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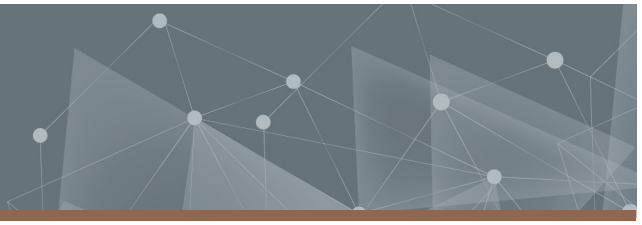

Next generation mobile integrated healthcare

Evaluation and development of the Skaraborg model

Master's thesis in Biomedical Engineering

AMIR ABASS

DEPARTMENT OF ELECTRICAL ENGINEERING

CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2022
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Department of Electrical Engineering
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Abstract

Sweden is recognized as having one of the best healthcare systems regarding medical outcomes at a reasonable cost. However, the Covid-19 pandemic has highlighted many shortcomings in the system: staff and bed shortages, increasing waiting times, and poor coordination of care for patients with complex care needs. Moreover, the demands on healthcare are predicted to increase further due to longer life expectancy, a higher proportion of patients with multiple diseases, and an increased population size. Home-based mobile integrated healthcare has become a prominent alternative. The Skaraborg model of mobile care, implemented in 2008, has been commended for increasing well-being and reducing healthcare consumption for elderly patients with complex care needs. However, the model has had limitations and problems that have escalated during recent years. The model only covered 0.2% of the regional population, and the mobile care unit struggled with staff shortage and a high workload. Thus, in 2020 a new model of mobile care was introduced, aiming to expand the beneficial outcomes of the 2008 model to a broader patient group and to further address the problems.

This thesis examined the new model of home-based mobile integrated healthcare at the Skaraborg Hospital Group (SHG) in the western region of Sweden. The aim was to identify the organizational structure, working process, the type of patients and examine the impact on healthcare consumption of the new model. The DMADCL method, an acronym for Define, Measure, Analyze, Design, Control, Learn, was utilized. The DMA-part consisted of defining the purpose through participative observations, unstructured interviews, and qualitative and quantitative analysis. The findings were then reviewed together with the mobile teams and issues that could be solved with digital tools were identified. These issues were addressed during the DC-part of the method, translating the teams' ideas to prototypes that were implemented and validated. During the Learn phase, the overall learnings for the mobile unit were summarized, providing additional ideas for future improvement initiatives.

The results demonstrate that the new model of mobile care covers a broader set of patient groups providing different types of services and has led to a reduction ($p<0.05$) in healthcare consumption. Moreover, two digital tools have been developed in collaboration with the mobile unit. One tool, a visual dashboard, enables the teams to identify care providers that are not utilizing the mobile unit to the full extent, thus aiding the teams in their goal to increase the number of referred patients. The second tool entails an online questionnaire to collect data on what healthcare resources had been used if the mobile unit had not been involved in the care of the patient. Concluding remarks highlight areas of development for the new model of mobile care and the potential for increased collaboration between different healthcare providers in the area.

Keywords: mobile integrated care, home-based mobile care, healthcare consumption, digital tools in healthcare, Skaraborg mobile care

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This thesis would not be what it is without Svante Lifvergren; the greatest of thanks for the tremendous support, guidance, and enthusiasm throughout the project in a perfect blend of insight and humor, elevating the thesis to the next level.

Many thanks to the personnel of the mobile teams for taking time out of their schedule and reminding me of the value we create for the patients, being seen as people and not numbers.

A special thank you to Charlotta Smedberg, Reza Javid Govinda, and Charlotta Rosenberg for their help facilitating the work, turning the large mountains into small hills, and to my examiner Stefan Candefjord for his valuable feedback.

Finally, to family and friends–forever grateful for the endless support through thick and thin.

Amir Abass, Gothenburg, September 2022

List of Acronyms

Below is the list of acronyms that have been used throughout the thesis, listed in alphabetical order:

Acronym	**Description**
ICD	International Statistical Classification of Diseases and Related Health Problems
ICP	Individual care plan
MPCP	Mobile primary care physician
SHG	Skaraborg Hospital Group
PO	Participative observation
USI	Unstructured interviews

Below follows a list of helpful explanations of terms used throughout the thesis, listed in alphabetic order:

Term	**Definition**
FMEMNÄ	South mobile team based in Skövde
Healthcare consumption	Unplanned emergency- and inpatient care
Inpatient care	Care through admission to a hospital
LMEMNÄ	West mobile team based in Lidköping
MMEMNÄ	North mobile team based in Skövde
Outpatient care	Care that can be provided without requiring admission to a hospital
SMEMNÄ	Emergency mobile team

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Introduction

In Sweden, hospital- and primary care services are organized at a regional level and after-care services at a municipal level [1]. The 21 regions in Sweden are responsible for specialized hospital care as well as primary care within their geographical areas [1]. The municipalities manage after-care services including home care and elderly care in nursing homes. Currently, Sweden's healthcare system is under a historical amount of pressure due to increasing life expectancy, including a higher proportion of patients with multiple diseases, an increasing population, and a pandemic [1–5]. The needs of elderly patients with complex care needs, i.e., multiple chronic diseases, were challenging to meet before the pandemic as they require significant resources [3, 6, 7]. With the further reduced resources, the current situation exposes the flaws and problems in the healthcare system. Particularly, the management of patients with complex needs [6, 8]. A transformation from hospital-based to home-based mobile integrated care for patients with complex needs, as done by the Skaraborg Hospital Group (SHG), has been thoroughly reviewed and provided multiple advantages allowing for the needs to be met, reducing unplanned emergency- and inpatient care visits (i.e., healthcare consumption), and increasing the well-being of the patients [1–4, 9]. However, a new working method for home-based mobile care covering a much broader set of patients was introduced less than two years ago and has not been evaluated yet. Hence, potential benefits as well as the effect of the new mobile care model in SHG on healthcare consumption has not been studied. Particularly, the mobile teams are unaware of the impact of their proactive patient contacts, why it is challenging to formulate objectives for future improvements of mobile care. By documenting and evaluating the new model and its impact and creating digital tools, the groundwork for improvement and expansion of SHG's mobile care model is laid.

1.1 Introduction to the mobile care concept

The healthcare system has always faced challenges, yet the complex situation of today with a growing population, longer life expectancy, and proportionally higher number of patients with multiple and complex diseases pose great challenges [2, 4, 9, 10]. In Sweden, a significant amount of healthcare resources, 80-85%, are spent on chronically ill patients, and 50% of the resources are dedicated to patients with

complex care needs [1,2,11]. Moreover, there is a shortage of staff in the health professions, further increasing the difficulties in the treatment of patients with complex needs [5,9]. These patients all require individual care plans (ICP) that integrate and coordinate their care across the different care providing organizations, i.e., hospitals, primary care units and municipality care facilities Thus, a shift from hospital-based care to patient-centric home-based mobile care is needed involving all the care providing organizations [1,3,11].

1.1.1 International and national examples of mobile care

International examples

An international literature review study looking at home-based primary care (HBPC) between 2010 - 2020 showed that HBPC decreased healthcare costs, reduced hospital admissions and inpatient care, and improved patients' quality of life and satisfaction with care providers [12]. The patient groups were often medically complex frail older adults [12]. Successful factors for HBPC teams practice were a shared vision, effective communication, and a holistic patient-centered care perspective [12]. HBPC patients had a higher cost for the first 12 months, but a lower cost after 24 months. Overall, the patients had lower inpatient- and higher outpatient care costs [12]. Biometric monitoring and distance contact devices between the care provider and patient increased over time and proved helpful for patients with complex chronic diseases, and in some cases, resulted in a reduction of home visits [12]. Connectivity issues and patients' struggle with new technology were identified as barriers in telehealth [12].

Recently, models for the care of patients living with HIV have shifted from hospital-based care to home-based care. The switch was due to an increasing number of patients, the unpredictability in the ratio of patients and healthcare providers, and increased costs [13]. The benefits of home-based care compared to hospital-based care for patients living with HIV and their relatives can be classified into eight categories: "patients' satisfaction, expanding access to services, quality of life, biochemical outcomes, adherence to ART, prevention of mother-to-child transmission, social outcomes, and psychological outcomes" [13, p. 199].

National examples

The Borgholm model is often referred to as a successful implementation of home-based mobile care from the primary units [14, 15]. With a population of 10 000, majority elderly, the Borgholm primary unit implemented "Hemsjukhuset" together with the municipality care, as a home-based mobile care model. The patients registered in the municipality care system are provided with home-based care by physicians when needed, and the municipality care nurses have a continuous dialogue with the primary unit regarding the patient [14]. The benefits of the model from the patient's perspective include a reduced risk for infections, fewer fall accidents, and an improved quality of life [14,15]. The "Hemsjukhuset" model has resources to care for 250 patients simultaneously. The primary unit consists of 50 employees, and

the municipality care has 20 nurses and 180 care employees [14]. Evaluations have shown a reduction in outpatient care (7.8%), inpatient care (7.2%), and emergency care (18.9%) [14].

In the Östergötland region, Linköping hospital has two sections that provide home-based mobile care, the Infirmary-connected home healthcare (LAH) section, and the local care section. LAH is responsible for ensuring good palliative care based on patients' unique needs [16]. The care is provided round-the-clock through specialized home-based care and specialized palliative inpatient care. Specialized home care focuses on unstable patients with complex care needs [16]. The inclusion process is based on patient-by-patient assessment, considering the individual patient's physical, mental, social, and existential needs to ensure that the patients have the highest quality of life possible in their final stages of life [16]. The teams are composed of physicians and nurses and have access to six reserved emergency beds [16].

Örebro region offers home-based mobile care to patients over 65 years of age with chronic illnesses [17, 18]. The mobile team consists of a chief physician from the geriatric ward and a nurse from Örebros municipality care [17]. The team provides basic care in the home, for example, blood tests, electrocardiogram (ECG), blood transfusions, and revising drug lists [18]. Emergency beds are also available at the hospital. After one year, an evaluation showed that 85% of all patients referred to the mobile team could be treated in their own homes [17]. The Örebro region plans to conduct a more extensive evaluation of the effect of mobile care on healthcare resources [17, 18].

1.1.2 Mobile care in Skaraborg

Västra Götaland Region (VGR), which includes SHG, is the second largest region in Sweden. As all regions, it is a politically controlled organization [19]. The regional council has the ultimate responsibility for the VGR operations and the SHG steering committee, which exercises political leadership over the hospital [19]. The Skaraborg region consists of 15 municipalities and has 31 primary care units [20]. SHG has four hospitals across the Skaraborg region, shown in figure 1.1 adapted from [21], Falköping, Lidköping, Mariestad and Skövde, and has around 4500 care employees [22]. SHG has a catchment area that entails 260 000 inhabitants [22]. The hospitals have 512 beds for patients [22]. In 2021 SHG had 31 450 cases of inpatient care, 301 400 cases of outpatient care, and 70 700 cases of emergency care excluding psychiatric care [23].

Based on the idea of providing home-based care to elderly patients with complex care needs, SHG implemented the use of home-based integrated mobile care in 2008 [3,9,11,14]. The care model focused on elderly patients with multiple chronic diseases and complex care needs [14]. The team consisted of a specialized physician and two nurses. The team took over the full responsibility of the patient, treating the patient for around four to eight weeks [3]. Since the working method required a high number of resources, the model only provided care for patients meeting at least four of the

Figure 1.1: A map displaying the region and hospitals within SHG

six inclusion criteria presented in table 1.1.

Table 1.1: Description of the six criteria used to assess patient cases for mobile care

Criteria number	Description
1.	Minimum of three hospital admission during the last 12 months
2.	Three or more chronic diseases
3.	Over six medications
4.	In need of health care at home
5.	Age 75 years or higher
6.	Dependent on activities of daily life

These criteria entailed around 0.2% of the population in the Skaraborg area, estimated to 200 patients at the time [1, 3, 14]. The idea of the mobile care model was that ordinary home care was provided by the municipality care, and when a patient become unstable the mobile team was contacted [4, 9]. If the patient fulfilled the inclusion criteria, the team took over the responsibility and developed an ICP for the patient together with the responsible municipality nurse [2]. The goal of the ICP was to relieve symptoms, increase patient's quality of life, and prevent unplanned emergency- and inpatient care. The ICP was shared with all healthcare actors connected to the patient [2, 4]. Additionally, a case manager oversaw and coordinated the care activities between the healthcare providers. The mobile team had access to reserved emergency beds at a regular ward in the hospital, but these beds were seldom used. When the patient's situation was stabilized, the patient was referred back to the open healthcare system [2, 14].

In 2011 a similar mobile based concept with a mobile primary care physician (MPCP) performing home-based patient visits was introduced [3]. The concept was co-

created by the SHG, primary care units, and municipality care facilitates [3]. The idea was that once the mobile team had stabilized the patient, the MPCP would take over the responsibility of the patient, now being classified as a stable patient with complex care needs [3]. Thus, the whole home-based care model consisted of municipality care, assisting stable patients with complex care needs with their daily needs, where the municipality nurse had a communication channel with the MPCP when a physician was needed, who in turn contacted the mobile team when patient became unstable, i.e., required specialized care. From 2018 all primary care units in Skaraborg were supposed to have an MPCP available for patients who had home-based municipality are [24].

The hospital-based mobile care model was shown to have a better effect than traditional hospital-based care for these patients [3, 4]. The patients treated in their homes by a mobile team had an 80% reduction of emergency visits, a 90% reduction of hospital days, and a reduction in cost per capita [4, 11]. Evaluations from 2009-2012 showed improved resource efficiency of 75-92% [14]. Further, the mobile team was able to reduce the healthcare cost per patient by 186 000 Swedish crowns on average [1]. Another critical aspect was the improvement of the patients' quality of life, as stated by one patient: "Doesn't it always feel good when you're not just a number? When someone really cares for you." [9, p. 23]. The increased well-being can be confirmed by research showing that home-based care compared to traditional hospital-based care results in a higher patient satisfaction [25–27]. In addition, since the patients from the 0.2% group suffer from multiple complex diseases, the hospital visits can be taxing and pose a risk of being infected with new diseases. The success was partly due to the joint financing of the SHG, primary care, and municipality care [14]. Another highlighted factor was the steering group's composition, which transcended the healthcare provider's borders. The concept was adapted by VGR in 2014 with the goal to generate the same effect across the region [1, 14].

Simultaneously, SHG started to experience problems with a shortage of staff. The physician that started the mobile team left her position in 2015. In the following years all full-time physicians in the mobile teams left their positions due to a high workload and insufficient support from SHG [28], rendering the mobile team without any physicians. In 2019 the mobile teams were working at a lower capacity, relying on physicians from other departments at the hospital. According to the physicians that left the mobile team, the lack of support from the SHG was two-folded. Firstly, the SHG expressed that the mobile teams were not managing enough patients [28]. Secondly, when the mobile team wanted to hire more physicians, SHG could not adhere to the request for economic reasons which led to an uneven distribution of the workload across teams [28]. The staff shortage created a high turnover of mobile team personnel making it challenging to preserve the model. Moreover, each team only had one physician, why the number of patients managed by the teams had to be reduced (Process leader of the mobile unit, private communication, Mar. 29, 2022).

In 2020 a new model for integrated mobile care was introduced at SHG to expand

the work of the old model. The initial main purpose was to include more patients, preserve the old model's effects, and address workload issues. The new model works as one mobile unit, consisting of four teams, acting as a supportive function for the hospital and primary care, with a similar goal as the old model, i.e., to prevent emergency and unplanned inpatient care [29]. A key difference is that the mobile teams in the new model are not taking over the full responsibility of the patients. Another key difference is the inclusion criteria of patients; all patients above 18 years of age can take part of the services of the new model.

The model has been active for less than two years, and no evaluations of the model and its methods have been carried out, nor has the model been compared to the old model, in particular, the effect of the new model of mobile care on healthcare consumption, making it challenging to identify key areas of improvement to the model. Hence, the new model needs to be evaluated to assist the mobile unit in identifying problems and in the development of possible solutions.

1.2 Aim

The aim of this thesis is to explore, document, and analyze the working process of the new mobile care model that was introduced at SHG in the beginning of 2020. Based on these findings, digital tools should be developed to aid the teams in their daily work with the overarching goal of further developing the model. The aim is specified through the following research questions:

1. What are the key features of the organizational structure, working processes and communication channels in the new model?

2. What impact does the new model have on healthcare consumption and what patient groups do the new model provide care to?

3. What are the main differences between the old and the new model?

4. Based on the evaluation of the new model, what kind of tools can be created to improve the daily practices in the mobile unit?

5. How should the new model further develop?

1.3 Delimitations

The scope of this project will be focused on the SHG mobile unit and its impact on hospital care in relation to the research questions. This study will exclude the potential impact of mobile care on primary and municipality care due to limited access to data. Further, the thesis will not account for the mobile unit's effect on hospital resources translated to cost per visit compared to the cost for inpatient care.

2

Theoretical Framework

This chapter covers the theoretical framework used as a basis for this thesis, the configuration of a sustainable healthcare system, clinical microsystem theory and quality improvement principle and practices.

2.1 Sustainable healthcare systems

Sustainable healthcare systems create value that meets the needs of the current and future customer and stakeholders, and further develop that which can create a more sustainable and robust system in the future [30]. A sustainable healthcare system is deemed adaptive if it can meet the demands of its customers in ever-changing settings while also benefiting the different stakeholders and resources impacted by its operations [9]. Resources are commodities that are either useful in and of themselves or can be used to attain valuable purposes [9]. Sustainable healthcare systems focus on developing and regenerating their financial, ecological, social, and clinical resources [30]. Furthermore, sustainable healthcare systems need to employ the concept of upstream thinking, which entails scanning for potential issues that may already be present in the upstream or the core of operations [30]. To use resources more efficiently downstream, an upstream perspective necessitates a proactive working style that anticipates potential problems and pitfalls [9]. Nonetheless, the modern healthcare system is structured based on various medical specialties, which has resulted in a system that is occasionally disjointed and poorly integrated [5]. An upstream perspective on the care provided is often absent, and there is a lack of a holistic view from the patient's point of view [30]. Care actions along a patient's journey frequently differ in time and location. In light of this, it is critical to assess how healthcare fulfills patients' needs thus creating value (i.e., satisfying patient needs [31]) to its customers and other stakeholders without squandering resources [5, 9, 30].

