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"We are doing it together, don't worry" – A qualitative study on the implementation of electronic medical records in German hospitals

„Keine Sorge! Wir gehen das gemeinsam an!" – Eine qualitative Studie zur Implementierung der elektronischen Patientenakte in deutschen Krankenhäusern

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ABSTRACT

Background: The ongoing implementation of electronic medical records (EMRs) in German hospitals is currently slow. Implementation science widely acknowledges the barriers and facilitators to implementation. Thus, specific preconditions are necessary to address the former and to support an effective EMR implementation. However, a lack of knowledge exists about these necessary preconditions in Germany. This study aims to gain insight into key stakeholders' experiences with implementing EMR systems in German hospitals to identify preconditions for embedding EMRs in this social context.

Methods: Expert interviews were conducted with members of hospital-wide implementation teams concerning EMR implementation. The interviewees belonged to the nursing, IT, medical, and pharmaceutical professions and worked in hospitals with different contextual characteristics. The interview guideline was based on the practical Consolidated Framework for Implementation, which supports the systematic assessment of potential barriers and facilitators to identify implementation strategies and necessary adaptations. Data was collected between May 2021 and September 2022, and the interviews were analyzed using qualitative content analysis.

Results: Thirteen interviews were conducted with employees from eleven hospitals. Five critical preconditions emerged for EMR implementation based on our analysis: 1) adaptation, where the clinical context and EMRs are aligned; 2) stakeholder co-production, where all relevant stakeholders (e. g., professional groups, departments, and hierarchical levels) are involved in planning, implementing, and evaluating; 3) end-user participation, where end-users are involved in the implementation through close support and training; 4) integration into daily routines, where EMRs are integrated into daily work, including work processes that initially require additional effort but are necessary to experience the relative advantages; and 5) the continuous Plan-Do-Check-Act cycle, where the EMR implementation process is continuously reviewed and adjusted. In addition, activities to enact these preconditions were derived based on the interview data.

Discussion: Our findings indicate that overall contextual adaptation is required. The five preconditions include essential activities to facilitate the integration of the EMR into daily routines. Participation, communication, and support are fundamental, as described in the international literature. Failure to comply

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with these preconditions can lead to challenges during implementation, such as end-user resistance.
Conclusion: Considering social and technical aspects is paramount in implementing EMRs, which may also apply to future digital innovations' change management processes.

