

# A Case Study of Technology Use and Information Flow at a Danish E-clinic

Berglind F. Smaradottir  
Dept. of Clinical Research  
Sørlandet Hospital Trust  
Kristiansand, Norway  
[berglind.smaradottir@uia.no](mailto:berglind.smaradottir@uia.no)

Rune W. Fensli  
Dept. of ICT & Centre for eHealth  
University of Agder  
Grimstad, Norway  
[rune.fensli@uia.no](mailto:rune.fensli@uia.no)

**Abstract**—There is an urgent call from health organizations, health professionals and health authorities to re-design care delivery for patients with chronic conditions and multi-morbidities. The research project 3P- Patients and Professionals in Productive Teams aims to study health care services that are run with different patient-centered teamwork models. In this context, a case study was made of an E-clinic in Denmark, with a focus on the technology use and information flow in a patient-centered clinical care context. Qualitative methods were applied with observations and interviews with key informants. The results showed that information flow worked well in a patient-centered care perspective, even though the technology was a standalone system for the E-clinic and with limited interoperability with other health care providers.

**Keywords**—*telemedicine, patient monitoring systems, health technology assessment, health care information systems, chronic obstructive pulmonary disease*

## I. INTRODUCTION

Globally, health care services are facing challenges of providing individualized treatment to the sharp increase of persons prone to chronic conditions and multi-morbidities [1]. This trend is threatening the sustainability of the health care systems [2][3][4] and there is a need for innovative action to transform a classical profession-centered health care system to a citizen-centered system that is 1) person-centered, 2) integrated and 3) proactive [1]. A patient-centred health care system supports self-management and builds on a proactive stepped care plan with personal goals. Technical solutions for communication between health providers and patients are a central element in integrated and patient-centered care models [1]. Patient-centered care teams that operate across organizational borders need efficient technical solutions that support the clinical workflow and facilitate coordination in the information flow [5].

In this context, the research project 3P- *Patients and Professionals in Productive Teams* aims to study health care services models that are run with patient-centered teamwork approaches in four health regions of Denmark and Norway [6]. 3P is a 4-year long project (2015-2019) with five scientific work packages that target different aspects of the patient-centered collaborative work, including digital support within a care team and across organizations [7][8][9], implementation [10], patient

experiences [11] and patient safety. One of the health organizations included in the 3P-project is the E-clinic that is located in the Odsherred Municipality in Denmark.

This paper presents a case study of the technology support and information flow in the E-clinic. The E-clinic was run with a service model targeting 40 chronic conditions and had a telemedicine service for chronic obstructive pulmonary disease (COPD) patients. The service model had the aim of supporting the self-management and independent life of the citizens in the region by providing telemedicine services, in line with the other models [12][13]. The World Health Organization (WHO) has predicted COPD to become the fourth fatal disease globally in 2030 [14] and also emphasized the need for patient-centered health care service models [15]. This patient group is prone to pulmonary infections and exacerbations requiring hospital admission for medical treatment [16]. In this context, the E-clinic aims to prevent hospitalization with rapid actions on deterioration based on an algorithm embedded in the telemedicine solution. The research questions (RQs) stated for the study were:

RQ1: *How does technology support the communication and information flow within the E-clinic and with patients?*

RQ2: *What are the benefits and constraints of the technology used in the E-clinic?*

Following this introduction, the research methodology is presented. The results from the evaluation of the information flow and technology are described in section III. In section IV and V, a summary on the study contribution is made and conclusions are drawn.

## II. METHODOLOGY

Qualitative research methods were applied in the study of the E-clinic [17][18]. A field study with observations at the E-clinic was made during two days in September 2019. A total of 7 people contributed as informants, including health care professionals (nurse and physician), technical developer, patients and a family member.

Two semi-structured group interviews were made with 3 informants, (2 nurses and 1 physician). Another semi-structured group interviews was made with a COPD patient, a family member and physician. The patient made a demonstration of the

---

This research was funded by the Norwegian Regional Hospital Trusts with Grant number 243857 HelseForsk.

technology used for remote monitoring during the interview. The interviews addressed organizational issues, use of technology, experienced usability and challenges in the operation. They also targeted benefits and constraints and the information flow in the E-clinic and the telemedicine intervention, particularly focusing on coordination and communication within the team, with the patient and across organizations.