A typology of three general value configurations adapted for healthcare refers to how care activities are carried out and how the factors that are building blocks in meeting the patient's needs, such as duties, services, and levels of standardization, are organized [9]. The typology distinguishes between chains, shops, and networks [32]. The chain configuration is the most well-known of the three value configurations

[9,32]. Porter's value chain concept is a widely acknowledged language for depicting and analyzing the logic of firm-level value creation [32]. When the configuration is applied to a healthcare setting, care chains (i.e., care processes or patient's care journey) can be sequentially integrated, tying together care resources to provide value to patients throughout their care journey [9]. The shop is a configuration that focuses on resolving complex customer issues in a cyclic relationship between the activities [33]. The shop's structure is defined by what necessary skills and resources are gathered so that they can interact based on the customer's needs [33]. In this circumstance, the patient should have access to all required competencies for dealing with a unique medical problem. The network configuration brings organizations together and enables them to interact, solving problems in parallel that could not be solved independently [33]. In this context, the patient can often be considered a co-creator in the value-creating network through medical technology and mobile care teams [9].

2.1.1 Clinical microsystem theory

The clinical microsystem theory, embedded in the healthcare context, is usually depicted as layers of circles, see figure 2.1. At the core is the patient, providing self-care. The next level represents the individual care provider, i.e., a physician or a nurse. Following is the microsystem, which can be illustrated as a team of medical personnel, and in this thesis is the mobile unit. A clinical microsystem is a small team that works together to provide care for a defined group of patients [9,11,34]. The microsystem achieves results and adapts over time, usually within the framework of larger systems or organizations [11]. These systems and organizations are called mesosystems and macrosystems, respectively [34]. The microsystems are complex adaptive systems, and as such, they must both perform their primary tasks that are their purpose, meet the needs of their staff in the team, and survive as a clinical team [9]. Mesosystems allow microsystems to shift from disparate teams to those aiding patients along their care process by linking the teams [9, 11, 34], often represented as departments in the healthcare setting. The macrosystem is classified as the structure that contains the micro-and mesosystem [9, 11, 34], which in the healthcare context would be healthcare providers–e.g., hospital-, primary- and municipality care–that collaborate within a delimited geographical area. The clinical microsystem theory holds that the quality of care provided by the system can never surpass the care quality of its microsystems [9].

A clinical microsystem team can function as a chain, shop, and network independently while also being a part of a meso- and macrosystem [9]. The team operates as a shop creating value for the patient from a care perspective. The team collaborates with other shops (microsystems), that form the value chain (mesosystem) representing the patient's journey through the healthcare system. Finally, in the macrosystem configured as a network, the team adds value to the healthcare community by knowledge sharing. The concept as a whole emanates from the patient's needs, creating a more sustainable system and allowing for improvement and increased value creation [9].

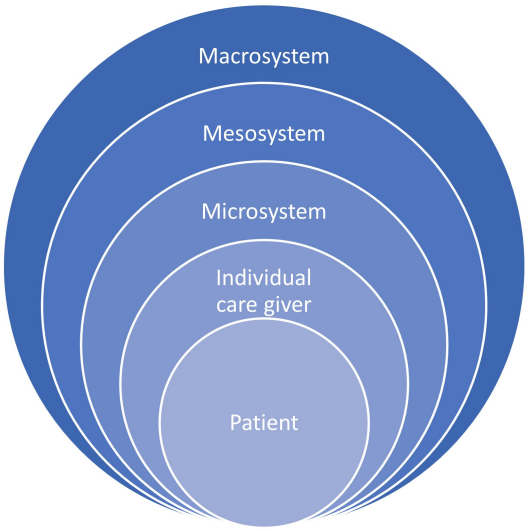


Figure 2.1: A depiction of various system levels in clinical microsystem theory

2.1.2 Quality improvement

Creating more sustainable healthcare microsystems in the aspect of the mobile team is done by preserving the successful aspects of the previous model and applying upstream thinking [9, 30]. Key points for quality improvement are similar to those of a successful microsystem in sustainable healthcare systems. For a microsystem to be successful, it is essential to create participation in cross-professional teams, account for the patient's perspective, make decisions based on facts, continuously monitor results to improve, and jointly formulate long-term goals for joint learning that can effectively bridge the barriers between healthcare actors [9, 35]. Thus, quality improvement can be depicted as a process that defines, analyzes, acts, i.e., designs solutions, and learns upon and from current and potential problems. Improvement work of this type often emanates from the Plan-Do-Study-Act (PDSA) cycle, sometimes referred to as PDCA, Plan-Do-Check-Act [30, 36]. The cycle is often used in healthcare, assisting cross-professional teams in providing better patient care using a structured experimental learning and change-testing methodology [30]. For larger and more complex improvement projects, the DMAIC method, Define-Measure-Analyze-Improve-Control, is often recommended over the PDSA cycle [36]. However, both the PDSA and the DMAIC cycle assume that there is a process to improve [30]. When a new process is to be designed or multiple current processes need to be combined, it is advantageous to use a cycle adapted for design steps, such as the DMADCL method, Define-Measure-Analyze-Design-Control-Learn [30].

3

Method

The method in this thesis has been based on the DMADCL method, depicted in figure 3.1. The DMADCL method considers the key aspects of a successful sustainable microsystem and employs an upstream approach in its phases [30]. The DMADCL method is standardized at SHG [30], making it easy to collaborate with the SHG personnel based on a commonly understood method. As the new model of home-based mobile care at SHG is yet to be evaluated, the DMADCL method has provided a suitable framework for the case. Since this thesis transcends the fields of product development and system evaluation, and the ideas have emerged during the evaluation, the DMADCL method was deemed most suitable to implement and structure the report after.

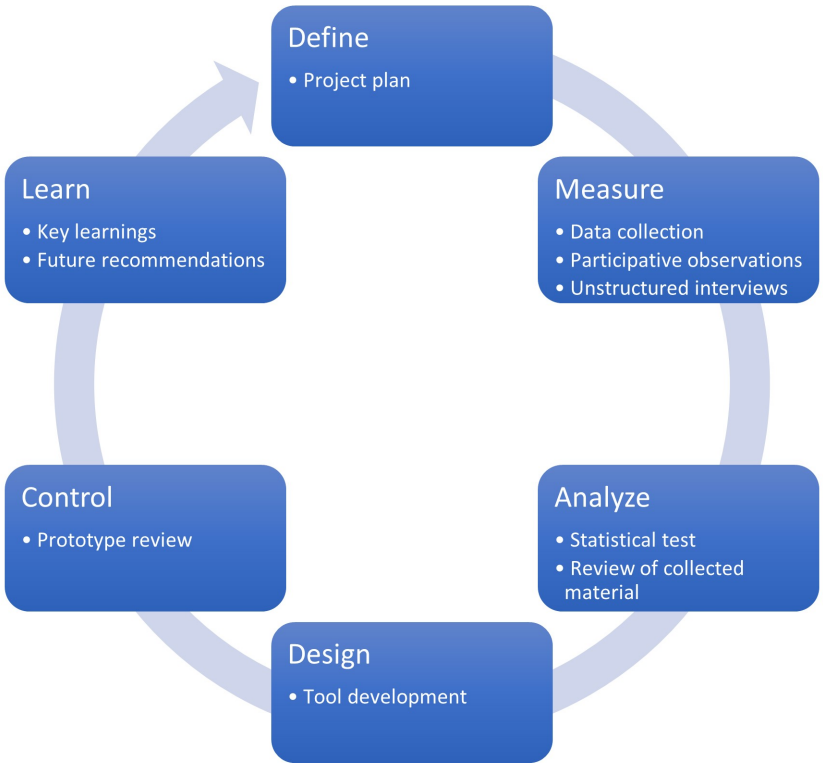


Figure 3.1: A visualization of the DMADCL method used in this thesis

The project can be divided into two parts: DMA-part and DCL-part. The DMA-part constitutes the first steps of the process, including participative observations (PO), unstructured interviews (USI), extraction of quantitative data, and an analysis of these data. Thereby, key quality problems and their potential causes were identified. The DCL-part addressed these problems, focusing on a) the development of digital tools that aid the mobile teams in their daily work, and b) illuminating key learnings both internally for the mobile unit and externally for other healthcare actors to inspire future improvement initiatives. Discussions with the mobile teams at SHG occurred continuously throughout the process, but in particular as a bridge between the analysis and design phases in the DMADCL method. The PO and USI constituted the ground material for the analysis of the new model and provided a comprehensive understanding of the quantitative data. The PO, USI, and analysis were the basis of the design phase. The design- and control phase generated fruitful discussions and learnings on the mobile care model, i.e., the learn phase, leading to further questions, data collection, and analysis, thus creating the circular process.

3.1 Case context–SHG, mobile unit and data systems

The organizational structure of the SHG can be divided into four levels: hospital board, the steering committee, departments and units, see figure 3.2

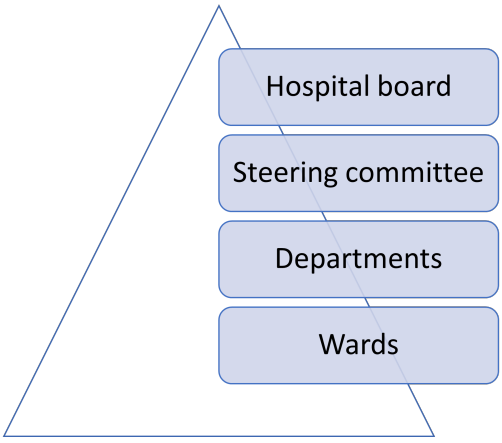


Figure 3.2: Overarching organizational structure of SHG

The hospital board is politically elected and is responsible for the performed care [19]. The steering committee includes the hospital director and the department mangers that manages the hospital [19]. The departments cover different areas of the organization, and can be divided into three blocks: the medical (M), surgical (K) and operational blocks. All departments are listed under one of the three blocks. Figure 3.3 illustrates the organizational chart of SHG. Under the medical and surgical departments are the wards, where the daily patient care activities are performed, not depicted in figure 3.3.

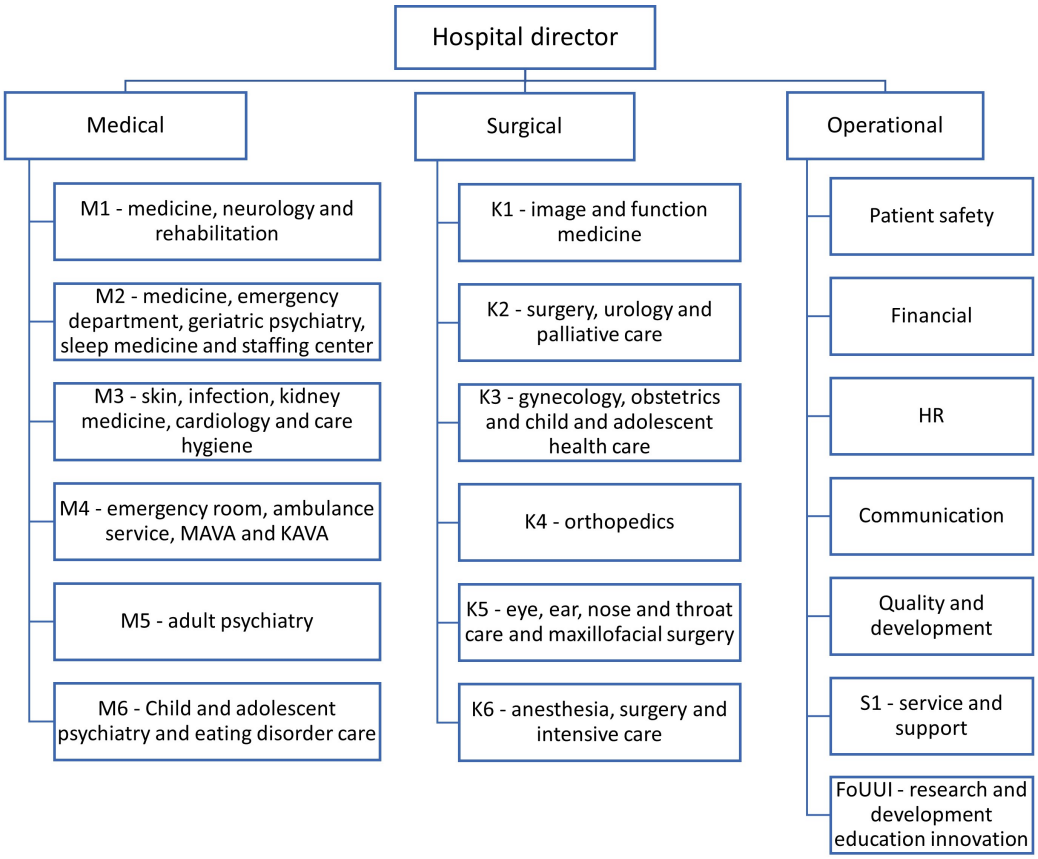


Figure 3.3: Detailed organizational chart of SHG

The four mobile teams are organized under the medical departments M1-M4. The organizational structure of the mobile teams are presented in section 4.1.2 and illustrated in figure 4.1. All patient contacts in the hospital, except for ambulance services (see below), are registered in the patient administrative data system ELVIS, which is used for healthcare contact registration. ELVIS contains information on the type of care (responsible ward that performed the registration), type of contact (how the contact with the patient took place), diagnosis, operational actions, responsible department, and more [37]. Melior is the electronic medical journal system used at SHG, containing different functions for documentation of patient history, drug lists, and clinical documentation [38]. Ambulance service at M4 registers patient contacts in AmbuLink, a regional digital medical journal system designated for ambulance care, which contains the patient journal, transport data, and medical information regarding the patient during the transport [39].

3.2 Define

The define phase was the first step of the thesis, defining the purpose and goals of the project as well as a rough time plan. The phase consisted of introductory meetings with the mobile unit, discussions of research questions, and planning of physical visits.

3.3 Measure

During the measure phase quantitative and qualitative data were collected through POs, USIs, and data extraction.

3.3.1 Participative observations

Observation is a gathering technique of qualitative data based on perceptual findings of the study object in its habitat [40–42]. The observer aims to learn about the object by documenting and analyzing observed activities connected to the object. It is essential to keep an open mind to the observations, i.e., document the observation in an unbiased manner [40,42]. The observations should be based on pre-defined focus points, or research questions [40,42]. Additionally, aids in the documentation such as field notes, dictation, or photos are recommended [40–42]. The observer can choose a passive or participative role, or a mixture of the two [40]. The passive observer does not interfere, whereas the participative observer contributes and collaborates with the participants, acting as a member of the group [40, 42]. PO was chosen for this thesis as the research questions focused on evaluating the structure and working methods of the mobile teams as well as collaborating with the mobile teams to aid their development. To gain a more in-depth understanding the POs were complemented with unstructured interviews.

3.3.2 Unstructured interviews

Interviews are an effective method to extract necessary information regarding the studied subject [40,41,43]. There are three main types of interviews: unstructured-, semi-structured-, and structured interviews [40, 41, 43]. The USIs has multiple advantages [41,43]:

1. It is a time-effective method to gather enough data
2. It is useful when exploring an unknown area
3. It is flexible and allows the interviewer to pursue new leads during the interview
4. The tempo of the interview can be modified
5. It gives the interview subject more control of the interview

As a part of the purpose of the thesis was to understand and help develop the concept of mobile care, USIs were the most suitable combination with POs. USIs also allowed the interviews to take place whenever there was an opportunity during the field visits as a part of the POs. Additionally, it allowed the interview object, be it a patient, physician, or nurse, to speak freely in a side-tracked discussion. USIs proved fruitful for idea generation, creating a balanced perception of power, i.e., showcasing the researcher as a colleague with a purpose to help and not an

unknown external evaluator [41]. A complete list of all interview subjects can be found in table 3.1. The identities of all mobile unit staff have been made anonymous to protect the identity of all participants.

Table 3.1: Interview subjects

Identification tag	**Role**	**Location/Unit**
1	Process leader (PL)	Mobile unit
2	Nurse	Mobile unit
3	Nurse	Mobile unit
4	Physician	Mobile unit
5	Nurse	Mobile unit
6	Nurse	Mobile unit
7	Nurse	Mobile unit
8	Physician	Mobile unit
9	Medical secretary	Skövde hospital
10	Head of medical ward, extended responsibility	Skövde hospital
11	Development Director	Skövde hospital
12	Patient G	Hasslösa
13	Patient B	Grästorp
14	Patient S	Gillstad
15	Patient W	Lidköping
16	Municipality nurse	Lidköping dementia care

The POs and USIs were recorded through handwritten filed notes during physical visits. Some USIs were also recorded with an audio recorder and later transcribed. Table 3.2 lists all visits, including the method of data collection, the topics, the participants, the location, and the date of the physical visit. The functions and roles of the respondents from the mobile unit in table 3.2 and 3.1 are outlined in section 4.1.2.

Table 3.2: Physical visits during the thesis (H indicates a visit of a mobile team at a hospital)

Method	Topic	Participants	Location	Date
PO, USI	Understanding mobile care	Physician, Nurse, Nurse	Lidköping H	2022-03-24
PO	Patient visit	Physician, Patient	Lidköping H	2022-03-24
PO, USI	Patient registration, working method	Physician	Lidköping H	2022-03-24
PO, USI	Patient visit	Physician, Nurse	Grästorp	2022-03-24
USI	Old model	Nurse, Nurse	Lidköping H	2022-03-25
PO	Patient visit	Nurse, Nurse	Gillstad	2022-03-25
PO	Patient registration	Nurse, Nurse	Lidköping H	2022-03-25
PO	Patient visit	Nurse	Lidköping	2022-03-25
PO	Mobile care routine	One mobile team	Skövde H	2022-03-29
USI	Organizational structure	Process leader (PL)	Skövde H	2022-03-29
USI	Working method	PL, Nurses	Skövde H	2022-03-29
USI	Goal and aim of mobile care	Head of medical ward, PL	Skövde H	2022-03-29
PO	Tool development	PL, Nurse, Nurse	Skövde H	2022-03-29
PO	Informative event	Emergency ward	Skövde H	2022-03-29
USI	Patient registration	Nurse	Skövde H	2022-03-30
USI	Old vs new	Physicians, PL	Skövde H	2022-03-30
PO	Idea generation	Nurse, Nurse	Skövde H	2022-03-30
PO	Tool development	Data analyst	Skövde H	2022-03-30
PO	Concept review of tools	One mobile team	Skövde H	2022-05-11
PO	Cross regional online discussion on mobile care	Mobile units across the regions	Skövde H	2022-05-11
PO	Prototype implementation	Full team	Skövde H	2022-05-24

Lidköping hospital was visited once during a two-day visit since Lidköping hospital was furthest away from Gothenburg and the majority of the mobile unit personnel including the process leader were located at Skövde Hospital. As can be seen in the table the first visits, 24-25/03, entailed patient visits aiming to create a basic understanding of the mobile care model through PO and USI. The visits during 29-30/03 entailed further documentation of the mobile care model and data analysis as well as the design phase, i.e., tool development. In addition to the physical visits multiple virtual collaborative meetings were held with the staff of the mobile teams throughout the project covering all phases of the thesis.