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ZUSAMMENFASSUNG

Hintergrund: Derzeit zeigt sich eine nur langsame Einführung der elektronischen Patientenakte (ePA) in deutschen Krankenhäusern. Die Erkenntnisse der Implementierungswissenschaft legen nahe, dass bei der Einführung von Innovationen stets förderliche und hemmende Faktoren wirken. Um Letztere zu identifizieren und eine effektive Implementierung zu erreichen, müssen bestimmte Gelingensfaktoren erfüllt werden. Bezogen auf Deutschland sind die notwendigen Gelingensfaktoren bisher jedoch nicht bekannt. Ziel dieser Studie ist es, einen Einblick in die Erfahrungen der Akteure bei der Einführung der elektronischen Patientenakte in deutschen Krankenhäusern zu gewinnen und wesentliche Gelingensfaktoren für die Integration der elektronischen Patientenakte in den sozialen Kontext des Krankenhauses zu identifizieren.
Methodik: Im Rahmen der Studie wurden Mitglieder krankenhausweiter Implementierungsteams für die Einführung der elektronischen Patientenakte als Expert*innen interviewt. Die Befragten gehörten zu den Berufsgruppen Pflege, IT, Medizin oder Pharmazie und arbeiteten in Krankenhäusern mit unterschiedlichen Charakteristika. Der Interview-Leitfaden basierte auf dem CFIR, einem praktischen Framework, dessen Nutzung die systematische Erfassung potenziell förderlicher und hemmender Faktoren sowie die Ermittlung von Implementierungsstrategien und notwendigen Anpassungen ermöglicht. Der Zeitraum der Datenerhebung lag zwischen Mai 2021 und September 2022; die Interviews wurden mittels qualitativer Inhaltsanalyse ausgewertet.
Ergebnisse: Insgesamt wurden 13 Expert*innen aus 11 Krankenhäusern interviewt. Die Analyse zeigte, dass fünf Gelingensfaktoren von entscheidender Bedeutung für die erfolgreiche Implementierung in den verschiedenen Krankenhäusern sind. 1) Anpassung: Der klinische Kontext und die elektronische Patientenakte sind aufeinander abgestimmt. 2) Co-Produktion der Stakeholder: Planung, Durchführung und Evaluation des Implementierungsprojekts erfolgen unter Einbindung aller relevanten Beteiligten. Dies umfasst verschiedene Berufsgruppen, Abteilungen und Hierarchieebenen. 3) Anwender*innen-Beteiligung: Die Anwender*innen werden über eine enge Begleitung und Schulungen in die Implementierung eingebunden. 4) Integration in die täglichen Abläufe: Die elektronische Patientenakte wird in den Arbeitsalltag integriert. Dies bedingt eine Veränderung der Arbeitsabläufe, was zu Beginn zwar mit einem höheren Arbeitsaufwand verbunden, für eine spürbare Arbeitserleichterung jedoch unabdingbar ist. 5) Kontinuierlicher PDCA-Zyklus: Die elektronische Patientenakte sowie der Implementierungsprozess werden regelmäßig evaluiert und angepasst. Darüber hinaus wurden aus dem Datenmaterial wesentliche Maßnahmen zur Umsetzung der Gelingensfaktoren abgeleitet.
Diskussion: Insgesamt zeigen unsere Ergebnisse, dass eine kontextbezogene Anpassung erforderlich ist. Die fünf Gelingensfaktoren beinhalten wesentliche Maßnahmen, welche die Integration der elektronischen Patientenakte in die tägliche Routine erleichtern. Wie auch in der internationalen Literatur beschrieben, sind Partizipation, Kommunikation und Unterstützung grundlegend. Werden diese Voraussetzungen nicht erfüllt, kann dies zu Herausforderungen bei der Implementierung führen, z. B. Widerstand seitens der Anwender*innen.
Schlussfolgerung: Bei der Implementierung einer elektronischen Patientenakte ist es von größter Bedeutung, dass neben der technischen Umsetzung auch die sozialen Aspekte berücksichtigt werden. Dies kann auch für Change-Management-Prozesse weiterer digitaler Innovationen gelten.

Background

The implementation of electronic medical records (EMRs) in hospitals represents a foundational step in the broader digital transformation of healthcare systems. EMRs serve as a repository for patient information and enable the integration of advanced digital tools and innovations, which are essential for improving clinical workflows and patient outcomes.

Our study focuses on the EMR of a digital fever chart used by clinical and administrative hospital staff for inpatient care that records vital signs, medication, and medical and nursing documentation. This EMR's implementation in German hospitals is ongoing slowly [1], possibly due to the current investment backlog in this area. Against this background, the Hospital Future Act [Krankenhauszukunftsgesetz (KHZG)] came into force in October 2020 to address this issue and provide incentives to invest in digitalization [1].

Despite this more supportive political and financial framework, EMR implementors in hospitals still face challenges related to general and specific implementation aspects due to a lacking overview of implementation experiences in the German context as an instructional model. Existing studies [2–4] and handbooks [5] have referred to experiences abroad, which may limit transferability due to cultural or process-related differences. The German literature has only focused on department-specific implementation (e.g., ophthalmology and pediatrics) [6,7] or concentrated on only one hospital [8].

German hospitals face common implementation challenges from an implementation science perspective since introducing innovations into healthcare settings is not a straightforward process due to ongoing barriers that challenge their implementation [9,10]. Unfortunately, no one-size-fits-all approach can address these barriers due to highly individual hospital contexts, which refer to everything else beyond the innovations [11], including the legal frameworks, professional dynamics, departmental structures, and operational and technological intricacies [12]. Each hospital constitutes a unique and dynamic social system [13,14] with specific end-user contexts [9,10,15] that requires tailored implementation strategies [10,14,16].

Against this background, we see the urgent need for research efforts aimed at exploring facilitators and barriers and developing context-sensitive strategies to promote effective EMR implementation in the German hospital landscape. We aim to derive preconditions for EMR implementation in hospitals based on previous implementation experiences. Additionally, activities to achieve these preconditions are identified, which can be implemented differently according to the local context.

Methods

Our study is part of the eCoCo project (**e**lectronic Patient Record and its Effects on Social Aspects of Interprofessional **Co**llaboration and **C**linical W**o**rkflows in Hospitals) [17] and was conducted by two researchers (KD and MO). It was approved by the Ethics Committee of the Medical Faculty of the University of Cologne (20-1349) and registered in the German Clinical Trials Register (DRKS00023343). The eCoCo project used a mixed-methods approach to gain insight into changes regarding interprofessional collaboration and clinical workflows resulting from EMR implementation. Furthermore, paper-based and electronic medical records [18], as well as structural and administrative data, were analyzed.