An observation was made of a physician and the technology use during a clinical first time consultation at the home of a COPD patient, for inclusion to the telemedicine intervention of the E-clinic. Finally, a field visit was made to the technical developer of the telemedicine system with a thorough demonstration of the user interface and functionalities available, and an interview was made.

The collected data consisted of audio recordings and detailed annotations, that were analyzed and categorized into three main groups. The Norwegian Centre for Research Data approved the study, with project number 53771 [19]. All informants participated voluntarily and signed a consent form.

### III. RESULTS

#### A. The Organization of the E-clinic

The E-clinic was organized as a municipal health service, with 2 nurses responsible for the daily operations, see Fig. 1 and with a physician available for medical advises and consultations 24/7. The E-clinic was established to improve the health services to patients with chronic conditions in the region. There was a telemedicine service for monitoring of COPD patients, with the overall aim of preventing exacerbations and clinical worsening of the disease. The patient himself and other health providers could initiate contact with the E-clinic. In the inclusion procedure, a physician visited the patient at home for medical examination, clinical measurements and digital registrations. For each included patient the physician prepared a personal plan for treatment and a set of medications that were available at patient's home. The E-clinic worked as one-point-of contact for the enrolled patients and there was a team of emergency nurses that could attend patients at home and there were patient rooms available for short-time stays.

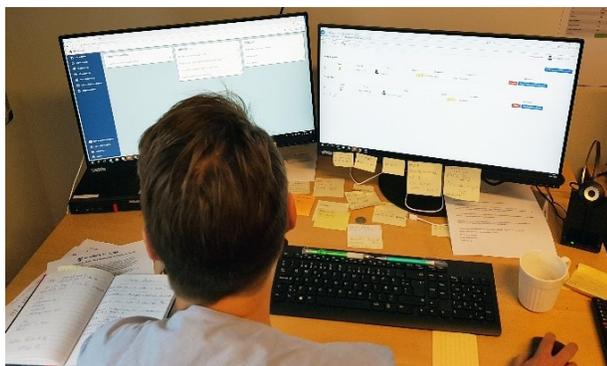


Fig. 1. A nurse using the two work stations in the Response and Coordination Central of the E-clinic.

#### B. The Patient at Home

COPD patients at home had a tablet device, with a pulse oximetry and spirometer with Bluetooth transmission, see Fig. 2. The tablet had a simple user interface that made it easy for the patient to make measurements, register them and sending to the E-clinic. There were also a few clinical questions to answer in the user interface. The equipment needed network connectivity for transmission to the E-clinic. Videoconference and telephone was used to communicate with the E-clinic. The municipality owned the technical equipment and it was permanently borrowed out to the patient.

Newly included patients for the telemedicine intervention had a home visit by two nurses from the E-clinic that installed the technical equipment and provided user training. New patients were asked to send measurements daily for a period of 14 days to establish overview of the clinical status and register trends. Later, measurements could be sent mainly during deterioration and need of medical treatment. The patients had access to own medical information stored in the tablet solution and digital access to the medication list in the national health data repository, but no access to remote monitoring information in electronic health records (EHR).



Fig. 2. A patient using the telemedicine equipment at home.

#### C. The Technology and Information Flow

Two technical systems were used to carry out the services at the E-clinic: Appinux and Cora. In addition, the patient's data was stored at the General Practitioner's (GP) EHR system and also in the hospital EHR. Fig. 3 shows the information flow between the involved actors and the technology. The solid blue lines represent direct data access, the dotted blue lines indicate messages that can be sent between the inter-organizational team partners. The dotted red lines indicate possibilities for access to national health data registries, like the Joint Medication Card.

Appinux was used as EHR-system for the E-clinic with functionalities to have a whiteboard overview of the enrolled patients and their current status, for communication within the E-clinic and supporting the clinical workflow in remote monitoring. The clinical measurements sent by patients at home had early warnings to detect deterioration and there was clinical decision support with color triage.