3.3.3 Quantitative data collection

The quantitative data are based on extractions from ELVIS, entailing information on patient contacts with the hospital. Due to the social service and patient acts, the electronic medical record Melior, could not be accessed, nor could patients' contact with primary or municipality care be extracted. Data were extracted with help from personnel in the development and data department at SHG. Data collection occurred multiple times since the research questions were continuously refined during the thesis, and further data were needed. The data extraction included all patients with one or more contacts with the mobile teams over the period from 2020-01 to 2022-05, resulting in 968 unique patients. The extraction included all hospital contacts, i.e., outpatient-, emergency-, inpatient- and mobile care, resulting in a total of 25 710 contacts, out of which 2503 were performed by the mobile teams.

All extractions followed the same base criteria, excluding psychiatric patients and patients younger than 18.

Data expansion

The extracted data from ELVIS were restructured and categorized on the following points to facilitate the analysis:

- Index creation
- Expansion of data
  - Creation of a superset for the type of care
  - Text definition for diagnosis and operational codes
  - Creation of age groups

The data contained patients' personal identity numbers (PIN) and thus needed to be rewritten and removed before leaving the SHG intranet. A translation tool was created to re-code the PIN to an index: P1, P2 ... PX. The reason for this being done post-extraction, in contrast to the standard procedure of pre-extraction, was to enable the mobile unit to track interesting findings back to the patient for an explanation.

A superset was created to analyze the data and effectively find patterns for the diagnosis codes and the hospital wards connected to each registration. The latter is identified by a specific code indicating which ward and hospital that provided the care and performed the registration. For example, SKAM represents the emergency ward at Skövde Hospital. The superset distributed wards in the data in one of four categories: emergency care, outpatient care, inpatient care, and care performed by the mobile teams. Similar reasoning was applied to the diagnosis codes. Each diagnosis has an exact code according to the global medical classification list by WHO, International Statistical Classification of Diseases and Related Health Problems (ICD) [44]. Thus, a superset was created to simplify the search for patterns by sorting the diagnosis codes by section level according to the 10th revision of the ICD, ICD-10. For example, diagnosis I509 (heart failure) was also labeled with I30-I52 - Other forms of heart disease. Lastly, additional information such as age and age group were added. The age groups were created based on nine years, i.e., 20-29, 30-39 up to 100-109. All patients between 18 and 19 were placed in a separate group, 18-19. An excerpt of the original extracted data can be viewed in figure 3.4a, and an excerpt of the same data but in the expanded version in figure 3.4b, with the reservation for changed order of registration. The "vdgkat" indicates which type of care provider that performed the patient contact, "SSK" indicates a nurse and "LÄK" a physician. Finally, the empty cells for one of the registration showcases that not all registrations contained all information.

Care team	PIN	Registration time	Gender	Type of visit	vdgkat	Diacode 1
LENM	YYYYMMDD-XXXX	2021-02-22 08:15:00	M	E	SSK	D649
LAKM	YYYYMMDD-XXXX	2021-08-16 17:27:00	F	J	LÄK	R539
LMEMNÄ	YYYYMMDD-XXXX	2021-05-04 14:17:00	F	H	SSK	I509
SKIAKA	YYYYMMDD-XXXX	2020-01-08 00:00:00	M			I702
FMEMNÄ	YYYYMMDD-XXXX	2021-05-28 14:21:00	F	FH	SSK	I509

(a)

Care team	Type of care	Index	Age	Age group	Registration time	Gender	Type of visit	vdgkat	Diacode 1 section level	Diacode 1 section descr.	Diacode 1 specific	Diacode 1 specific description
LENM	Outpatient care	P632	71	70-79	2021-02-22 08:15:00	M	E	SSK	D60-D64	Aplastic and other anaemias	D649	Anaemia, unspecified
SKIAKA	Inpatient care	P123	83	80-89	2020-01-08 00:00:00	M			I70-I79	Diseases of arteries, arterioles and capillaries	I702	Atherosclerosis of arteries of extremities
LMEMNÄ	Mobile team	P10	82	80-89	2021-05-04 14:17:00	F	H	SSK	I30-I52	Other forms of heart disease	I509	Heart failure, unspecified
LAKM	Emergency	P67	99	90-99	2021-08-16 17:27:00	F	J	LÄK	R50-R69	General symptoms and signs	R539	Malaise and fatigue
FMEMNÄ	Mobile team	P250	85	80-89	2021-05-28 14:21:00	M	FH	LÄK	I30-I52	Other forms of heart disease	I509	Heart failure, unspecified

(b)

Figure 3.4: (a) Showcases an extract of the first data set, (b) Illustrates an extract of the expanded data set

3.4 Analyze

Following the data collection during the measure phase, an analysis of the qualitative and quantitative data was carried out.

3.4.1 Qualitative analysis

The qualitative data, collected through field notes and audio recordings during the POs and USI, were analyzed from the perspective of the research questions. The analysis, inspired by the works of Hseih and Shannon [45], was performed by reading the material multiple times, aiming to analyze the content from new perspectives, followed by a summary of the covered material. The analysis identified key themes related to the research questions, which led to discussions with the mobile unit for internal validation and further data collection and analysis, thus creating an iterative process.

3.4.2 Quantitative analysis

The quantitative data were analyzed in Microsoft Excel (Microsoft 365 Version 2206 Build 16.0.15330.20144) and JMP (JMP® Pro, Version 16.0.0. SAS Institute Inc.), studying sub-populations, patterns in the patient contacts of the mobile teams, and statistical tests on the healthcare consumption. JMP was used for overarching and

comprehensive data analysis and visualization to identify general patterns. The statistical tests were conducted in Excel.

Sub-populations

As the new model of mobile care included a broader range of patients, an analysis attempted to identify new patient groups, i.e., sub-populations. The sub-populations were analyzed in JMP, searching for patterns in the number of contacts, type of contact, diagnosis codes, and contacts with the mobile unit in relation to other types of care–care at the emergency ward as well as inpatient- and outpatient care.

Healthcare consumption

To answer the research question: "What kind of impact does the mobile care model have on healthcare consumption?" a paired t-test was deemed the most suitable test [46, 47]. Paired t-test is also called correlated pairs t-test, a paired samples t test, dependent samples t test, or one sample t-test [46]. Paired t-tests are often used in medical research to measure health effects on a patient before and after an intervention, e.g., a new medical treatment. In this thesis, the paired t-test was used to measure the healthcare consumption of patients before and after visits by the mobile unit. A paired t-test has three main assumptions regarding the data [46, 47]:

- Each observation should be independent of every other observation
- The measured difference should be normally distributed or the number of samples should be >20
- No extreme outliers should exist in the difference

The assumptions were controlled, i.e., the data fulfilled the assumptions, and are further addressed in results, section 4.2.1. The paired t-test was of one-tail format since the test was made to examine if the new mobile healthcare model had the same decreasing effect on unplanned healthcare consumption as the old model did.

The t-value is calculated by equation 3.1 [46, 47].

$$t = \frac{\Sigma d}{\sqrt{\frac{n(\Sigma d^2)-(\Sigma d)^2}{n-1}}} \tag{3.1}$$

Where d is the difference between the number of visits before the first contact of the mobile unit and the number of visits after the first contact with the mobile unit for the same patient, n indicates the number of patients. The limit for significance was set at the standard value of $p<0.05$ [46].

3.5 DMA to DCL

After the DMA-part of the project, the qualitative and quantitative results were re-analyzed from a different perspective in discussions with the teams to identify problems that could be solved using digital tools as well as other, remaining problems that should be addressed in future improvement initiatives. The next step was thus the DCL-part of the method, where the design part represented the development process of the digital tools, the prototype trial and implementation constituted the control part. The final part addressed the learnings made by the mobile unit during the DMADC-process.

3.6 Design

The design phase of the tool development process consisted of problem and goal definition, idea generation, formulation of needs later translated into requirements, and concept creation. Discussion of the qualitative findings with the mobile unit identified two issues that could be solved with digital tools, adhering to the fourth research question. The first issue regarded the lack of awareness of the mobile unit amongst other healthcare actors, which resulted in the development of the visual dashboard, further described below. The second issue concerned the evaluation of the mobile units effect, i.e., what resources were saved by using the mobile unit, which resulted in the evaluation tool, further described in 3.6.2. Even though the processes were influenced by each other, they are separated here to facilitate understanding and reading.

3.6.1 Design process of the visual dashboard

The following part describes the process of the development of the visual dashboard.

Problem definition

One of the short-term goals of the mobile unit is to increase the number of patients referred to them (Head of medical ward, private communication, Mar. 30, 2022). The problem was formulated as "Not enough patients are being referred to the mobile teams." The problem could be further divided into three root causes:

1. The belief that mobile unit still operated according to the old model
2. Lack of awareness of the mobile unit
3. The high turnover of healthcare staff throughout the region

Based on these factors, the most effective way to spread the information, considering the time that the mobile unit personnel had for marketing activities and the organizational structure of the healthcare actors, was to physically inform about the existence and working methods of the mobile unit. The problem was defined as:

"How can we identify which hospital wards and primary care units to reach out to with the goal of increasing the number of patients referred to the mobile unit?"

Idea generation

An idea generation session based on the problem definition above was held with members of the mobile unit on-site on the 29th of March at Skövde hospital. The idea generation took the form of a timed brainstorming session, where all ideas were written down on a whiteboard. The next step was a screening process evaluating each idea, resulting in a proposed idea to create a visual dashboard displaying the number of patients being referred from each hospital department/ward and primary care unit. The needs expressed during idea generation were translated to requirements:

- The dashboard should always be viewable
- Interpreting the data should require minimum effort
- The dashboard should automatically and regularly update data

Concept creation

With a defined idea and a set of requirements, the next step was to develop a concept solution. The requested information could only be accessed in ELVIS, as the referral was documented during the registration of a patient by the mobile unit. Therefore, the dashboard needed input directly connected to ELVIS to provide continuous updates on where the referrals originated from. JMP was used to create a visual representation of data, shown in figure 3.5.

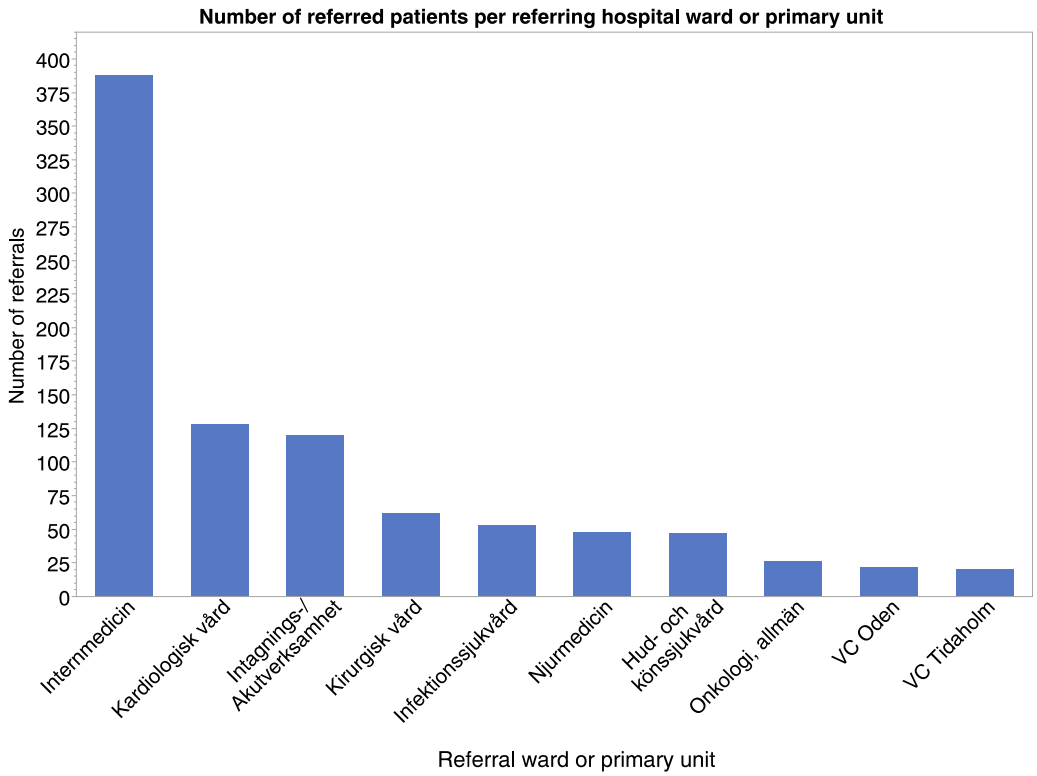


Figure 3.5: Concept of the visual dashboard–showcasing an excerpt of the number of referrals and the referring actor

The histogram depicts each specialty from which the patient was referred on the x-axis and the number of patients from each specialty on the y-axis. This figure was shown to the mobile unit to ensure that the needs had been interpreted correctly. The next step was to create an actual prototype that was connected to ELVIS. With the assistance of the development department and their access to the full suite of Office 365, PowerBI (Microsoft Power BI, 2022) was used to generate the dashboard in a similar format as in figure 3.5.

Concept review

The concept was presented to the unit, upon which some changes were proposed:

- Split the ward "Internmedicin" into two units
- Split the ward and "Akutmottagning & verksamhet" into two units
- Create two different time versions, one total stretching from the beginning of the mobile unit and one displaying the current month
- Split the internal hospital wards from the primary care units into two different histograms

As seen in the JMP prototype version, the "Internmedicine" and "Intagning/akutverksamhet" generated 50% of all patients. However, neither of these specialties consisted of one single ward that the unit could inform. Therefore, the mobile unit suggested that new ward-referral labels should be created to provide a more informative view of where the patients were coming from. The task was completed in collaboration with the ELVIS IT department, and the complete list of changes can be found in Appendix B. The other two suggestions were combined, resulting in a dashboard with four pages displaying the referral on a monthly and total basis since the start of the model, as well as two pages only displaying referrals from the primary care units, monthly and total. The final design is presented in chapter 4, section 4.4.1.

3.6.2 Design process of the evaluation tool

The following part describes the process of the development for the evaluation tool.

Problem definition

The evaluation of the mobile unit's impact on care resources was performed retrospectively, looking at the patient cases for the past month, approximately every three to four months, and estimating what kind of care the patient would have received had the mobile unit not been involved. Subsequently, the personnel of the mobile teams tried to assess whether a team visit might have facilitated the patient's care journey or prevented unplanned care visits to other care providers. Thus, the purpose of the evaluation was to continuously assess potential effects on patients' care consumption, which was necessary both for internal validation and to provide the steering committee with data on the value the mobile unit was creating. However, the evaluations were difficult to carry out–they were time-consuming, not standardized, and lacked continuous data over time.

Idea generation

An idea generation session was held with the members of the mobile unit that were on-site at Skövde Hospital on the 30th of March. Following similar steps as in the process for the visual dashboard, the idea was to develop an digital tool that solved the issues with the current evaluation method. The user needs of the teams for a proposed evaluation tool were:

- The evaluation should be fast, simple and standardized
- The evaluation should be made after each visit
- The evaluation should be registered in connection to the patient visit

A second brainstorming session was held the following day, discussing how the evaluation output should be displayed. A key request from the teams was that the output should be easily understood in a visual format displaying the unit's impact.

The evaluation question was defined as: "What kind of care would the patient have had if the team had not been involved."

The following options were agreed upon as pre-selected answers:

- Primary care unit
- Outpatient care
- Ambulance
- Emergency ward
- Inpatient care

First concept

The next step was to create the tool based on the ideas and needs expressed above. The first concept solution was an Excel sheet with virtual buttons that asked the user, i.e., the nurse, to select the most suitable alternative. A "click" generated a response row with a value between one and zero. The selected alternative was marked as a "1" and the rest as "0". The numbers visualized the responses through a histogram with each alternative as a bin that increased by one increment for each evaluation. A sketch of the concept is illustrated in figure 3.6.

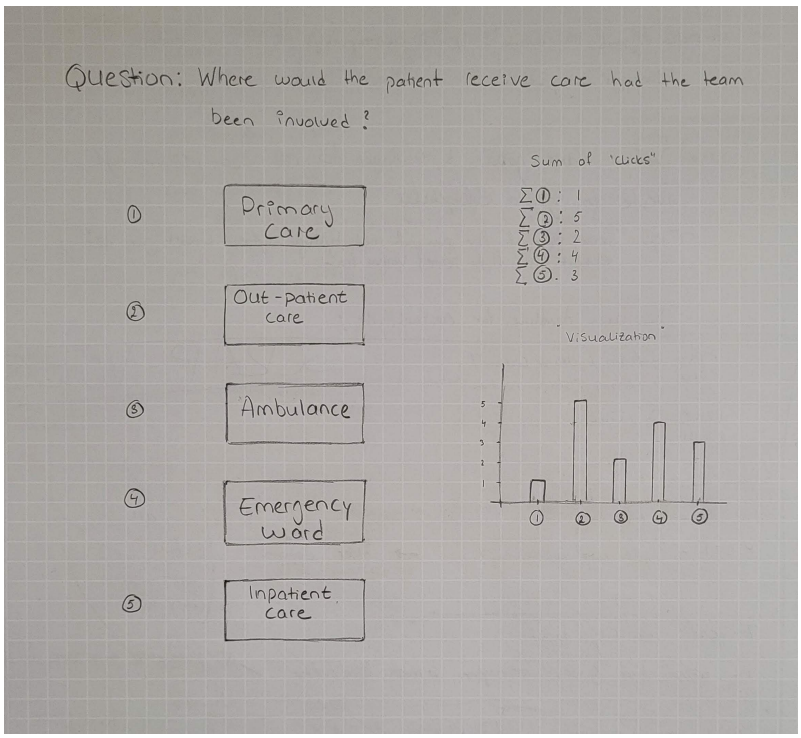


Figure 3.6: A hand drawn visualization based on the first concept of the evaluation tool

A discussion on the first concept with the teams resulted in the expression of further needs. The teams should be able to make changes to the tool without assistance or step-by-step instructions. Further, the tool should be easy to use. Both needs correlate to the outspoken goal of SHG to increase the capacity of the mobile care unit's personnel (Head of medical ward, private communication, Mar. 30, 2022). Thus, that required experience or knowledge in a programming language would not meet the expressed needs.

Second concept

Based on the review of the first concept, the idea was to create an evaluation tool in the form of a survey, based on existing software, that had an user interface that was easy to use and edit. The Microsoft Forms (Microsoft 365 Version 2205 Build 15225.20204) was a tool that fulfilled all the teams' needs. In addition, SHG is using Office 365 as the standardized software, which further facilitated the implementation. The evaluation tool would be implemented in SOFIA, which is a SharePoint application used by the whole mobile unit in daily activities and is easily accessible.