Sampling

The most important inclusion criterion for participants was participation in a hospital-wide implementation team. Hence, the participants experienced EMR implementation with its planning and evaluation. Gender and professional groups were less important. German hospitals that had introduced the EMR were identified via an internet search. These members of a hospital-wide EMR implementation team were emailed directly or via hospital management. The study included hospitals of varying sizes, as illustrated in Table 1.

Recruitment continued until thematic saturation was reached, defined as the point at which no new themes emerged. Table 1 shows that the purposive sample included members of clinic-wide EMR implementation teams of 11 German hospitals with different contextual characteristics.

Data collection

A semi-structured interview guide was developed according to Helfferich [19] (see Appendix A, Supplement 1). To capture all determinants possibly relevant for successful implementation, we applied the Consolidated Framework for Implementation Research (CFIR) [9], which assesses contextual factors with a strong influence on implementation outcomes. The CFIR consists of five domains: intervention characteristics, outer setting, inner setting, characteristics of individuals, and process [9].

A common interview guide was developed since the experts were interviewed as members of the implementation team, not as part of their occupation. Helfferich recommended using narrative impulse at the beginning of an interview [19]. Thus, we encouraged the participants to talk about their previous work experience. Next, we referred to the EMR to create a shared understanding of it. Thereafter, the EMR implementation in the hospital was addressed (e.g., in individual wards and the resulting changes). In conclusion, the interviewees were asked to share implementation advice.

The interviews occurred between May 2021 and September 2022, either in person or via video call with one of four researchers (i.e., KD, MN, MO, and JS). The interviews lasted 51 minutes on average (with a minimum of 23 and a maximum of 111 minutes). All researchers were trained in interviewing. All interviews were audio-recorded, anonymized, and transcribed verbatim.

Table 1
Characteristics of the interviewees und hospitals.

Interviwees	**N = 13**	**Percentage**
Gender		
Male	7	54%
Female	6	46%
Occupation		
Nursing	5	38%
IT	5	38%
Medicine	1	8%
Pharmacy	1	8%
Quality Management	1	8%
Hospitals	**N = 11**	
Hospital size		
less than 500 beds	2	18%
501-1000 beds	0	0%
1001-1500 beds	3	27%
1501-2000 beds	4	37%
more than 2000	2	18%

Data analysis

All transcripts were entered into MAXQDA© 2022. We used qualitative content analysis [20] for interpretation and CFIR 2.0 as a deductive category system. The interview guide was developed in 2021 based on the available version of the CFIR at that time. CFIR 2.0 was published in 2022 and was applied during analysis. The construct definitions were adapted to the intervention (i.e., EMR implementation) and the setting (i.e., a hospital) in a code book. Preconditions, including recommended activities, were added as an inductive category since they prevented contextual factors from acting as barriers while enabling facilitating factors. Two researchers (i.e., KD [nursing science] and MO [sociologist]) conducted independent analyses to ascertain intercoder agreement and guarantee data interpretation reliability [20]. The coding results were presented and discussed in weekly research circles within the eCoCo team, with coding discrepancies clarified between the two coders [20].

After structuring the data along the CFIR constructs, we noticed that the outer setting domain was rarely coded. The coded sections referred to the effects of the COVID-19 pandemic on the implementation and the legislation of the KHZG obligating German hospitals to implement the EMR. Therefore, the outer setting domain was excluded from further analysis due to our focus on the hospital level. Categorical thematic overlap occurred despite the inclusion and exclusion criteria of each category in the code book. In a second coding round, recurring themes were grouped, which led to more clearly delineated topics that were formulated as preconditions presented in the results below.

Results

We conducted 13 interviews. The characteristics of the interviewees are presented in Table 1 for reference. Based on the interviewees' implementation experiences and learnings, five preconditions and activities to meet these preconditions were derived (Table 2). They did not follow a consecutive order but were dynamically interrelated.

Adaptation: The context and EMR must be aligned

The interviewees highlighted the importance of context analysis: *"We need to first collect information before we can even start"*

Table 2
Preconditions towards successful EMR implementation and activities derived from the learnings of the implementation teams[1,2].

