for the nursing staff [21]. Although these specific benefits were not mentioned by our participants, a similar disparity between the user groups was recognized in our study. Also, Schuld et al. found that both user groups considered clinical pathways equally as a valuable tool to obtain a better overview of the routine workflow [21]. Although our study did not question the benefits of the clinical pathways itself, but instead focused on the software, this benefit was also recognized in the software used by our participants. However, the executive staff in our study did not acknowledge this benefit as much as the decision makers (respectively 30 % vs. 62 %).

The study conducted by Sung et al. found a significant increase in the satisfaction score of doctors when comparing usual care to care according to the CPS (from 36.9 ± 5.5–45.4 ± 4.3, $p < 0.001$), but no significant change in the satisfaction of nurses. The physicians were notably satisfied with factors concerning for example the convenience of prescription, convenience of performing the preoperative workup, and convenience of making a plan of discharge. The nursing staff however was not satisfied with any factor of the CPS after implementation [23]. Although our study did not assess these aforementioned specific benefits, we did also find that the decision makers were satisfied with the CPS while the executive staff perceived the CPS as significantly less useful as expected.

The study conducted by Franke et al. found that after the implementation of the CPS, the software was barely used. Reasons for not using the CPS as stated by the users are, amongst other things, lack of integration in hospital and medical software systems, inflexibility, and difficulties in handling questionable viability of guidelines [25]. These findings are somewhat in line with our findings; 22 % of the participants indicated that the CPS was not used enough, and 25 % mentioned that the software was not flexible enough. Also, the usability of the software was criticized by 31 %.

To the best of our knowledge, this is the first study evaluates the perceived effectiveness of CPS comparing the user groups and based on both TAM and objectives of the software. It should be emphasized that the measurements did not measure the actual effectiveness of Check-It, but its perceived effectiveness, since it is based on the opinions of healthcare professionals. In addition, this study is conducted in one academic hospital, evaluating one particular software program. Since the participating departments were not exactly the same in the pre- and post-phase, the generalizability of the results might be limited. Using the same measures in other hospitals with another CPS would strengthen the value of these results. Finally, there are many environmental variables which could have biased the results of the pretest, such as previous exposure of users to Check-It, or unreasonable expectations of users we were not able to measure. However, we limited these factors as much as possible and did not find anything particular in the interview.

Although the group of respondents was not very large, the perceived effectiveness from the user groups' perspective could represent the differences between the decision makers and executive staff since the groups were large enough. Factors such as national culture, type of hospital, the composition of CPS system components, and the length of use of system can have an influence on its perceived effectiveness. Future studies are needed to examine the effect of these factors. Finally, future studies need to address how the findings from CPS are relevant to other initiatives such as EDSS.

## 6. Conclusion and implications

Our study showed that CPS is effective from healthcare professionals' perspective due to its ability to increase monitoring of protocol-based working and enhance the efficiency on the work floor. The most important benefits of CPS as perceived by its users were the better overview of tasks it provides and facilitating documentation. However, the users also acknowledged that the software lacks usability, is not flexible enough and results in an additional workload. CPS seems to be perceived as more effective for physicians, medical specialists than for 'executive staff' (general nurses, paramedics and (medical) support personnel). The executive staff scored significantly lower in terms of perceived usefulness, were less convinced of its ability to improve monitoring protocol-based working, and indicated that their effectivity did not increase after the implementation of the CPS.

Our results have implications for the implementation of CPS in practice. First of all, policy makers should be more focused on informing and training the executive staff more thoroughly when implementing a CPS. Our results strongly suggest that executive staff members need to be convinced of its usefulness and the added value a CPS provides. This should be accompanied by a well-conducted pilot phase with enough supervision and support in order to get them accustomed to the software. Furthermore, since the participants in our study complained about the usability of the software, software developers and policy makers should involve the users in the design phase of the software. By involving them and incorporating their preferences in terms of usability features, the usability and the satisfaction with the software could be improved. Lastly, more research should be done to further investigate the differences in perceived effectiveness among various user groups. A very important factor is the scope of the study; a large-scale study assessing different software applications in order to be able to generalize results is needed. Further research should focus on the determinants that are most important for the perceived effectiveness of a CPS. If the underlying reasons for this disparity in perceived effectiveness between user groups can be tackled, we believe that the workflow efficiencies can be enhanced.

## Summary points

### What was already known on the topic?

- Clinical pathways increase in popularity and are known to lead to several benefits in the hospital environment.
- Paper-based CPs can result in more paperwork instead of simplifying daily routines of healthcare workers. Healthcare organizations can work with electronically-based CPs or software based CPs to facilitate the management of CPs.
- Insufficient research has been conducted on the acceptance of electronic CPs by different user groups.

### What this study added to our knowledge

- CPS was effective from healthcare professionals' perspective because it increases monitoring of protocol-based working, enhances the efficiency, and provides better overview of tasks.
- Executive staff perceived the software as less useful than expected compared to physicians. Executive staff were less convinced of the ability of the CPS to improve monitoring protocol-based working.
- CPS seems to be perceived as more effective for physicians and medical specialists than for executive staff.

*Author contribution*

MA, and FAA designed the study. FAA collected the data and performed the interviews. JLYYT performed data analysis under supervision of MA and MMs. MA and JLYYT drafted the paper. All the authors revised the paper critically, help interpreting the results, and improved discussion. Author declare they have no conflict of interests.

## Transparency document

The Transparency document associated with this article can be found in the online version.

## Declaration of Competing Interest

All authors declare that there is no conflict of interests.

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