Three versions of the tool in Microsoft Forms were created as suggestions to be reviewed by the teams; see appendix A for a visual illustration. As all the forms had the same structure, the key difference was the section asking the question of what would have happened if the team had not been involved.

- The first version was a "yes/no" based form; the user was able to select whether the patient would have received care from one of the pre-selected options or not

- The second version prompted the user to select how probable each of the pre-selected options was be based on the scale of 0 to 3, where 0 = would not happen, 1 = would probably not happen, 2 = might happen, 3 = would probably happen

- The third version displayed each care option as separate questions, asking the user to rank each one from 1 = not at all likely, to 10 =extremely likely

In addition to the key question, there were three other questions and a comment section. The first question asked the user to indicate when the visit was made. The second question asked the user which mobile team carried out the visit. The third question asked whether the team had managed or organized transport for the patient to the hospital. This did not occur often, but as per the teams' suggestion, it was phrased as a statement: "The mobile team sent the patient to the hospital." If this was the case, the user would indicate "yes" and submit the response ignoring the key question described above. Microsoft Forms provided the results in a continuously updated Excel file. The output could thus be visualized according to the preferences of the mobile teams and adapted depending on which version of the form was selected. An example illustration of the outcome can be seen in figure 3.7.

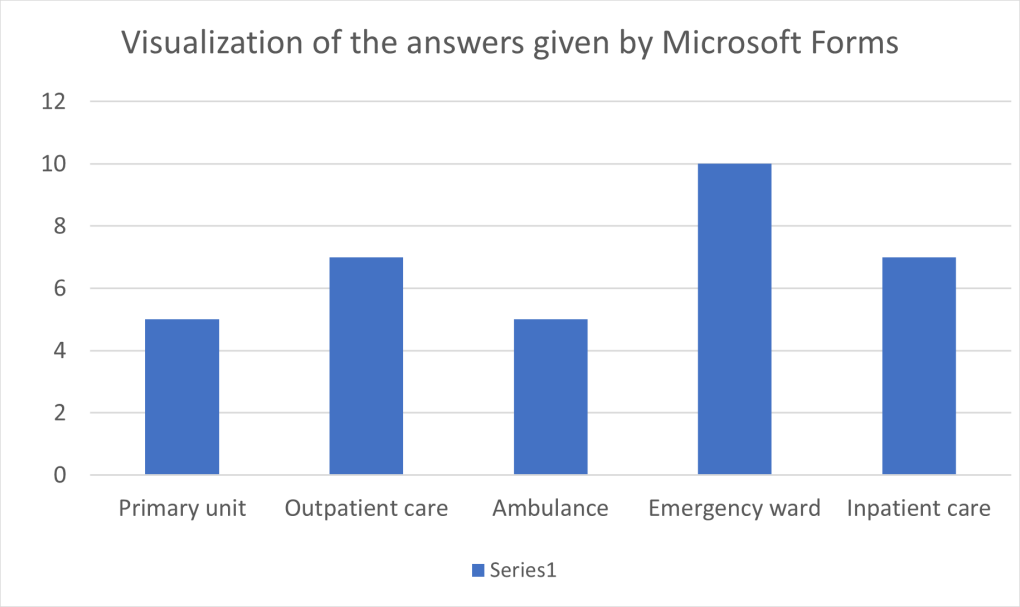


Figure 3.7: Concept visualization of the outcome of the evaluation tool

Note that the numbers used for this figure are randomized and only used as an example, thus not representable for the mobile unit.

Concept review

The teams reviewed the three concept versions during a morning meeting. The review discussion reached a consensus of selecting the second version, 0-3, on the basis that it would be the least time-consuming version since the user's choice did not impact the statistics to the same extent as the yes/no version would. In addition, as these situations are subjective assessments, a yes/no version could create a situation of indecisiveness. The third version, 1- 10, was eliminated on a similar basis; the concept was too time-consuming and had too many choices for the user, making the process cumbersome and being viewed as a burden. Moreover, changes were made to the form by removing the specific team selection, as all the teams operated under the same premise but had different codes due to political regulations. Hence, indicating which team had cared for the patient would be unnecessary regarding the purpose of the evaluation tool. To clarify what type of care was meant by outpatient care, the option was specified as "outpatient care hospital." The evaluation tool was added to the "checklist," a template used daily by the nurses further described in subsection 4.1.3, to ensure that the form would be incorporated into the daily routine. Lastly, the question was reformulated as: "Where would the patient have received care if the team had not been there?"

3.7 Control

During the control phase, the prototypes were created and tested to control if they fulfilled the previously developed requirements. Based on the feedback of the con-

cepts, prototypes were created and implemented in the mobile teams' daily routines. The final solutions are presented in section 4.4.

3.7.1 Visual dashboard prototype

Based on the feedback from the concept review, a prototype was created at Skövde Hospital in PowerBI, continuously updated with new registrations from ELVIS. The prototype was implemented by connecting a laptop, using a general account, to a television screen in the meeting room, giving the mobile teams an overview of the referral situation and allowing all teams to provide feedback on the prototype. After a trial period of two weeks, the feedback on the prototype was the wish of being able to view the number of referrals from the current month up to six months back. Thus, the mobile teams could monitor the impact of informative meetings, spreading awareness of the mobile care concept, amongst the remaining healthcare actors.

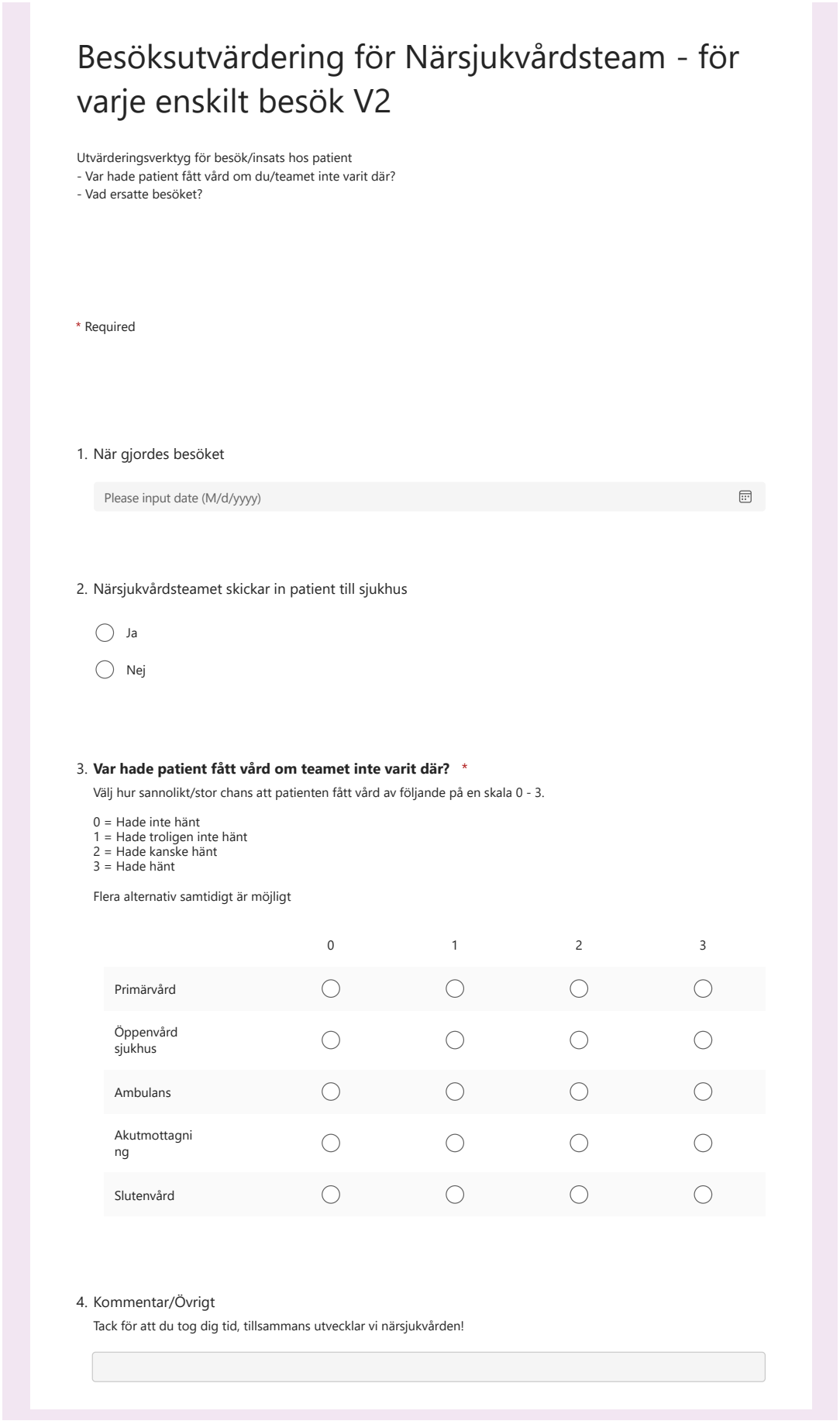
3.7.2 Evaluation tool prototype

The prototype was created by adapting the concept according to the feedback. The tool was then added to SOFIA, as a link to the form, for a trial run of two weeks. The prototype version can be viewed in figure 3.8.

The feedback on the prototype was to elaborate on the alternatives to the statement about whether the patient was admitted to the hospital by the team. The reasoning was that there were cases where the emergency ward had resources that the team did not have and that the patient was sent home after that or, in some cases, admitted to inpatient care. Further, the pre-selected written options to the key question, "What would have happened had the team not been there?" were too abstract and difficult to answer in the 0-3 version. Thus, options were changed to 0-2, i.e., no, maybe, and yes. The options were weighted to account for the number of users and difference in reasoning, 0 = 0.2, 1 = 0.4, 2 = 0.8. Lastly, a fourth option was added, indicating that the alternative is not applicable since the patient was sent to the hospital. All changes are summarized in table 3.3.

Table 3.3: Summary of key changes from prototype to final version of the evaluation tool

Question/statement	**Prototype**	**Final version**
The mobile team sent the patient to the hospital	Yes No	Directly admitted to the ward Taken to the emergency ward No
Where would the patient have received care if the team had not been there?	0 = would not happen 1 = would probably not happen 2 = might happen 3 = would probably happen	0 = No 1 = Maybe 2 = Yes Not applicable



Besöksutvärdering för Närsjukvårdsteam - för varje enskilt besök V2

Utvärderingsverktyg för besök/insats hos patient
- Var hade patient fått vård om du/teamet inte varit där?
- Vad ersatte besöket?

* Required

1. När gjordes besöket

Please input date (M/d/yyyy)

2. Närsjukvårdsteamet skickar in patient till sjukhus

- ◯ Ja
- ◯ Nej

3. **Var hade patient fått vård om teamet inte varit där?** *

Välj hur sannolikt/stor chans att patienten fått vård av följande på en skala 0 - 3.

0 = Hade inte hänt
1 = Hade troligen inte hänt
2 = Hade kanske hänt
3 = Hade hänt

Flera alternativ samtidigt är möjligt

	0	1	2	3
Primärvård	◯	◯	◯	◯
Öppenvård sjukhus	◯	◯	◯	◯
Ambulans	◯	◯	◯	◯
Akutmottagning	◯	◯	◯	◯
Slutenvård	◯	◯	◯	◯

4. Kommentar/Övrigt

Tack för att du tog dig tid, tillsammans utvecklar vi närsjukvården!

Figure 3.8: Prototype of the evaluation tool

3.8 Learn

The last phase of the DMADCL was the learn phase. Learnings during the separate project phases were iteratively fed back into previous phases, whereas learnings from the overall project were summarized and reflected in suggestions for future improvement initiatives. The mobile unit's learning from the results are presented at the end of chapter 4, and the learnings from the whole project are discussed in chapter 5.

3.9 Validation

Internal validation

Internal validity concerns determine whether one variable is causally related to another [5]. Internal validity checks have been integrated into the work to ensure that the thesis investigates cause and effect relationship in the mobile care processes. Reliability is a component of internal validity [5]. Thus, reliability can be evaluated through repeated measurements of the same occurrence, ensuring no unintended variation between measurements caused by the measuring procedure. In addition, key themes and results from the qualitative and quantitative analyses have iteratively been discussed with mobile unit personnel for input and validation. Furthermore, the method of this thesis is thoroughly described in the thesis, which facilitates a similar evaluation by other actors. Thus, the data obtained for this thesis is presumed to have high internal validity.

External validation

The extent of certitude that findings or results obtained in a specific context using defined techniques be generalized and transferable to other contexts are known as external validation [5]. The findings in this thesis are thoroughly described, i.e., the process of the mobile care model, the impact on healthcare consumption, and the development of simple and efficient digital tools. Thus, the findings are transferable to other models of mobile care to some extent and can be used for reflection, learning or implementation.

3.10 Ethics

The ethical framework of this thesis rests on the pillars of consent and privacy according to the Helsinki declaration [48] and the Belmont report [49]. All activities have been performed and presented in a manner that does not harm participants by endangering or violating the individual's privacy. Regarding the quantitative aspects, importance has been placed on the security and privacy of the patients and their relatives. Therefore, all the PINs were removed and placed with a patient index. In the qualitative parts, all participants have been kept anonymous by removing the name and, in the case of the mobile unit, the location as well. The decision is based

on the low number of employees per team, which might enable an external actor to identify unique personnel solely based on role and location. Additionally, before conducting patient visits and USIs, consent was obtained from each participant, employee, and patient by informing them of the project's objectives and requesting their approval.

4

Results

The chapter presents the results connected to research questions 1-5. Drawing from qualitative and quantitative analyses from the DMA part of the project, section 4.1 addresses the organizational structure, working processes, and communication channels of the new model. Section 4.2 presents results regarding healthcare consumption and patient groups in the new model. In section 4.3 the main differences between the new and the old model are outlined. Section 4.4 presents the digital tools that were created during the design and control phases of the project. Finally, section 4.5 portrays lessons learned by the teams for more immediate development of the new model. Future, long-term development areas for the model are elaborated on in chapter 5.

4.1 Case description: New model of mobile care

The following section describes the new model of mobile care presented in four main subsections: an initial introduction, the organizational structure, the working process of the model, and an example day of the mobile teams.

4.1.1 Introduction to the new model of mobile care

The mobile care unit's function has changed from a team that took over the responsibility for the patient to a supportive team that provides care to the patient and assists the surrounding healthcare system, acting to promote health and prevent deterioration of chronic illnesses. In the transformation toward the new model of integrated mobile care, an official mission was defined by the steering committee of SHG in the fall of 2019. The mission can be summarized as follows:

- Create an organizational ground for four teams of mobile care connected to the medical departments M1, M2, M3, and M4 at SHG

- Ensure that the work methods meet the criteria for mobile care: emanate from the patient's perspective, document all activities in an individual care plan, further develop the collaboration between mobile teams, primary and municipality care, and continue the work of the old model with elderly patients

with complex care needs

- Establish a well-structured collaboration between the mobile teams regarding patient distribution and assistance

The official goal of the mobile care unit is also formulated on the SHG website: "The team performs medical measures and nursing interventions such as follow-ups, assessments, and treatments for a shorter period or as a single intervention. The goal is to increase the conditions for good, safe and secure care at home and reduce avoidable inpatient care and/or emergency contacts" [50].

4.1.2 Organizational structure

The mobile care unit consists of four teams, covers different geographical areas within the Skaraborg catchment area, and emanates from two hospitals at SHG, summarized in table 4.1. The table can be viewed with the map in figure 1.1 to visualize the geographical locations of the mobile teams' areas and the hospitals.

Table 4.1: The mobile teams, geographical name, hospital and department base

Team code	Geographical name/area	Hospital base
FMEMNÄ	South team	Skövde hospital M1
LMEMNÄ	West team	Lidköping hospital M2
MMEMNÄ	North team	Skövde hospital M3
SMEMNÄ	Emergency team	Ambulance station in Skövde M4

- South areas include: Falköping, Skövde, Tidaholm
- North area include: Gullspång, Hjo, Karlstorp, Mariestad, Tibro, Töreboda
- West area include: Essunga, Grästorp, Götene, Lidköping, Skara, Vara
- Emergency team covers all areas above

The mobile teams act as one unit regarding development work, daily meetings, case-related questions, and similar activities. However, officially, each team is subordinated to one of the medical departments at SHG, M1-M4. Consequently, each team must register all information in different departments, M1-M4, in ELVIS & Melior, in adherence to the patient act. As the fourth team, SMEMNÄ, is an ambulance team, all contacts are registered in Ambulink and later registered in ELVIS by a medical secretary. However, all contacts transferred from AmbuLink to ELVIS lack diagnosis and operational codes. An illustration of the organizational structure of the mobile unit at SHG can be found in figure 4.1.

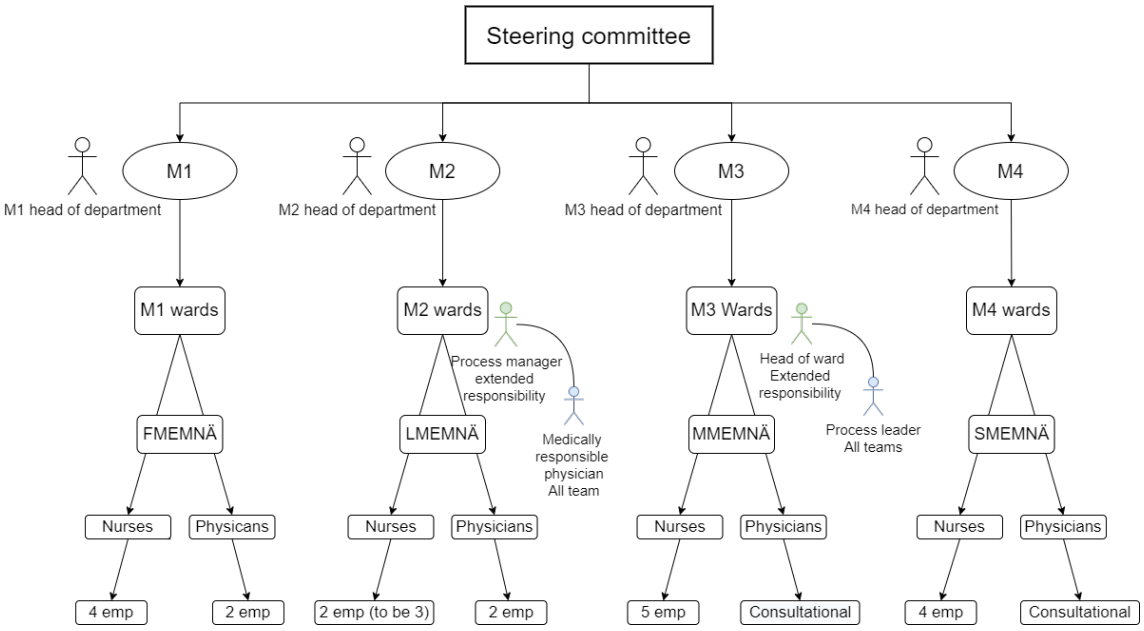


Figure 4.1: Organizational structure of the mobile care unit

At the top of the figure is the steering committee of SHG, represented by the hospital director, the medical chief of staff, the development director, the quality director, the chief nurse, and the head of all departments, including M1-M4, depicted as stick figures. Subordinated to these are the head of wards, for example, the heads of the emergency-, oncology-, and dermatology wards. Two stick figures below the department heads, normally functioning as heads of wards, have extended responsibility for the mobile teams. Subordinated to these are the process leader and the medically responsible physician for all mobile teams, depicted as stick figures. The four teams are composed of nurses and physicians. Each team has resources for two full-time nurses, i.e., 200%. The number of personnel differs from team to team. For example, the FMEMNÄ team comprises four part-time nurses, working 50% with the mobile team and 50% in the M1 department, and two part-time physicians. In comparison, the LMEMNÄ team consists of two full-time nurses, soon to be one full-time and two part-time, and two part-time physicians. The MMEMNÄ and SMEMNÄ are both teams without part-time physicians. Instead, they use physicians from their respective departments, M3 and M4, in consultation functions.