1. Adaptation: The Context and EMR must be aligned

- Assess the status quo on site: current documents, processes and procedures, relevant occupation groups, department specifics, operating system interfaces, technical infrastructure and equipment, e.g. through
  - Structured interviews with representatives of occupation
  - Shadowing every day work
  - Meetings with staff
- Tailor EMR to the context
  - Take enough time for the adjustment process of every department
  - Discuss in detail the display of the user interface with the end users
  - Insist on close collaboration between end users and IT to ensure clinical and technical practicality
  - Allocate sufficient time for agreement on the visualisation
  - Develop a basic configuration of the EMR with the possibility of adding department specific features
  - Allocate sufficient time for upgrading technical infrastructure
  - Carefully consider operating system interfaces and clinical practicability
- Take sufficient time for testing
  - Test, observe and troubleshoot as many times as needed before expanding to other departments
  - Test from different perspectives
  - Agree on a testing phase with the software company
- Assess (anticipated) changes through implementation of EMR and make them clear to the end users
  - Consider experiences and lessons learnt from other departments, hospitals and the software company
  - Jointly discuss with end users how to digitise the paper documentation
  - Clearly communicate expected changes and ensure that roles, responsibilities and tasks within the EMR are clear to all relevant occupation groups

2. Stakeholder co-production: All relevant stakeholders should participate

- Ensure that all relevant occupation groups, departments and hierarchies are participate in planning and implementation
- Plan sufficient time for agreements between stakeholders
- Mediate between end users and IT for a design that is clinically and technically practical

3. End-user participation: End users must understand the EMR and commit to its implementation

- Ensure personal contact and low-threshold communication
  - Proactively approach end users, talk to them, offer help
  - Motivate end users to ask questions, report problems
  - Openly address common challenges, offer joint solution finding
  - Proactively address negative emotions and feedback: Reduce fears through targeted information, show understanding
  - Ensure responsiveness to end users
  - Offer remote troubleshooting
  - Offer a hotline number on all phones, stick hotline number in visible places
- Strengthen ownership of the end users by developing the EMR interface with them
- Train end users
  - Be aware that questions asked may indicate necessary adjustments
  - Include issues observed during rollouts into future trainings
  - Address specific needs, e.g. regarding occupation groups, departments
  - Offer basic computer training for end users, if needed
  - Consider language proficiency when preparing and conducting trainings
  - Offer follow-up trainings
  - Possibly include pharmacy for training units regarding medication
- Personally accompany end users during rollout and adaptation
  - Ensure sufficient staff resources or take key-user approach
  - If accompanying night shift staff is challenging, adjust the shift time to accompany them at least shortly alongside the day shift staff
  - Talk to head nurse/chief physician and find out about special needs of staff (e.g. computer or language skills) and take sufficient time to accompany these end users
  - During adaptation period adjust personnel planning to compensate for increased documentation time and to give end users time to learn using the EMR while daily operations continue
- Strengthen commitment on all levels
  - Ensure that high level leaders communicate the prioritisation of EMR implementation and are responsive to implementation challenges
  - Convince head nurses and chief physicians about the EMR implementation
    - Start collaboration with them at an early stage
    - Continuously seek collaboration and exchange: Involve them in needs assessment, planning of training and practical accompaniment, seek their feedback regarding EMR and the implementation process, let them suggest key-users
- Identify pioneers of digitisation within the hospital and work together
- Carefully select the first department to roll out for a successful kick off
- In case using of key-user approach: Ensure that medical key-users have a higher position than assistant physician

4. Daily routine integration: End-users must integrate the EMR into daily work

- Continuously mediate between groups by explaining how roles and tasks depend on each other within the EMR
- Highlight relative advantages of EMR use
- Help end users to adopt EMR in their everyday work
  - Motivate end users to take along ward trolley with computer into the patient room and directly document
  - Remind end users to schedule new tasks such a charging EMR devices
- Take a stepwise approach
  - Explain the approach to end users
  - Gradually reduce the use of paper: Give very insecure end users the possibility to document hand written first and transfer it to the EMR later

5. Continuous PDCA cycle: The EMR and implementation process must continuously reviewed and adjusted

- Proactively and regularly monitor the implementation process
  - Conduct monitoring from clinical and IT perspective
  - Seek feedback from end users: e.g. schedule feedback rounds on team level, hold talks with head nurses and chief physicians, use options of written feedback (e.g. hang lists)
  - Visit departments personally to observe and talk to staff and leadership
  - Conduct quality checks of the documentation
  - Assess and apply lessons learnt
- Adjust implementation strategy flexibly
- Continuously improve and develop EMR
  - Conduct continuous quality management
  - Continuously test and adapt

[1] The table summarises the experiences of the interviewees and their implementation teams. Due to the unique context of each hospital, the lessons learnt may serve as examples and possible inspiration but cannot be understood as guidelines.
[2] A German translation of the table is found in the Appendix A, Supplement 2.