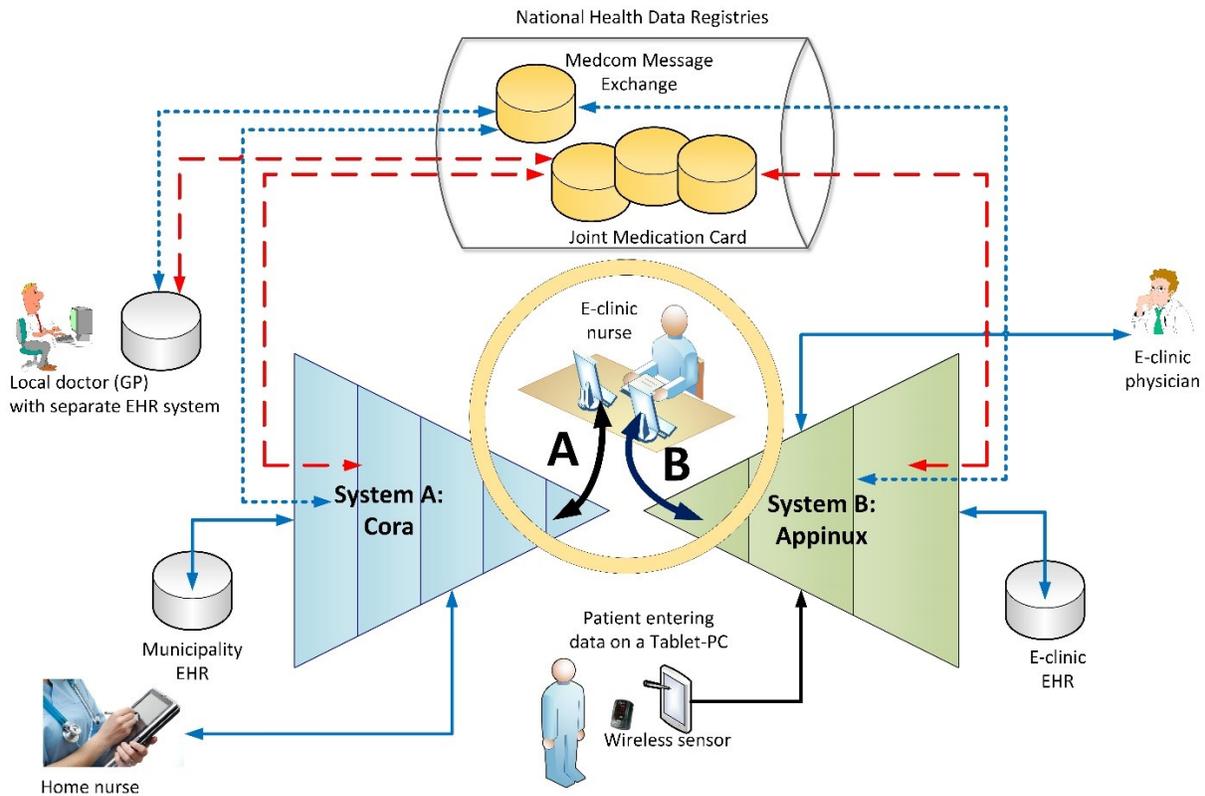


Fig. 3. The information flow between the E-clinic and other health care providers.

The system was connected to a centralized data server for storage through broadband access. The system was not technically integrated with other health care providers, meaning that electronic messages could not be sent. The information in this system was only available for the health professionals at the E-clinic and not to other municipal staff. The system had not implemented 2-way communication between the patient and the E-clinic for confirmation of verbal information as written messages or notes.

Cora was the municipal EHR system that was used for statutory documentation and communication with other health care providers, using the national message exchange services. To avoid double manual work in the input to both systems, it was possible to copy information from one system to the other one. This was an important task for the E-clinic nurse at the Response and Coordination Central, which had to use two different workstations for the two EHR-systems. The physician had access to the national health data registry for list of medications.

#### IV. DISCUSSION

This paper has presented a study of the technology use and information flow at an E-clinic run with a patient-centered care model. The research questions (RQs) are answered based on the results.

RQ1 asked about how the technology supported the communication and information flow at the E-clinic. To be able

to carry out remote monitoring different systems had to be used. One system targeted the telemedicine intervention, with an overview of enrolled patients, overview and clinical triage of measurements and it was also used for internal messages within the E-clinic and communication with the physician. This system had a specific digital form for the physician upon inclusion of patients. Another system had to be used for communication with other health care providers and for statutory medical information. To access the patient's medication list a third system had to be used.