Each team has access to vehicles as needed. The medical equipment of each team consists of blood sample equipment, drugs adapted for each patient (i.e., antibiotics, pain killers, inhalator, diuretic drugs, blood bags), bladder scan, equipment to analyze CRP (C-reactive protein), catheter, equipment for wound treatment, defibrillator and a limited number of ultrasound devices shared across the teams. Additionally, each team has a portable computer with access to Melior and software for digital meetings with physicians at the hospital, which can be used when the physician is absent during the physical visit. Electrocardiogram (ECG) is available with the emergency car, and additional material can be made available depending on need.

Internal communication channel

According to several of the mobile unit's employees, the communication channels are not aligned with the organizational structure presented in figure 4.1. Figure 4.2 illustrates the perceived communication pathway of the nurses and physicians from the mobile teams. The process leader has a key role in securing and managing continuous communication between the mobile unit personnel and the supervisors. However, not all discussions regarding mobile care need to include the whole steering committee. The process leader is mainly responsible for all types of communication.

The organizational changes and current communication channel are experienced as dislocated by some, as expressed by a nurse:

When it comes to organizational changes, I experience that we on the floor seldom have a significant influence (ID 6)

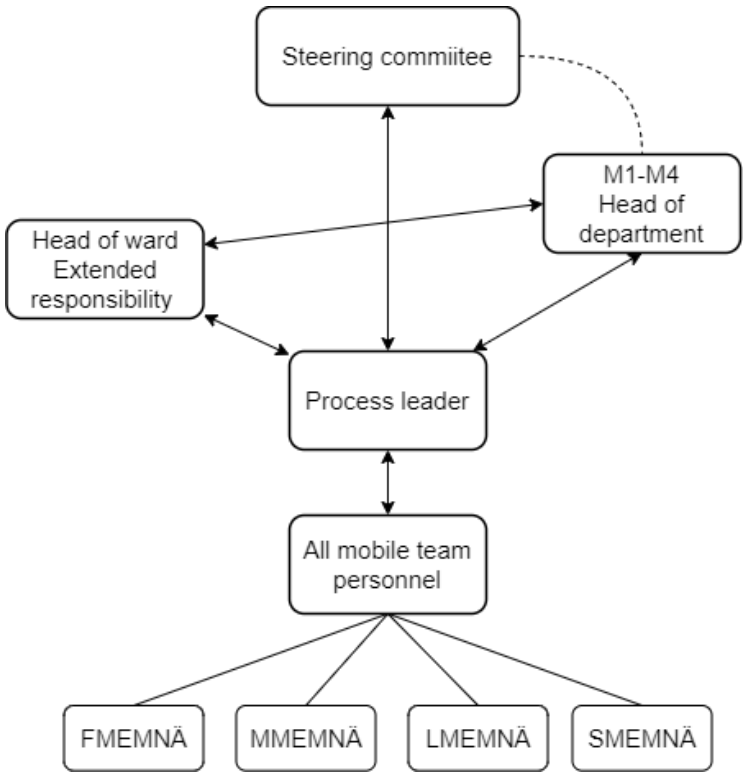


Figure 4.2: Experienced communication channel within the mobile unit

4.1.3 Working process

The working flow of the mobile care unit, from the first stage of receiving a referral regarding a patient to the last stage of registration of the provided care, is illustrated in figure 4.3

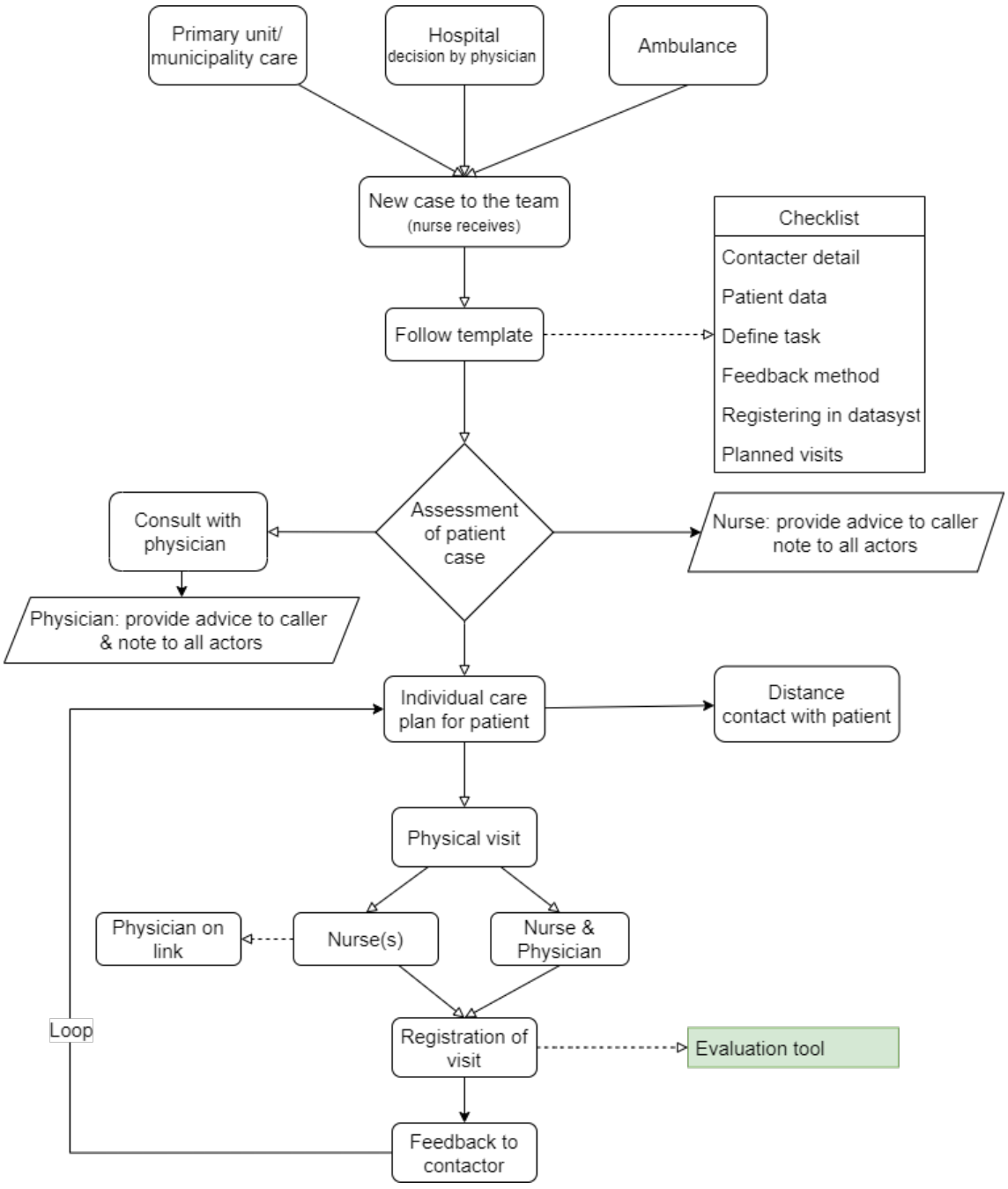


Figure 4.3: Flowchart illustrating the working process of the teams, from referral to documentation of contact

A healthcare employee, a nurse or a physician from the hospital or primary unit, or a nurse from the municipality care, contacts the mobile care unit by phone regarding

a patient. During the call, the mobile team nurse that receives the call goes through a checklist, a dynamic paper template that lists the necessary information:

- The patient's medical history provided verbally by the caller, in addition to the patient journal
- The patient's current condition and the specific task to execute for the team
  - Example tasks; take tests, administer drugs, provide blood
- Medical history provided verbally by the caller, in addition to the patient journal
- How the caller wants to be updated after the action of the mobile team
- If the patient has organized home care provided by the primary or municipality care

The checklist, developed by the mobile teams, is used to create a standardized process ensuring good quality in provided care, as stated by the process leader:

The checklist is of high value ensuring a standardized working method of receiving and executing a task. It's very common for one nurse to receive the call and another nurse to perform the visit, register in ELVIS and reconnect to the caller. Here the checklist is very valuable as it clearly states the necessary information, what the task is and how the caller wants to be contacted after the visit for future discussion on the patient (ID 1)

The nurse then assesses the case together with the physician. Some cases result in a phone call to the patient by the physician or nurse. Most patient cases result in a visit by one or two nurses or a nurse and a physician. In some cases, the physician concludes that too many actors are involved and that it is in the patient's best interest not to involve the mobile team. Instead, the mobile team provides the calling healthcare employee with a recommendation on what actions should be taken in the patient's case. The task is planned in detail, scheduled, executed, documented in ELVIS and Melior, and as a result of this thesis project, evaluated through the evaluation tool. The caller is then contacted and given feedback on the patient according to the preferred method. Depending on the patient's need and the caller's capacity, the team can plan for multiple contacts over a specific period. However, the team never assumes full responsibility for the patient.

Internal development of mobile unit

As the old model provided an entirely new type of care at the time, it needed strong support to be plausible to implement. Thus, there was an overarching understanding of the idea and goal, and strong support from a joint committee with leaders from all key healthcare actors, such as primary and municipality care, and the hospital

director. The support remains but not to the same extent, as the "hype" of mobile care has decreased, and the primary focus has been the Covid-19 pandemic and its impacts. Moreover, as the new model has expanded with more personnel and a longer chain of communication, there is a gap in the involvement of all personnel, mainly nurses, in the development of mobile care and less participation in evaluating meetings. As expressed by a mobile team nurse:

In the old model we would have recurring evaluation meetings with the steering committee, now it feels far away. Although the information is provided, we don't participate to the same extent (ID 2)

In the new model the mobile unit initiated monthly meetings discussing potential areas of improvement with the aid of a physical whiteboard, referred to as the improvement board. However, it could not be used with all teams during the Covid-19 pandemic and has now been replaced by a digital version.

Registration of contacts in ELVIS and Melior

The contacted mobile team registers patient actions in either Melior or ELVIS, or in both systems. Melior is used when the mobile team provides the caller who referred the patient with a recommendation on what to do without involving the team as a care provider. The most common scenario is when the team performs a physical visit in the patient's home, resulting in registration in ELVIS and Melior. If the visit is performed by a nurse and a physician, a physical visit by a nurse combined with a physician on a digital link, or two separate teams visiting the same patient, it results in two registrations in ELVIS; one registration is documented as a partial visit, indicated by X in ELVIS, and the other registration is documented as a regular visit, indicated as FH/H or other depending on the type of visit. A partial visit indicates that the visit was subordinated to another visit to avoid a double patient invoice.

The partial visit registered in ELVIS does not contain information such as diagnosis or operational codes, only the date and role of the care provider. The correlated normal visit includes diagnosis codes, operational codes, visit types, and more. When a physician and a nurse conduct the visit, the nurse registers a partial visit, and the physician dictates information from the visit. After the visit, a medical secretary, trained on diagnosis code registration, registers the visit in ELVIS and assigns the diagnosis and operational codes to the visit. If a nurse or nurses solely perform the visit, the nurse registers and assigns the diagnosis and operational codes. The nurses in the mobile teams are not officially trained on the ICD classification system. During the registration, the nurses use a guide created by a medical secretary in collaboration with the mobile unit.

4.1.4 Example day of a mobile team with patient visits

A typical day for the teams starts at 08:15 with a digital meeting with the whole unit, nurses and physicians, in Lidköping for LMEMNÄ, and in Skövde for FMEMNÄ

and MMEMNÄ, covering general updates, questions, and specific cases. Before the meeting, the nurses check the voicemail to see if any new cases have been referred to the teams. After the meeting, lasting between 10 - 45 minutes depending on discussion points and the number of planned visits, the team prepares for the first patient visit of the day. The necessary equipment and medicines are packed into box-designed backpacks. The team makes their way to the patient using the designated mobile team car.

First visit patient G

The first visit of the day is the first home visit for patient G. The case was referred to the team three working days earlier, when patient G had contacted the assigned municipality nurse, showcasing breathing problems. The nurse recommended patient G to visit the emergency ward, and an ambulance was called to patient G. On arrival, the ambulance personnel assessed that the patient did not need to be admitted to the hospital and instead contacted the mobile team. The purpose of the patient visit by the mobile team is to examine patient G's health and control the drug list. On arrival, the physician asks introductory questions about patient G: history of the house (an old-style house built in the early 1900), personal history, and education. These questions create a rapport between patient G and the physician, and the patient is observed to relax a bit. The conversation continues with questions that require patient G to talk for a period long enough for the physician to control the shortness of breath and the level of cognitive function. The physician backtracks to the day of the ambulance, asking the patient how the health problem that caused a 112 call feels today. The physician then performs a physical examination, controls the medication list, makes some changes, then asks if patient G has any questions, and explains to the patient the plan for the coming days. The mobile team will continue with a follow-up in the coming week, doing another examination and taking an ECG, then contacting the primary care to communicate the patient's revised care plan and ask primary care to take over the responsibility of patient G–end of visit.

If the ambulance had not contacted the mobile team the patient would probably have been admitted to the hospital. As stated by the physician:

Had we not been contacted by the ambulance patient G would have been taken into the emergency ward and admitted to the hospital for a few days to inpatient care for observation; a burdensome process for a patient like patient G (ID 8)

Following the visit to patient G, the physician, once back at the hospital, dictates all necessary information regarding the visit to be registered by the medical secretary. After an internal discussion by the physicians and nurses regarding the performed visits, the preparations for the second visit take place.

Follow-up visit Patient B

The second visit of the day is a follow-up visit at patient B. The patient had had many contacts with the team over a long period, and this visit was a follow-up after

identifying a weakened immune response in the patient. The purpose of the visit was to revise and update the drug list according to the current situation. A physician and a nurse perform the visit. The visit has a similar form to that of the visit at patient G. Patient B is given time to explain the current situation. Additionally, patient B's partner provides additional input on patient B's situation from her perspective and information such as the weight development. The physician listens to the breathing of patient B while the nurse measures the blood pressure and the oxygen content of the blood. The physician controls the medication list and makes some changes. The physician then explains to patient B that high creatinine levels have been observed. Therefore, medication X will be increased, and medications Y and Z removed. The explanation is detailed, and all changes to the medication are motivated. The physician asks if patient B has understood the reasoning and if there are any questions.

The primary unit that is supposed to be the care provider for patient B has a staff shortage leading to a high number of locum physicians, which is an issue as expressed by patient B:

I feel like I'm not being taken seriously. I have to call multiple times to get an appointment as they are almost always out of appointments and ask me to call back later. Contacting the primary unit results in me having to go through my medical history every time a new physician is responsible, which happens often (ID 14)

Patient B, having been in multiple contacts with the mobile team over a longer period, expresses the value and benefits of the mobile team:

Contacting the mobile team is reassuring, it's the same people–they know my history, they follow up and listen to me, making me feel safe (ID 14)

The physician concludes that a follow-up visit will take place to monitor the effect of the changes to the drug list. After the visit, the physician highlights the remarks by patient B and connects to the potential of a functioning MPCP:

The increased feeling of safety creates an environment for the patient to express more information than would have been expressed during a hospital visit, aiding identification of underlying issues. Further, having a good relationship based on trust can help convince the patient to apply for home-based municipality care. And if the MPCP concept was improved a MPCP would be the natural actor to take over the responsibility for patient (ID 8)

On the way back to the hospital from the patient visit, the nurse expresses the value of having the same patient over a longer period:

We've had patient B for a longer period. It is not supposed to be that way in the new model. We should only have the patient for a short period, but we've chosen to keep following up with patient B since there is no clear actor to take over. A combination

of providing care through short tasks, as the goal in the current model, and taking over patient responsibility in some cases, following the patient over a longer period could be a solution. And that has a value, for example, we can go to a patient to administer diuretic medicine, but we discover entirely different issues that were not previously identified and can ensure that proper care is provided directly (ID 6)

The day ends with the registration of the visit and preparations for the following morning.

4.1.5 MPCP from the mobile unit's perspective

The MPCP concept introduced in 2011, (see section in 1.1.2) is still in the development phase when comparing different primary units in the Skaraborg catchment area. Depending on the allocation of resources, the allocated time for the MPCP in the mobile role can vary between 10% to 80% of the work time. Thus, some MPCPs cannot fulfill their role as mobile physicians, causing the mobile teams to take over the responsibility increasing the workload.

The quality depends on the primary care center, mainly on the resources and the director who allocates the resources. The primary physician is working at the clinic and as a mobile physician. The major difference from one primary care center to another is the allocated time of the physician. In some cases, the physician has 80% of their work time dedicated to the role as an MPCP; in other cases, it is much lower, around 10%. Subsequently, the whole idea of MPCP does not work nor generate improvements in all cases. With low resources and few MPCPs, the municipality nurses that take care of the patients will have difficulties getting hold of a responsible MPCP. Instead, the nurses contact the mobile unit, and we "take over" the role of the MPCP, increasing our workload (ID 8)

The effects of non-utilized MPCPs are well illustrated in the visit of patient G. When the nurse needs support, the nurse will ideally contact the MPCP. However, since this function is not fully developed in the primary unit of patient G, the mobile unit is contacted, and a mobile team physician takes over the role of an MPCP. Another problem with MPCPs is the high turnover of healthcare personnel and the insecurity newly graduated or young physicians have. A physician illustrates the situation:

The personnel questions can be raised here as well, as there is a lack of physicians to work as MPCPs. These physicians must be experienced, as new physicians or the ones doing their residency often feel insecure and sends the patients to the hospital even though home care would have sufficed, defeating the purpose of mobile care (ID 8)

4.2 Quantitative data on the new model

The reflection on the qualitative findings with the mobile teams highlighted that some research questions were still unanswered and could not be answered through

the qualitative data. Furthermore, discussions led to the formulation of additional questions.