(ID3). Every department had individual needs to be captured beforehand, which created considerable work. Avoiding this work created a pitfall due to missing department specifics later: *"In the first department, for instance, we did not ask 'Which documents do you use?' We did so only as from the second department because we noticed without it, it does not work"* (ID3).

The interviewees listed various approaches to context assessment: onsite inspections, structured interviews with representatives of professional groups, meetings with department teams, and work shadowing. They assessed the status quo (e.g., current documents, processes and procedures, occupation groups, department specifics, and technical infrastructure) as well as expected changes with end-users wishes and needs. The importance of analyzing the context on site was stressed: *"You cannot just do it from the desk. You must look at the processes on site from the beginning. Otherwise, the best project management program will be no good*" (ID8). Further, the interviewees gathered relevant reports of experiences from other departments, hospitals, and software companies.

Tailoring the EMR to the context involved several circular steps (e.g., dialogue, adjustment, and testing). Sufficient time was needed to test the practicability and functionality from different perspectives (e.g., IT, pharmacy, and clinicians). The goal was to "*find as many mistakes as possible*" (ID4). Thus, the EMR was adjusted to the context and vice versa. Introducing the EMR changed the way of thinking from a paper format to data packages. Therefore, a one-to-one transfer of the paper record into the EMR proved unhelpful.

Interviewee 5 narrated how the EMR user interface, guided by the individual sheets of the paper record, led to unnecessary scrolling and slow page loading. In this regard, the interviewees called for early interdisciplinary collaboration between the clinicians and IT. IT had to know the view of the end-users and participate in the development instead of only putting into practice what the clinicians planned alone: *"A big mistake [. . .] is to only reach out to physicians and nurses. They really always compare it one-to-one with the paper record. You cannot directly compare it. Digital is always different than paper. Also, workflows change. You really have to think it completely new*" (ID4).

While stressing the importance of tailoring the EMR to the individual departments, the interviewees also highlighted the need for a certain level of standardization due to the interlinkage of departmental processes. Therefore, the interviewees opted for a basic configuration with the possibility of adding specifics, which was observed to reduce end-user fears of systems that were too rigid by allowing for moderate adjustments.

The choice of the EMR system was usually guided by technical interoperability. In the context of clinical users, technical interoperability was typically given greater weight than performance. In this regard, Interviewee 5 stated: "*From my personal experience, I would always advise to take the integrated ones [EMR systems] because of the deeper integration and interaction*." In our sample, apart from one case, all decided on the EMR software of the existing hospital information system (HIS), even if the clinicians would have preferred a different software.

Stakeholder co-production: All relevant stakeholders should participate

The interviewees stressed the importance of including the end-user perspective: "*You need a multi-professional team. It is not sufficient if two IT specialists come up with something because they always only have their view of what works theoretically. One also has to think from the end-users' perspective*" (ID10). The end-users were not described as a uniform group but included nurses, physicians, and administrative staff with varying levels of experience working in departments with individual workflows, digital applications, and social cultures. The interviewees emphasized the importance of involving these different views in the implementation process. However, the diversity was challenging due to the high workload and the lack of time for certain groups.

Nevertheless, it was crucial to insist on the participation of all stakeholders: "*The surgical departments did not participate in the planning phase, and during rollout, it became apparent that the basic configuration developed by the internal medicine departments was not suitable for them*" (ID5). Interviewee 6 experienced tension between nurses and physicians due to adverse equipment needs that were not discussed earlier. Several interviewees experienced lengthy agreement processes between different groups and emphasized the importance of planning with sufficient time.

End-user participation: End-users must understand the EMR and commit to its implementation

The interviewees underlined the importance of helping the end-users understand the EMR and feel part of the implementation process. They needed to feel supported, understood, and involved: "*I think it is important that they [end-users] are well taken care of. Really well taken care of. Even when they have problems, not 'see how you manage.' That does not work because then you soon face lack of acceptance*" (ID3). In this regard, personal contact played an important role. Communication and information reduced end-users' negative feelings and resistance, the latter of which was often related to fear (e.g., the inability to operate the EMR or uncertainty about the new workflows), an unwillingness to document in a standardized format, and difficulties in relinquishing familiar processes. Resistance was also reported in cases where end-users felt a lack of participation in the implementation process.