The tablet application at patients home was easy to use and stored a history of own measurements, but it had the constraint of lacking 2-way communication with a message function from provider to patient to confirm verbal information such as medical advises given over telephone or videoconference. The patient had access to no other information stored at the E-clinic.

RQ2 asked about benefits and constraints of the technology used in the E-clinic. The study showed that the technology used for telemedicine intervention was tailored for remote follow up of COPD patients. It was suited for collaborative teamwork that incorporated professionals within the E-clinic. However, the system was run beside the municipal EHR and administrative system and had limited technical integration and communication with other health providers such as General Practitioner (GP) and hospital specialists. A benefit of the technology was that the telemedicine equipment was placed permanently at the patient's home and with no time limitation for the intervention, other similar interventions often have a time limitation [7][20].

Consultations were mainly carried out in worsening of the patient's clinical conditions and the patient could choose when to send in clinical measurements. The videoconference function was available, but not frequently used as the nurses at the E-clinic also attended patients at home, and for this reason they considered telephone as more practical for remote follow up. The ambulant nurse service was a supplement of the service in case of deterioration, with clinical measures and blood sample equipment. During ambulant visits the nurses had access to and could enter clinical information to the systems using a tablet device.

This study has some limitations, such as a limited number of informants and performed in one health region. However, the study participants had different professions and backgrounds, meaningfully representing the target user groups at telemedicine clinical services. The main contribution lies on the evaluation of benefits and constraints, applicable and transferable to other patient-centered care contexts.

## V. CONCLUSION

Through the E-clinic project in Odsherred Municipality, new ways of digitally supported service delivery focusing on citizen-centered care at home and collaborative work is being tested over time. The different EHR systems in use have different focus in how to organize patient information. The E-clinic system gave an easy overview of the patient's actual status, measurements made at home with triage and an overview of technology in use, in addition to team functionalities as messages and calendar functions. The municipal EHR system focused on the patient's functions, needs of health care support and initiated care plans with visits of home nurse. Also, the list of consents given. The GPs EHR system focused on the patient's status, diagnoses and medication, in addition to referrals and epirises. This different focus in how such EHR systems are designed will have an impact on their use and how they can be tailored for different contexts. As such, it seems difficult to combine a reasonable medical support, team function support and telemedicine functions for patients at home with a need of efficient information flow with his/her support-team. Those issues need to be solved, to be able to work with a patient-centered care model with collaboration and coordination across digital systems and organizational borders.

For successful implementations and operation of telemedicine, a close collaboration is needed between municipal health services, hospitals and GPs, which was well-planned and established in the E-clinic. New services are costly to operate and it takes time for realization of benefits. However, already after few months of operation, there are indications of reduced admissions to hospital. A long-term evaluation on large-scale operation is needed to gain evidence for the service model, and a before-and-after study is being made.

In addition to telemedicine intervention, the next step might be to test out other ways of delivering digital health services, such a virtual home visits. Future research agenda targets a comparison of the results from the E-clinic with organizations utilizing telemedicine in other countries.

## ACKNOWLEDGMENT

The authors thank Søren Vingtoft for collaboration and outstanding helpfulness in the practical organization of the interviews in the research arena.