- What was the impact on healthcare consumption in pure numbers?
- What patient groups are covered in the new model, and which diagnoses were most common?
- Is there a difference between the teams in regard to number of contacts per unique patient and number of contacts from the patient groups if there any?

These questions required a quantitative analysis. In particular, the analyses entailed the impact of mobile care on healthcare consumption through a paired t-test, traits of the mobile units in types of contacts with the patient–diagnosis codes and distribution of patients between the teams, patient groups (i.e., sub-populations) that receive care from the mobile unit. The idea of sub-populations was suggested to the team during the discussion to facilitate the identification of patient types. The sub-populations were determined based on the number of contacts with the teams per unique patient, illustrated in figure 4.10, classified as the service group, low consumption group, middle consumption group, and high consumption group, further detailed in section 4.2.3.

4.2.1 Healthcare consumption

The number of unplanned emergency- and inpatient care contacts (i.e., healthcare consumption) before and after the engagement of the mobile teams was measured through a paired t-test. The selection criteria of the data were patients having had contact in the form of FH-visits (first home visits) with the mobile teams between 01-07-2020 and 23-11-2021. Based on this selection, all inpatient and emergency care visits, six months before and after the FH-visit of mobile teams, made up the two sample sets for the paired t-test. There was no dependency between the patients, the measured difference of the data was normally distributed, illustrated in figure 4.4, and the set included 661 samples, fulfilling the first and second assumption of a paired t-test.

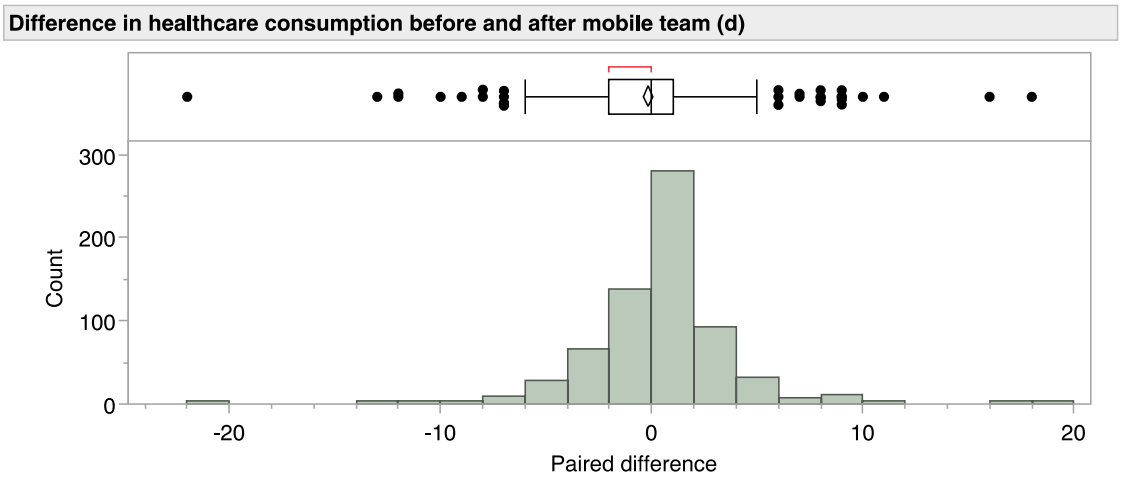


Figure 4.4: Distribution of the measured difference in healthcare consumption

Regarding the third assumption of outliers, the data include outliers, as shown in figure 4.4. Excluding all extreme outliers, i.e., the data outside of the lower- and upper limit of the box plot as according to literature [46,47], resulted in an exclusion of around 5% of the data, 33 patients. A distribution on the difference in healthcare consumption data excluding outliers can be seen in figure 4.5.

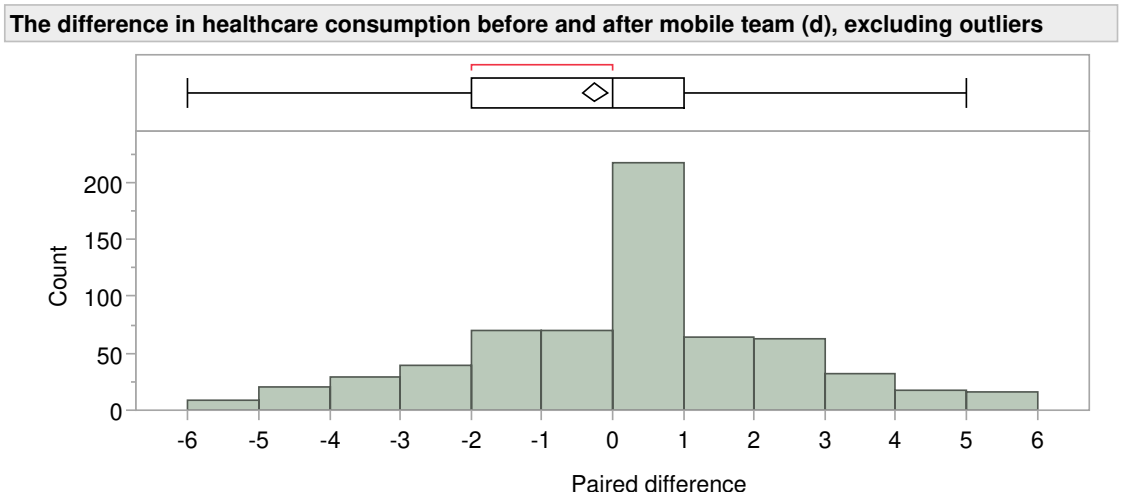


Figure 4.5: Distribution of the measured difference in healthcare consumption excluding outliers

Figure 4.6 shows that the mean value of healthcare consumption measured as number of patient visits has decreased after contact with the mobile teams, unaffected by the outliers, further validating the usage of a paired t-test.

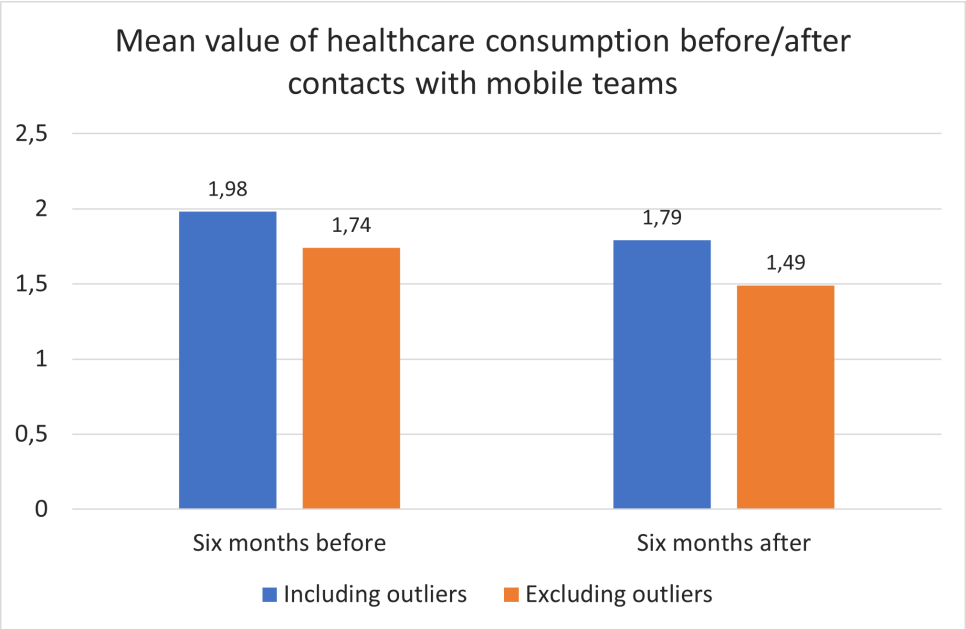


Figure 4.6: Healthcare consumption measured as mean value of number of visits six months before and after the first contact with the mobile unit, including and excluding outliers

The paired t-test was performed on a set of 628 patients, $n = 661 - 33 = 628$. The null hypothesis, (H_0), being "The healthcare consumption did not decrease after receiving care of the mobile unit, between the period six months before the first visit of the mobile unit and six months after the first visit of the mobile unit." The alternative hypothesis (H_1) being the opposite: "The healthcare consumption decreased after receiving care of the mobile unit, over a period of six months." The t-test variables are summarized in table 4.2.

Table 4.2: Variables of the paired t-test - based on JMP exclusion of outliers (5%) outside whiskers of figure 4.4

Variable	**Value**
α	0.05
DoF	627
Table value	1.65
t-value	-2.76
p-value	0.012

The t-test observed a t-value of -2.76 and a p-value$<$0.05. Both these values mean that the null hypothesis is rejected in favor of the alternative hypothesis, indicating that there is a statistically significant decrease in healthcare consumption, of emergency and inpatient care, after the first visit of the mobile unit.

4.2.2 Data on patients of the mobile unit

This subsection covers the quantitative data analysis for all patients that have had contact with a mobile team: the most common type of contact, diagnosis codes, patients' age, and the number of contacts per mobile team.

Type of contact

Listed in table 4.3 are the types of contact the mobile team had with patients in order by size.

Table 4.3: Type of patient contacts of the mobile team

Type of contact	Number of contacts	Description
FH	1342	First home visit
H	830	Home visit
X	115	Partial visit
ET	106	Following telephone contact
TÖ	40	Other type of distant contact
FT	37	First telephone contact
E	16	Following visit
Ö	6	Other
K	5	Consultation
F	3	First visit
B	1	Treatment during current SV
DS	1	Digital written distance contact
EV	1	Following contact by video

FH- and H-visits cover 54% and 33% of all contacts, making up more than 85% of contacts. When validating the complete data set, some faulty registrations regarding the type of contacts were found, i.e., the difference in indicated contact type depending on the user registering. Hence, the E contacts should be marked as H contacts, and F should be FH. Thus, most of contacts by the mobile team were performed in the home of the patient.

Age distribution

The age distribution for patients having been in contact with one of the mobile teams is depicted in figure 4.7.

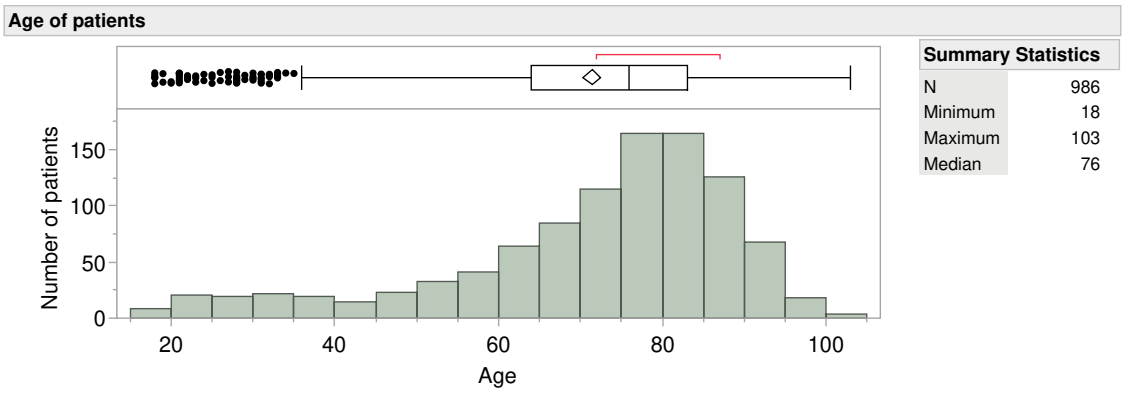


Figure 4.7: Histogram of the distribution of the unique patients' age

The majority of patients covered in the new model are classified as elderly, >70, and the median age is 76. Thus, the age is similar to that of the old model, considering the change of the age criteria from 75 to 18.

Diagnosis codes

An excerpt of the number per diagnose codes for patients on a section level can be seen in figure 4.8 and an excerpt of detailed diagnosis codes in figure 4.9. A complete list of main diagnosis codes can be seen in Appendix C and a complete list with specific diagnosis can be seen in Appendix D.

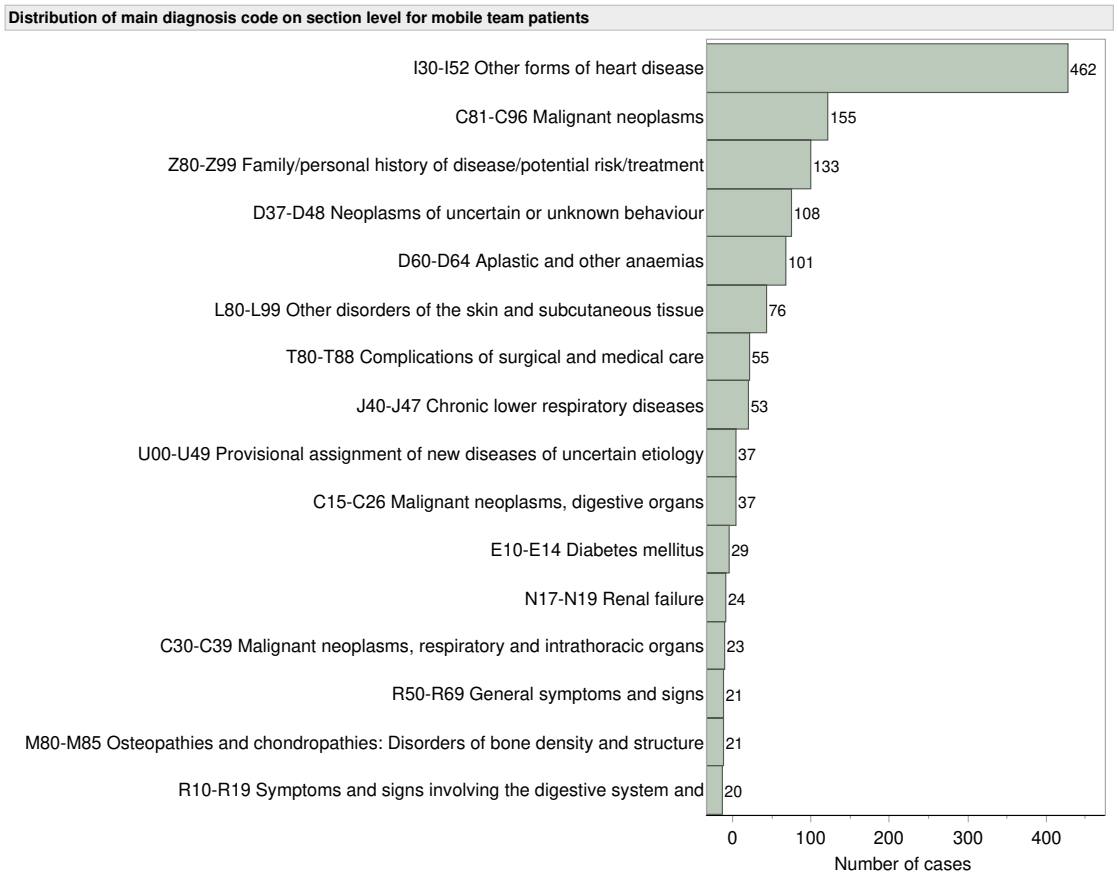


Figure 4.8: An excerpt of diagnosis codes for all patient contacts of the mobile team on sectional level, excluding all diagnoses with less than 20 registrations

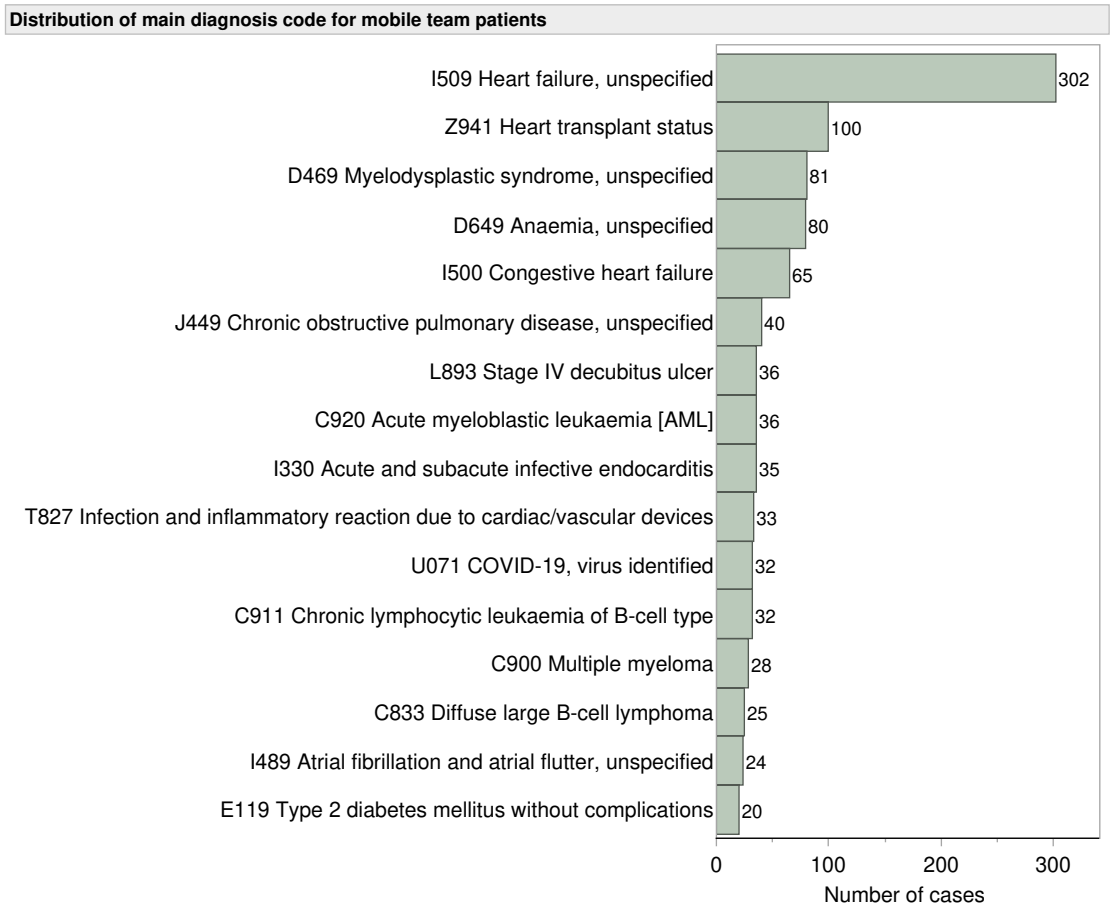


Figure 4.9: An excerpt of diagnosis codes for all patient contacts of the mobile team on detailed level, excluding all diagnoses with less than 20 registrations

The figures show the diagnosis codes on the sectional and detailed levels on the y-axis. The x-axis represents the number of registrations of each diagnosis, with a total number of 1746 cases. The most common sectional code is related to heart disease, I30-I52, making out 426 cases (24%) of all diagnoses on the sectional level. Heart failure (I509) is the most common diagnosis making up 302 of the 426 cases of heart disease and represents 17% of all diagnoses. The diagnoses congestive heart failure (I500), acute and subacute infective endocarditis (I330), and atrial fibrillation and atrial flutter (I489) make up the remaining cases of the section code I30-I52, representing 7% of all diagnoses. Further, the second most common diagnosis, heart transplant status (Z941), is also related to heart diseases/issues. Diagnosis codes ending with a 9, i.e., unspecified type of the section level diagnosis, make up 845 cases (34%) of all diagnoses, the largest being heart failure (I509), myelodysplastic syndrome (D469), and anemia (D649). The remaining diagnosis codes can be viewed in appendix D.