The interviewees noted that the implementation team should openly address challenges: *"You must say openly that the program will have problems. [. . .] The end-user should report the problem, and then we will find a solution together. It is also very important that there is a low reporting threshold so that everybody can easily say, 'There is a problem that I don't understand; how can I deal with it?'*" (ID9). Showing willingness to compromise and find joint solutions was seen as helpful for the end-users. Further, proactive department visits of the implementation team encouraged end-users to ask questions and report problems. Interviewee 11 called for ownership: "*We will not operate this system. It is your system. Make something out of it*."

Training and practical accompaniment were crucial to achieving understanding and commitment. The hospitals used different training approaches. In some hospitals, the implementation team or the software company trained all end-users, while other hospitals took the key-user approach, where only a few staff members were trained with the aim of training their colleagues. Practical accompaniment was perceived as particularly helpful since, initially, many end-users felt insecure, even post-training.

During practical accompaniment, contact persons accompanied the end-users to support and answer questions: *There was big fear: "It's starting, oh God and I can't do it." But during the first days, there was always somebody to support them. [. . .] If you have trainings that take two hours and longer, then obviously, you have seen everything, but when you need to apply this knowledge five days later, what do you still remember? Surely not every detail. Therefore, I believe it was most useful, among others, to be onsite and to say, "Okay, come on, think again" or "We are doing it together, don't worry" (ID5).*

The intensity of accompaniment and responsiveness to end-users was closely linked to the staff resources of the implementation team. In this regard, the key-user approach[2] was useful.

Apart from involving and accompanying end-users, the interviewees described further facilitators regarding the acceptance of EMR. First was a commitment on all levels: "*You need both leadership as well as staff on your side because you cannot implement this against somebody's will*" (ID13). High-level leaders needed to show that they have prioritized the implementation (e.g., by addressing it openly and being responsive to challenges). Head nurses and chief physicians who were convinced of the implementation of the EMR convinced their teams. Therefore, the interviewees called for early engagement with department leaders to jointly plan the rollout.

Second was the identification of pioneers of digitization and starting the process with them: "*They will then convince resisters*" (ID9). A successful kick-off in the first department would have spillover effects in terms of demand for EMR. Third was rotating staff from departments already using EMR to positively influence colleagues still using paper documentation. Finally, resident physicians as key users faced acceptance problems, so medical key users needed a higher hierarchical position.

Daily routine integration: End-users must integrate the EMR into daily work

The interviewees highlighted that introducing the EMR brought changes into the existing context, particularly regarding workflows. For instance, physicians needed to assume documentation tasks that were previously delegated to nurses and resident physicians. After the transition to the EMR, documentation required the physicians to log in. When they failed to do so, subsequent documentation for other occupational groups was delayed. For instance, nurses could only document the administration of medication if physicians had prescribed it in the EMR.

Moreover, controlling required surgeons to indicate in the EMR that a surgery was completed to process invoices. After experiencing work stagnation due to unawareness of such changes, the interviewees emphasized the importance of organizational development and communication. Thus, professional groups and departments should be aware of new workflows and each other's responsibilities within the EMR.

The interviewees also observed that experiencing the advantages of EMR use facilitated the functioning of new workflows. For example, Interviewee 11 described the difficulty of convincing physicians to type consultation reports into the EMR. However, this attitude changed when they realized the fast transmission, easy access, and avoidance of extra phone calls due to using it.

Therefore, the relative advantages of using the EMR were emphasized as immediately unapparent but evident later on. Initially, the EMR was perceived as extra work. The end-users' early feedback was that the system was not intuitive, too different, too complicated, and required too much time to log in. Interviewee 3 stressed addressing such issues empathetically while underscoring the prospects: "*I tell them, 'Sure, it is more complicated. You are learning something new. This cannot happen overnight. But I tell you, in four weeks, you will ask yourself why you did not have this earlier.*"