## REFERENCES

- [1] G. Berntsen, F. Strisland, K. Malm-Nicolaisen, et al., "The evidence base for an ideal care pathway for frail multimorbid elderly: combined scoping and systematic intervention review," *JMIR*, 21(4), e12517, 2019, doi:<http://dx.doi.org/10.2196/12517>
- [2] S. Afshar, P.J. Roderick, P. Kowal, et al., "Global Patterns of Multimorbidity: A Comparison of 28 Countries Using the World Health Surveys," Hoque MN, Pecotte B, McGehee MA, eds. *Applied Demography and Public Health in the 21st Century*. Cham: Springer International Publishing 381-402, 2017, doi:10.1007/978-3-319-43688-3\_21
- [3] C. Violan, Q. Foguet-Boreu, G. Flores-Mateo et al., "Prevalence, determinants and patterns of multimorbidity in primary care: a systematic review of observational studies," *PLoS One*, 9:7, e102149, 2014, doi:<https://doi.org/10.1371/journal.pone.0102149>
- [4] S.H. van Oostrom, R. Gijzen, I. Stirbu et al., "Time trends in prevalence of chronic diseases and multimorbidity not only due to aging: data from general practices and health surveys," *PLoS One*, 11: 8, e0160264, 2016, doi:<https://doi.org/10.1371/journal.pone.0160264>
- [5] B. Smaradottir, R. Fensli, I.A. Naley Ås and F. Gallefoss, "Telemedicine follow up of chronic obstructive pulmonary disease integrated into a patient-centered health care team setting," 2017 International Conference on Computational Science and Computational Intelligence (CSCI), Las Vegas, NV, 2017, pp. 1779-1781, IEEE, doi:10.1109/CSCI.2017.311
- [6] Norwegian Centre for E-health Research. 3P- Patients and Professionals in Productive Teams. [retrieved: Nov, 2019]. Available from: <https://ehealthresearch.no/prosjekter/3p/>
- [7] B. Smaradottir and R. Fensli, "A case study of the technology use and information flow at a hospital-driven telemedicine service," *Stud Health Technol Inform*, 244, pp.58-62, 2017, doi:10.3233/978-1-61499-824-2-58
- [8] B. Smaradottir and R. Fensli, "The technology use and information flow at a municipal telemedicine service," *Stud Health Technol Inform*, 251, pp. 293-296, 2018, doi:10.3233/978-1-61499-880-8-293
- [9] B. Smaradottir and R. Fensli, "Evaluation of technology use in an interdisciplinary patient-centered health care team," *Stud Health Technol Inform*, 257, pp. 388-392, 2019, doi:10.3233/978-1-61499-951-5-388
- [10] H.K. Andreassen, K. Dyb, C. May, et al., "Digitized patient-provider interaction: How does it matter? A qualitative meta-synthesis," *Soc Sci Med*, 215, pp. 36-44, 2018, doi:10.1016/j.socscimed.2018.08.036
- [11] E. Lee and D. Gammon, "Identifying personal goals of patients with long term condition: A service design thinking approach," *Stud Health Technol Inform*, 244, pp. 93-97, 2017, doi:10.3233/978-1-61499-824-2-93
- [12] E.H. Wagner, B.T. Austin and M. Von Korff, "Organizing care for patients with chronic illness," *The Milbank Quarterly*, 74:4, pp. 511-544, 1996, doi:10.2307/3350391
- [13] K. Phanareth, S. Vingtoft, A.S. Christensen, et al., "The Epital care model: a new person-centered model of technology-enabled integrated care for people with long term conditions," *JMIR Res Protoc*, 6: 1, e6, 2017, doi:10.2196/resprot.6506
- [14] C.D. Mathers and D. Loncar, "Projections of global mortality and burden of disease from 2002 to2030," *PLoS Med*, 3: 11, 2011-30: e442, 2006, doi:10.1371/journal.pmed.0030442
- [15] World Health Organization. Framework on integrated, people-centred health services. Report by the Secretariat, April 2016. [retrieved: Nov, 2019]. Available from: [http://apps.who.int/ebwha/pdf\\_files/WHA69/A69\\_39-en.pdf?ua=1](http://apps.who.int/ebwha/pdf_files/WHA69/A69_39-en.pdf?ua=1)
- [16] T.A.R. Seemungal, G.C. Donaldson, E.A. Paul, et al., "Effect of exacerbation on quality of life in patients with chronic obstructive pulmonary disease," *Am J Respir Crit Care*, 157: 5, pp. 1418-1422, 1998, doi:10.1164/ajrccm.157.5.9709032

- [17] N.K. Denzin and Y.S. Lincoln, Handbook of qualitative research, SAGE Publications Inc, 1994.
- [18] H.K. Andreassen and M.V. Trondsen, "How to use qualitative interviews in e-health research," Proceedings of the Seventh International Conference on eHealth, Telemedicine, and Social Medicine: eTELEMED, pp. 22-27, 2015.
- [19] The Norwegian Centre for Research Data. [retrieved: Nov, 2019]. Available from: <http://www.nsd.uib.no/nsd/english/index.html>
- [20] M. Gerdes, F. Gallefoss, R. Fensli, "The EU project "United4Health": Results and experiences from automatic health status assessment in a Norwegian telemedicine trial system," J Telemed Telecare, 25:1, pp. 46-53, 2017, doi:10.1177/1357633X17735558