Distribution of patient contacts per team

The number of patient contacts performed by each mobile team is represented in table 4.4.

Table 4.4: Number of contacts per team

Team	Number of contacts	Percentage	Contacts per unique patient
FMEMNÄ	994	39.7	2.8
LMEMNÄ	298	11.9	7.5
MMEMNÄ	598	23.8	2.7
SMEMNÄ	613	24.4	1.2
Total	2503	100	-

The column to the furthest right represents the number of contacts each team performs per unique patient. FMEMNÄ and MMEMNÄ teams have a similar average, 2.8 and 2.7, respectively. The SMEMNÄ team, acting as an emergency team, has the lowest average at 1.2. However, the LMEMNÄ team has the highest number of contacts per unique patient, 7.5, showcasing that the LMEMNÄ team takes fewer contacts in total but the highest per patient. The number of contacts for each team distributed over time is visualized in appendix E.

4.2.3 Sub-populations

To further study the type of patients treated by the mobile teams, the patients were divided into sub-populations based on the number of contacts. There are 986 patients, making up a total of 2503 contacts. The patterns for each sub-population are only studied from the mobile teams' perspective, i.e., only using the contacts with the mobile teams. The number of contacts with the mobile unit per unique patient can be viewed in figure 4.10.

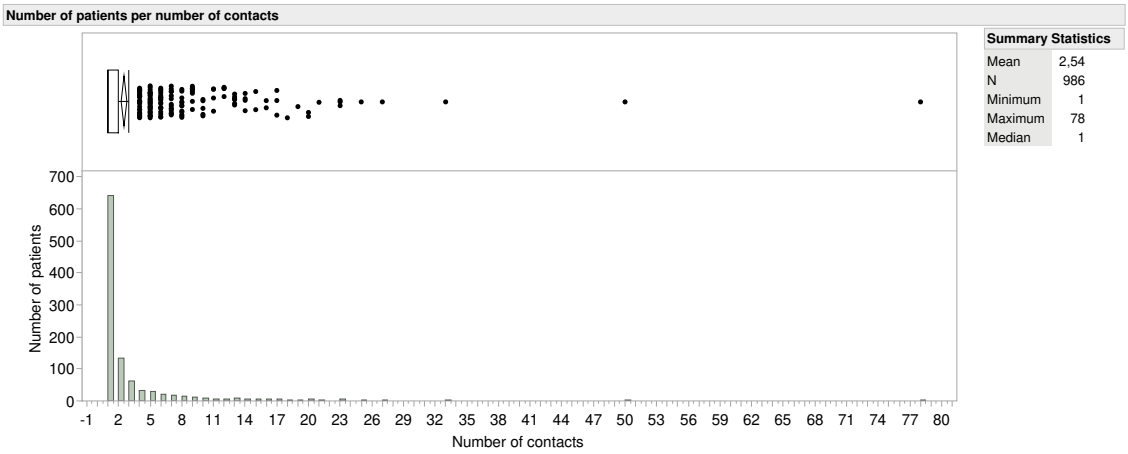


Figure 4.10: Distribution of the number of unique patients on the y-axis per number of contacts on the x-axis, in the upper figure depicted as a box plot and in the lower as a histogram

The figure showcases a box plot and a histogram of the number of unique patients per number of contacts. Based on the figure, the sub-populations limits were decided in discussions with the teams. As seen in the figure, over 600 patients had one contact with the mobile unit and were labeled as the service group, signifying that the team in most cases performed a well-defined task during one visit that was requested from the referring healthcare actor. Patients with two to three contacts were classified as a low consumption group. There is an even distribution between patients with four to 21 contacts and these patients were categorized as the middle group. The upper limit of 21 for the middle group was validated by testing an upper limit at 17, 19, and 23. No significant difference in the group patterns was detected, and the limit of 21 contacts was kept. The most extreme outliers ranged from 34 to 78 contacts, as illustrated in the box plot. However, 22 to 78 were classified as the high consumption group to not further skew the data. A summary of the sub-populations and their data can be viewed in table 4.5.

Table 4.5: Data on the sub-populations including the limits of contacts for each sub-population, number and percentage of unique patients and contacts, and the number of registrations missing diagnosis codes

Sub-population	**Limits**	**N: patients**	**(%)**	**N: contacts**	**(%)**	**N: Missing**
Service group	1	640	65	640	25.5	410
Low consumption	$2-3$	191	19.3	441	17.6	127
Middle group	$4-21$	147	14.9	1140	45.5	200
High consumption	22+	8	0.8	282	11.3	20
Sum	-	986	-	2503	-	757

The column to the furthest right represents the number of registrations, i.e., contacts

that lack a diagnosis and operational code due to the factors mentioned in 4.1.3.

Sub-populations in the t-test

To highlight the correlation between the paired t-test and the sub-populations, i.e., identify from which sub-populations the outliers in the t-test belong to, the distribution of the number of patients from the t-test in the sub-population is illustrated in table 4.6 below.

Table 4.6: Distribution of the number of patients from the t-test in the sub-populations

	Service group	**Low consumption**	**Middle group**	**High consumption**
Included	398	113	111	6
Outliers	20	9	2	2

The first row showcases the number of patients that fulfilled the t-test criteria, and the second row illustrates the number of outliers of the t-test. Viewing table 4.6 together with figures 4.4 and 4.5 shows that most of the outliers are from the service group and that the high consumption group only has two outliers.

Type of contact in the sub-population groups

The type of contact, illustrated in table 4.3, is showcased per sub-population in table 4.7.

Table 4.7: Types of contact of the mobile unit per sub-population

Type of contact	Service group (%)	Low consumption (%)	Middle consumption (%)	High consumption (%)
FH	86.7	61.9	37.4	31.2
H	5.6	24.3	44.7	62.8
X	0.9	5.7	6.8	2.5
ET	1.1	3.2	7.1	1.4
TÖ	1.9	2.7	1.3	0.4
FT	3.0	0.9	1.2	0
E	0	0.5	1.0	1.1
Number of contacts	640	441	1140	282

The type of contacts aligns with the finding of contacts per unique patient for each sub-population. The majority of contacts with the service group are FH-visits as expected. The pattern is a decreasing rate of FH-visits and an increasing rate of H-visits for each sub-population. The high consumption group has most contacts as H-visits. In the middle and high consumption groups the FH-visits are not a "first" home visit. Rather, an FH-visit is registered for each new task, even if it is for the

same patient, as the mobile teams do not take over the responsibility of the patient and thus equals a new task with a new visit.

Looking at table 4.7 and table 4.5 it is worth noting that the partial contacts and visits, X, are included for all sub-populations in all data findings. In total, 115 cases of partial visits, <5%, and only the low and middle consumption group pass the 5% limit. A few of these are mistakes in the registration as there are no other contacts on the same date. A few cases are physicians from the outpatient ward contacting the mobile team for assistance in a home visit. Furthermore, if the partial contacts were removed, some contacts from the low consumption group would be moved to the service group, 12 patients in total. However, at the same time, if all partial contacts were excluded, the six patients discussed here would be removed from the data set, even though the visit was a full visit from a mobile team perspective, i.e., using resources that could have been used elsewhere.

Distribution of sub-populations contacts per mobile team

To further examine the difference between the teams, as shown in table 4.4, the relation of contacts per team for each sub-population is illustrated in table 4.8.

Table 4.8: The distribution of contacts between the mobile teams per sub-population group

Team	Service group (%)	Low consumption (%)	Middle consumption (%)	High consumption (%)
FMEMNÄ	15.2	18.7	58.9	7.1
LMEMNÄ	0	9	57.7	33.2
MMEMNÄ	16.6	22.7	43.8	16.9
SMEMNÄ	63.6	15.0	19.5	1.8

The percentage values in the table are based on the number of contacts per team per sub-population from table 4.5. The FMEMNÄ and MMEMNÄ teams both have a similar distribution over the sub-populations. One key finding is that the LMEMNÄ team has over 90% of all their patient contacts with the middle and high consumption groups, i.e., have a high number of contacts with each patient, further indicated by table 4.4. Another finding is that the SMEMNÄ team mainly performs single visits, i.e., contacts with the service group, acting as an emergency team that might align with the mobile care plan.

The high number of missing registrations in table 4.5, i.e., registrations without codes, of the service group, can be explained by the fact that the SMEMNÄ team covers 64% of all patients in the service group. As described earlier, the registrations for the SMEMNÄ team are performed in AmbuLink and thus lack the information in ELVIS.

Diagnosis codes in the sub-population groups

Table 4.9 represents the top three diagnoses on sectional level for the mobile team, as represented in figure 4.8, across the sub-populations based on the number of contacts in total.

Table 4.9: Top three diagnoses on sectional level for the mobile team across each sub-population

Diagnosis codes sectional level	Service group (%)	Low consumption (%)	Middle consumption (%)	High consumption (%)
I30-I52 Other forms of heart disease	10.0	18.5	30.1	37.4
C81-C96 Malignant neoplasms	5.2	9.6	11.9	0.38
Z80-Z99 Family/personal history of disease/potential risk/treatment	2.6	9.2	10.1	0.11

The description of the diagnosis codes is:

- C81 - C96: Malignant neoplasms, stated or presumed to be primary, of lymphoid, haematopoietic and related tissue
- Z80-Z99: Persons with potential health hazards related to family and personal history and certain conditions influencing health status

I30-I52 diagnosis is the most common for all sub-populations. The low consumption and middle groups have the same diagnosis pattern on sectional levels.

Table 4.10 represents the top three diagnoses of all patients of the mobile team across the sub-populations.

Table 4.10: Top three diagnoses across each sub-population

Diagnosis codes	Service group (%)	Low consumption (%)	Middle consumption (%)	High consumption (%)
I509 Heart failure, unspecified	8.3	10.8	19.8	23.6
Z941 Heart transplant status	0.9	6.4	8.3	0
D469 Myelodysplastic syndrome, unspecified	1.3	0.6	1.8	22.5

Both tables showcase the frequency of the top three diagnoses on a sectional and detailed level. The percentage is calculated based on registrations with a diagnosis code, subtracting the missing cases (listed in the column to the furthest right in table 4.5) from the total. A detailed record of the diagnosis codes and operational codes for each sub-population is represented in appendix F. As seen in both tables,

the service and high consumption groups deviate from the pattern of the low and middle consumption groups. For the service group, the diagnoses Z941 and D469 only occur in two, respectively, three unique cases. However, the diagnose codes of the service group are not representable for all sub-populations since 64% of the diagnosis codes are missing, as pointed out earlier due to the fact that the SMEMNÄ team performed the majority of contacts with the service group.

The low and middle consumption groups' top three diagnoses on a sectional and detailed level are almost identical to that of all patients, figure 4.8 and 4.9. The difference is diagnosis D469, making out 1.3% and 0.6% respectively of all cases for both groups. Instead, diagnosis D649 (Anaemia) is the third most common, with 20 cases (6.4%) for the low consumption group and 40 cases (4.3%) for the middle consumption group. Studying the tables further, one can conclude that the high consumption group, with the lowest number of unique patients and the highest number of contacts, is the reason for the difference between sub-populations in regard to D469 being the third most common diagnosis for all registrations, as showcased in figure 4.8.

From the high consumption group, patient 32 (P32) had 54 registrations with the I509 diagnosis and 24 with the I500 diagnosis, indicating a uni-disease patient. P891 has the same patterns of 15 cases with I500 and six with I509. P165 could also be classified as a uni-disease patient with 25 registrations of diagnosis D469 and four registrations with diagnosis D462. P173 follows similar traits with 26 registrations of D469, and 17 of those registrations included Z452 as the secondary diagnosis, indicating a uni-disease patient. Similarly, P358 and P421 appear as uni-disease patients studying the diagnosis codes. P386 has 15 of 23 contacts registered under codes R10-R19, Symptoms and signs involving the digestive system. P421 has diagnosis code T827, Infection and inflammatory reaction due to cardiac/vascular devices, registered in 33 of 48 contacts making up all the cases of T827 for all the mobile unit's patients, see figure 4.9.

4.3 Key differences between the old and new model of mobile care

Table 4.11 summarizes the key differences between the old and model of mobile care at SHG from the perspective of the results, that were discussed with the mobile teams.

Table 4.11: Key differences between old and new model of mobile care for SHG

Function	Old	New
Mobile teams' function	Take over patient responsibility	Supportive function to other healthcare actors
Patient criteria	Six criteria covering 0.2% of the regional population	One criterion: Includes all patients above 18 years of age that do not require psychiatric care
Organization structure	Separate department	Mobile unit split into four teams, all under different medical departments (M1-M4)
Personnel in teams	2 nurses, 1 physician per team, working full time	High number of personnel working part-time
Communication	Whole unit in dialogue with steering committee	Process leader communication channel between unit and steering committee
Working process	Assessment of patient, formulate long-term ICP, continuous follow-up, referral back to the system when stabilized	Standardized method (collect information, assess case, formulate ICP, provide care, inform case provider)
Patient referral method from other healthcare actors	Formal referral through the system	Informal phone call directly to the teams
Patient assessment	In-depth assessment of each patient, according to established criteria	Varies from case to case, quick assessment of teams' capability
Registration of patient contacts	Not known	Each contact registered in ELVIS and Melior
Effect on healthcare consumption	80% reduction of emergency visits 90% reduction of hospital days	Decrease in healthcare consumption ($p < 0.05$), mean value decreased from 1.74 to 1.49
Patient group	0.2% of the regional population, one distinct patient group–elderly unstable patients with multiple diseases	At least four patient groups: service, low-, middle-, and high consumption

The most significant differences between the old and new model, as perceived by the team members, are the function, and the inclusion criteria, which in turn generated other key differences. With expanded inclusion criteria, the number of patients increased, leading to more personnel and a changed working process. Moreover, with an increased number of patients, the patient groups have expanded, including uni-disease patients and patients with multiple diseases. The difference in the effect on healthcare consumption between the old and new model can not be compared on equal grounds, considering the patient groups and mobile unit's function. However, the new model has decreased healthcare consumption for its patients.

The next section constitutes the design and control phase of the DMADCL method, covering the fourth research question of the thesis. The development of digital tools,

based on analysis and reflection on the qualitative and quantitative results, that aid the mobile unit in improving aspects highlighted by the key differences between the old and new model and solving identified issues.

4.4 Digital tools

The final results of the digital tools are presented in this section.

4.4.1 Visual dashboard

The final product is a visual dashboard displaying the number of referrals from each hospital ward and each primary unit, where the user can filter out one or multiple of the three mobile teams: FMEMNÄ, LMEMNÄ, MMEMNÄM; SMEMNÄ could not be included as they report to Ambulink, as described earlier. The user can further select a period from one up to six months, from the current and backward, to display the referrals. The final solution is shown in figure 4.11.