Nonetheless, several interviewees observed that the end-users still used paper workarounds. They suspected that the end-users had not gotten used to directly documenting in the EMR.[3] *"Many took a piece of paper and wrote down vital signs and later entered them into the computer. […] So, we joined them for their morning round. We said, 'Take it [trolley with computer] into the patient room and type in your data directly in front of the patients'"* (ID3). Highly insecure end-users needed more time to adjust to the change. In such cases, the possibility of documenting on paper first and then transferring the information to the EMR later was seen as helpful. The interviewees assumed that using additional paper would be reduced with the further development of EMR functions.[4]

The studied hospitals implemented the EMR stepwise from department to department, and/or they digitized EMR functions stepwise. According to the interviewees, this approach helped to reduce end-users' fears. Not starting with exclusively digital documentation made them feel more secure. The stepwise approach facilitated guiding each end-user through the documentation process and maintaining operational procedures even if not all staff were trained. However, the stepwise implementation involved a phase of simultaneous digital and paper documentation, which created challenges (e.g., medical reports were partly digital and partly paper-based). Interviewee 5 observed that after becoming accustomed to the EMR, the end-users perceived having two parallel systems as disturbing. Retrospectively, Interviewee 5 believed that an immediate change to the EMR might have worked well. However, due to existing fears, the stepwise approach was useful.

Continuous PDCA cycle: The EMR and implementation process must be continuously reviewed and adjusted

The EMR was continuously adjusted and improved, even after rollout in the entire hospital. Interviewee 3 compared it to the nursing process: *"You check what you need […]. You prepare it, plan everything, and implement. Then, you check if it works or not. You evaluate and adjust again. And then it starts all over."* The interviewees mentioned various approaches to monitoring and quality assurance: regular feedback rounds, written feedback, observations, meetings with department leaders and representatives of professional groups, and quality checks of documentation. The role of personal communication was emphasized: *"Actually, you always need to actively reach out to the people. Are there problems? Because there are problems*" (ID2). Several interviewees found it challenging to convince physicians to participate in feedback rounds compared to high levels of participation from nurses. Nevertheless, the participation of both groups was important (e.g., for clarifying new workflows).

The interviewees stressed the need for flexibility toward necessary adjustments arising during the implementation process. They mentioned strategic adjustments after experiencing unforeseen challenges or reactions from end-users. Interviewee 5 described that due to the unexpectedly high demand for training, the implementation team conducted far more training than initially planned.[5]

Discussion

Our findings indicate that beyond technical considerations, EMR implementation is a highly social process [15] that entails agreement processes between stakeholders with the accompaniment and consideration of end-users. The context of EMR implementa-

[2] In Germany, medical products law defines an EMR as a level-1 medical product requiring that the training staff must be trained by the software company, even for software updates, which can cause challenges since every training involves financial costs and key-users' exemption from work.

[3] In some cases, there were not enough mobile devices for direct documentation or not all end-users had received training, so they had to document by hand at first and forward the information to their trained colleagues.

[4] At the point of data collection, the interviewees reported that care unit overviews were not yet displayable in the EMR, so they were usually printed out.

[5] The high demand predominantly came from part-time employees who feared missing out on information.

tion was identified as a unique and dynamic social system [13] that interacts with and influences the implementation process [16]. Therefore, the identified preconditions were achieved through different approaches depending on the local context. Even within the same hospital, departments applied varying implementation strategies. Not giving adequate attention to each department's context resulted in implementation flaws [3,21]. End-user satisfaction was highly influential in the implementation process and outcome [9,10]. Therefore, we suggest that social embedding is crucial to EMR implementation in hospitals.

Our findings strongly align with prominent theories in implementation science. In particular, our findings are consistent with normalization process theory (NPT) [13,22,23], which characterizes mechanisms empirically shown to motivate and shape implementation processes and influence their outcomes. Below, we discuss how the outlined preconditions and activities align with the four mechanisms of NPT: coherence, cognitive participation, collective action, and reflexive monitoring [13,23,22].

Coherence refers to end-users' sensemaking [24]. Since EMR advantages emerged only after the difficult initial implementation phase, starting with departments familiar with the benefits of digitalization would be helpful. Indeed, peers highly influenced attitudes toward EMR use [25]. Moreover, chief physicians and head nurses highly influenced the acceptance of the EMR within their departments. Their early involvement positively influenced its implementation [25].

Cognitive participation considers the relational work that facilitates end-user engagement [13]. Participation and face-to-face communication from the onset were key factors for end-user satisfaction [26]. The crucial role of training and practical guidance [3,27], as well as the benefits of the key-user approach [15,28], were previously described. We further emphasize that the latter enables the satisfactory accompaniment of end-users without challenging the implementation team's staff resources.

Collective action requires the EMR to be integrated into the work processes. The EMR is a new form of documentation that includes new workflows and clearer responsibilities [15]. Therefore, the context analysis must capture the status quo with the (anticipated) changes due to the EMR implementation [5]. These changes need corresponding organizational development, communication, and mediation between professional groups and departments to avoid workflow stagnation and subsequent end-user dissatisfaction. Directly experiencing the advantages of EMR use facilitates functioning workflows [15]. Further, hierarchies must be considered when assigning medical key users.

Regarding EMR implementation, the literature describes immediate[6] and stepwise approaches. The latter reduces productivity loss linked to workflow challenges and allows gradual learning but requires close attention to hybrid processes [2,5,8]. It also requires sufficient trained staff, close accompaniment, and high IT and software company responsiveness [8]. All cases in our study were implemented stepwise, which reduced end-user fear.

Reflexive monitoring is necessary to evaluate the implementation. Our findings show the importance of maintaining intensive communication with end-users by actively gathering feedback during planning, testing, rollout, and beyond. EMR implementation is a lengthy process that does not end with restructuring a hospital or introducing new software [8,15]. It is one step within the digitization process that builds on past digitization (e.g., HIS). The initial implementation is seen as a precursor to implementing more patient-centered technologies, such as Open Notes, where patients can access their medical records and notes in real time [29], which ultimately results in circularity. Indeed, the rollout of the EMR may be linear and monolithic, but the continuous adjustment and development of the EMR suggest a circular nature.

Our study underlines the need for a stronger linkage between research and practice. Although multitudes of implementation studies and frameworks exist [30,31], the interviewees experienced commonly mentioned pitfalls, such as not assessing department specifics before rollout. Moreover, they only harnessed fellow practitioners' experiences without research findings. This knowledge-practice gap [32,30] and the challenge of transferring scientific knowledge into practice [33] were described previously. Openly available research-based frameworks and practical toolkits (e.g., the Context Compass Framework [34] and the ItFits-toolkit [35]) need to be diffused to practitioners. One potential challenge for the German context is the use of English in frameworks and toolkits. Translations may be helpful for dissemination in non-English-speaking countries. Therefore, we provide the table of preconditions in German (see Appendix A, Supplement 2). Additionally, tailor-made training courses may benefit practitioners [33].

Strengths and limitations

Our study gives insights into EMR implementation processes in German hospitals by highlighting general preconditions and activities. However, an onsite study of the implementation process would have yielded more reliable data. Indeed, recall errors and socially desirable responses may have influenced the interviewees' memories. We used the CFIR deductively to ensure the consideration of all relevant context factors. Detaching the structure of our results from the CFIR reduced complexity and improved practicability.

Due to our sample size and the qualitative nature of the research, the findings are not intended to be generalizable to broader populations. The sample includes many interviewees with nursing and IT backgrounds. Therefore, physicians' reactions during implementation were predominantly described from the perspectives of nursing and IT. All cases were implemented stepwise, so our sample did not include interviewees who applied the immediate implementation approach. However, to our knowledge, this approach is not widespread in Germany. Given the ongoing digital development of hospitals in Germany, the current situation may differ significantly from the time of data collection in 2021. Nevertheless, based on Blase et al.'s report on the slow progress of digitization in German hospitals, this scenario seems unlikely [1].

Conclusion

Our results indicate that successful EMR implementation requires a deliberate intertwining of technical and social aspects. We emphasize that the strong influence of the local context and, particularly, end-users require a tailored implementation. The co-creation of all stakeholders and the participation of the end-users are essential. We also emphasize the importance of having an internal implementation team composed of representatives from all professional groups involved.

Our findings refer to EMR implementation but may also be transferable to other digital innovations in hospitals. Our study aligns with previous investigations and aims to bring research and practice closer together by packaging scientific results into preconditions and actions for practitioners to use. Hereby, our findings may especially apply to the German hospital context.

[6] The immediate approach minimizes hybridity (between different departments and within departments) but requires significant financial and staff resources [2,5,8].

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Conflict of interest

JKN: Associate Editor Zeitschrift für Fortbildung, Evidenz und Qualität im Gesundheitswesen (ZEFQ). The other authors declare that there is no financial/personal interest or belief that could affect their objectivity.

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Appendix A. Supplementary data

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