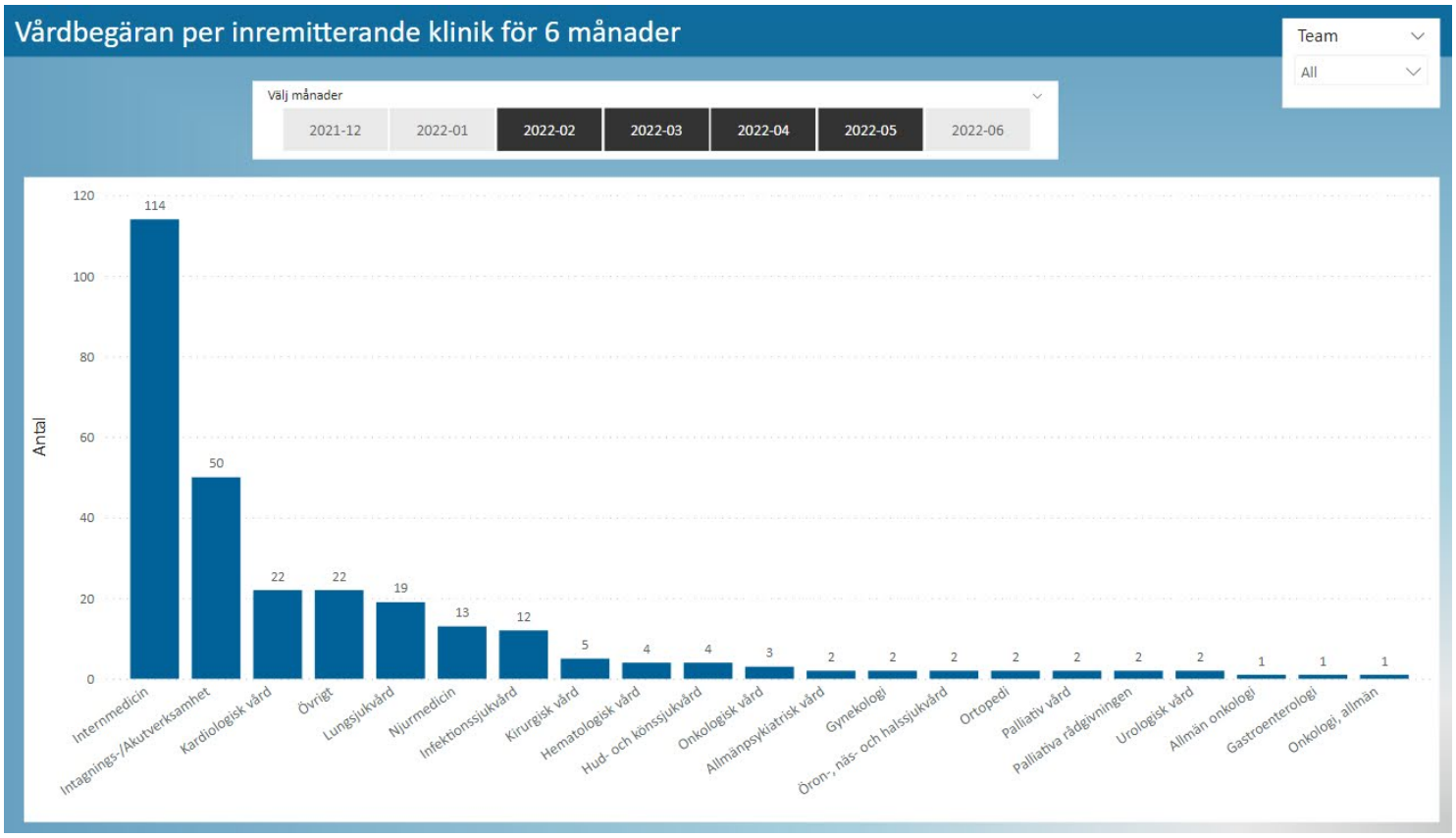
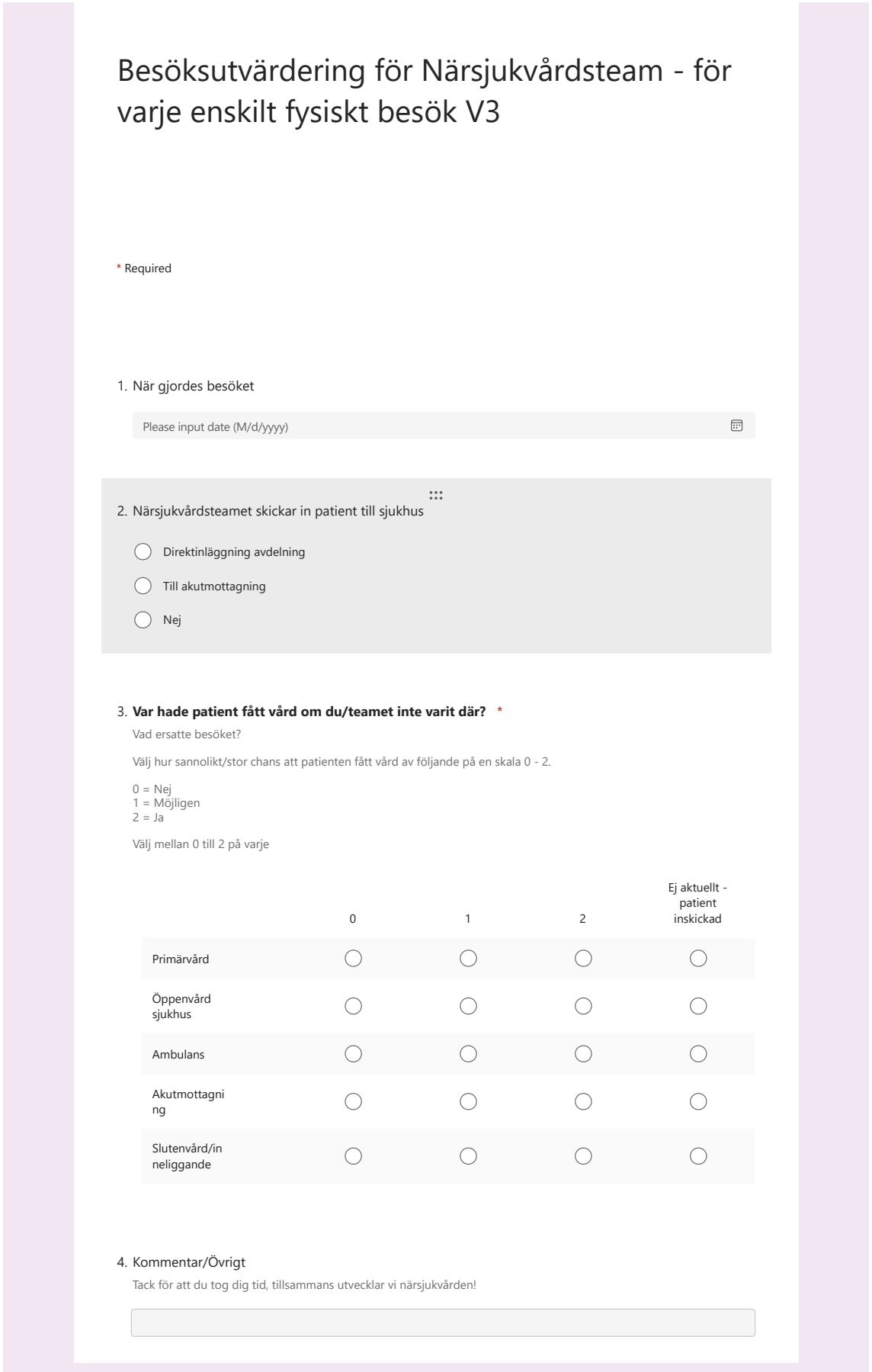


Figure 4.11: A visual of the final dashboard displaying the number of referrals from hospital wards at Skövde hospital

4.4.2 Evaluation tool

The final version of the evaluation tool can be viewed in figure 4.12. The visualization of the responses can be viewed in figure 4.13a and 4.13b.



Besöksutvärdering för Närsjukvårdsteam - för varje enskilt fysiskt besök V3

* Required

1. När gjordes besöket

Please input date (M/d/yyyy)

2. Närsjukvårdsteamet skickar in patient till sjukhus

- Direktinläggning avdelning
- Till akutmottagning
- Nej

3. **Var hade patient fått vård om du/teamet inte varit där?** *

Vad ersatte besöket?

Välj hur sannolikt/stor chans att patienten fått vård av följande på en skala 0 - 2.

0 = Nej
1 = Möjligen
2 = Ja

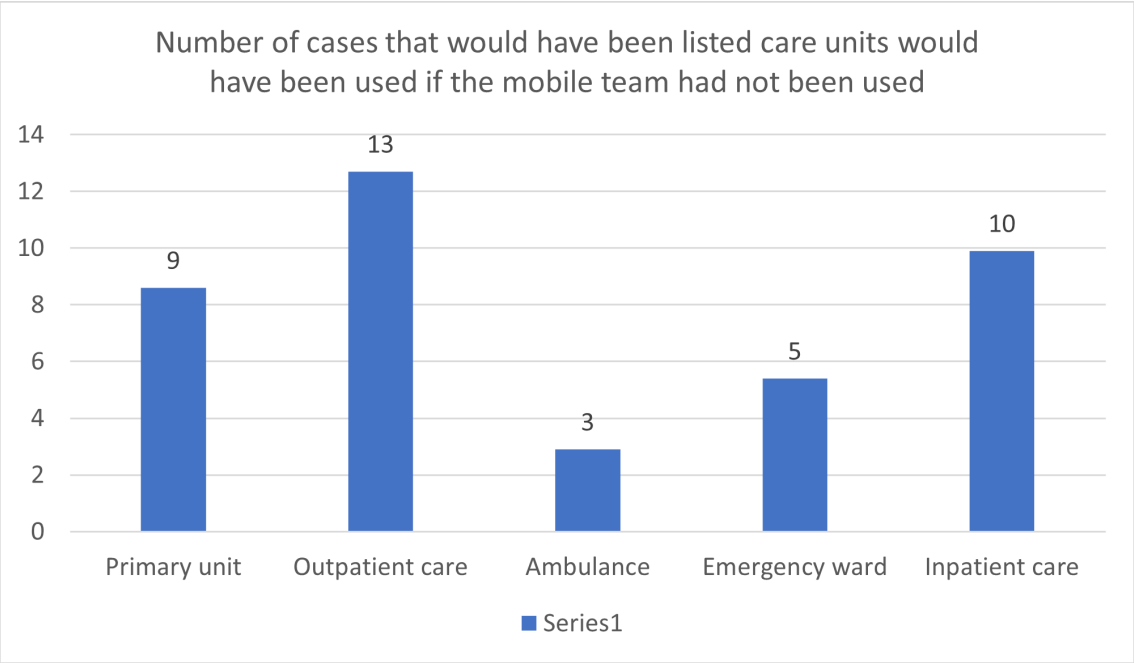
Välj mellan 0 till 2 på varje

	0	1	2	Ej aktuellt - patient inskickad
Primärvård	○	○	○	○
Öppenvård sjukhus	○	○	○	○
Ambulans	○	○	○	○
Akutmottagning	○	○	○	○
Slutenvård/inneliggande	○	○	○	○

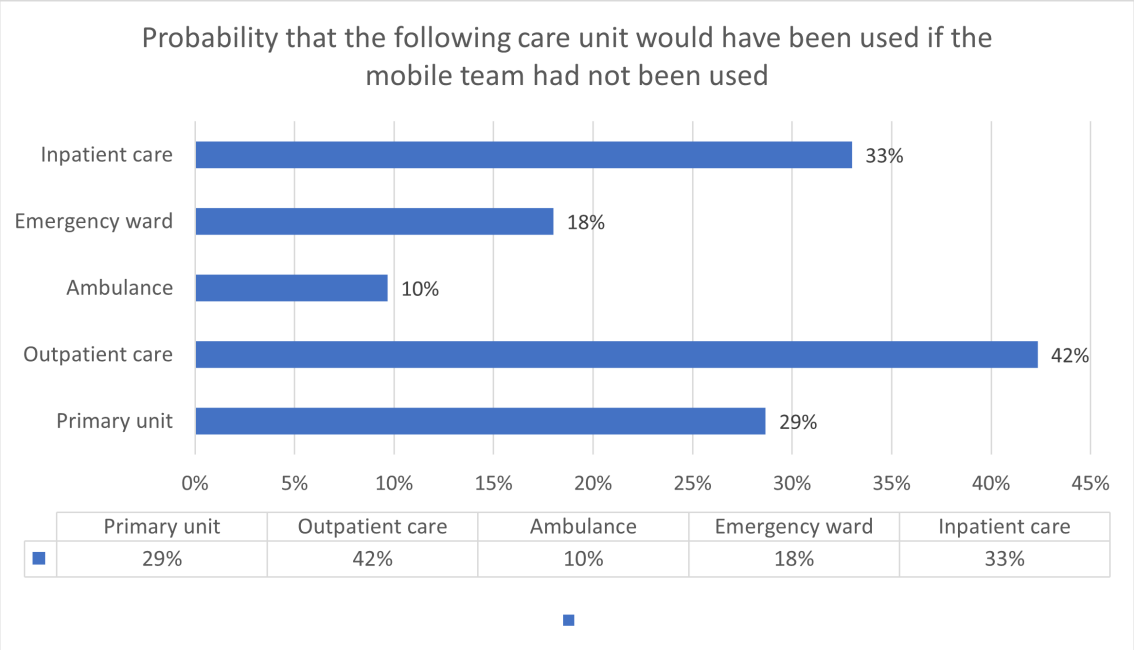
4. Kommentar/Övrigt

Tack för att du tog dig tid, tillsammans utvecklar vi närsjukvården!

Figure 4.12: Final version of the evaluation tool



(a)



(b)

Figure 4.13: (a) Showcases the number of cases that would have been handled by another care unit, by weighted values, (b) Presents the same numbers but in percentage format

4.5 Learnings of the mobile unit

During the documentation of the model, the working method/communication channel; the differences between the old and new; data on the teams: diagnosis, number of unique patients, sub-populations; digital tools, and where the patients are referred from have been highlighted. Hopefully, these learnings will enable the mobile unit to take the next step in developing home-based integrated mobile care.

Diagnosis codes

A diagnosis code registration by a nurse is uncommon in the remaining parts of the healthcare system, as neither physicians nor nurses usually register the diagnosis in code format in ELVIS. Registrations are generally performed by an officially trained medical secretary on the ICD classification system. When studying the pattern of diagnosis classification of the mobile teams, it was detected that several diagnoses are classified as unspecified diagnoses, indicated by the number 9 at the end of the diagnosis, see figure 4.9 for example. Further, 16 cases 0.9% are of the U999 format, i.e., lacking a formal diagnosis. Finally, the diagnosis classification becomes a subjective task, to some extent. Since the teams include a growing number of rotational staff (i.e., nurses), there are variations in the type of diagnosis classification and registration. The diagnosis classification must improve to create a more robust system for future expansion of the mobile care unit and a better basis for patient group identification and value creation. The findings of this issue have highlighted the problem for the team, and a workshop is planned to be hosted by a medical secretary, educated in ELVIS and diagnosis code registration, to help educate the nurses and standardize the registration process.

Sub-populations and team distribution

Further highlighted for the mobile care unit during this thesis work has been the difference between the teams in the contacts per patient and the type of patients. i.e., sub-populations that they cover. The difference between teams showcases a difference in working method, a discussion on these findings is needed to lay the ground for further development of the mobile care mission. Identifying sub-populations has provided a better understanding of what type of patients the teams cover and how the care is provided.

5

Discussion

This chapter discusses this thesis's findings in relation to the old model and the theoretical framework. The first part covers three topics of the key differences between the old and new model: 1. the experiences of the staff, 2. the patient types, 3. patients' experience and the idea of a combined model. The second part discusses the quantitative findings, mainly the healthcare consumption and the distribution of patient contacts per team. The final part covers the fifth research question providing recommendations for future development of the new model of mobile care.

5.1 Key differences in old to new model of mobile care

Teams' internal experiences of the new model

The participation and influence of the mobile unit's staff on the development of the new model are experienced as lower compared to the previous. These experiences have mainly entailed the communication with superiors, i.e., the steering committee, and decision-making regarding the whole unit. In that, there is a discrepancy between some of the personnel and the long-term goals and development of the mobile unit as a concept. However, as the new model operates in a different manner, as highlighted in table 4.11, and the mobile care concept is an established method, the mobile unit does not require the same type of support as during the introduction of the old model in 2008. Thus, meetings with the steering committee are not held as often. Further, with the new organizational structure, the process leader acts as the communication channel for the whole team, which might be more efficient than including all personnel in every meeting. However, further increasing the feeling of participation of the personnel is essential to ensure a successful microsystem [9]. A town hall meeting including all personnel of the mobile unit, i.e., all the workers of all four teams and department heads, is planned for September this fall, where the goal is to evaluate, define and develop goals for the mobile care concept. To adhere to the traits of a sustainable healthcare system, the mobile unit should increase the involvement of all personnel in reflective meetings to apply upstream thinking (i.e., identify potential issues that will arise or increase during the expansion of the mobile

unit) [9]. These suggested reflective meetings should contemplate the mobile unit's role in the meso- and macrosystem and its aim and long-term goals [9, 34].

Patients with multiple diseases and uni-disease in mobile care

During the development of the old model, it was stated that different patient categories should not be mixed, as it would result in poor outcomes [9]. The team in the old model claimed that the model was designed to cover elderly patients with multiple diseases and that the team could not handle uni-diseased patients [9]. Comparing the reasoning to today's model, where there are several uni-disease patients, especially in the high-consumption group, the question is whether this was a valid objection. The new model of mobile care is, in a supportive function, covering patients with multiple diseases and uni-diseases. Further, considering the results of the t-test on healthcare consumption, one could argue that the new model not only covers uni-diseased patients but does so successfully to some extent, based on the decrease in healthcare consumption. On the other hand, it was not possible to evaluate how the new model affected the healthcare consumption of patients with complex needs, the 0.2% group, from the old model. Thus, it would benefit the mobile unit to identify which sub-populations the patients with multiple diseases and the uni-disease patients belong to, what type of service is provided for these two types of patients and whether the decrease in healthcare consumption for elderly patient with complex care needs are on the same level as in the old model, see also section 5.5. Additionally, a recommendation for the mobile unit is to define goals on what kind of care and how this care should be provided for the different sub-populations, particularly patients with multiple diseases and uni-disease. These goals would be helpful for future continuous assessments and development of the new model.

Patient visits

The key learnings from the patient visits can be summarized as the need for improved collaboration, i.e., communication between the primary unit and the mobile team, the team preventing unnecessary admissions of patients–further highlighting the importance of the evaluation tools, and patients' experience of having home-based care.

The first point is further discussed in 5.4. The second point underlines the mobile unit's possible effect on healthcare resources, further discussed under section 5.5 future research question. The third point highlights that home-based care provided on a smaller scale in a safe environment, as experienced by patient B, can have a high effect on the patient's experience of care [51]. All patients who were visited during the thesis project expressed gratitude on multiple levels: the patients did not have to make the cumbersome journey to the hospital; they felt safe in the environment and could express worrying thoughts concerning their health. The patients also experienced a sense of being heard and seen more as a person than a patient.

The visits to patients G and B are good examples of the value of mobile care: the value of the new model, i.e., few visits in the case of patient G, and the value in the old model, i.e., multiple visits over a longer period with patient B. Thus, a recommendation for the mobile unit is to examine if a combination of the old and new models could be a successful and sustainable solution. The combined model would act as a shop supporting the other shops for patients like patient G and, in some cases, act as a chain, taking over the patient responsibility and providing the necessary care to stabilize the patient before referring the patient back to the ordinary healthcare system outside the mobile unit (i.e., the mesosystem). Based on the key elements of a sustainable healthcare system, an adaptive system that applies upstream thinking [9], a combined model should be planned in detail, applying the learnings from the old model in the combined model. Furthermore, the combined model would benefit from always securing that each patient has a case manager, responsible for the integration of care according to the ICP. The case manager might be located in the microsystem, at the hospital or in primary care. Dedicated case managers contribute to a holistic view of the patient care journey–a key requisite for sustainable care at all system levels [5, 30]. In addition, an ICP for each patient provides the mobile unit with feedback on how to provide sustainable care to satisfy the patient's needs [5, 9].

5.2 Interpretation of quantitative results

Healthcare consumption

The results show that healthcare consumption decreased after contact with the mobile team. The paired t-test only gave a significant difference when the extreme outliers were removed, p-value$<$0.05. However, a lower exclusion limit of the outliers than the current of the 5%, based on the distribution in figure 4.4, also gave a p-value$<$0.05. Excluding 0.5%, i.e., three patients in the data set based on the highest number of emergency- and inpatient care contacts, also showcased a decreased healthcare consumption in total (t-value 1.69, p-value$<$0.05). These three patients all had one contact with the mobile teams while having +30 contacts of emergency- and inpatient care nature. The limit of 5% for outliers was kept to adhere to the t-test assumptions of having well-distributed data.

Patient contacts per team

The SMEMNÄ team, acting as an emergency team, has most of its contacts with the service group and a few with the remaining sub-populations, which is logical considering the purpose of the emergency team. There is a substantial difference between the service group and the middle and high consumption groups from the LMEMNÄ team perspective. The team has zero contacts with the service group, 58% of all contacts with the middle group, and 33% of all contacts with the high consumption group. Considering that not all partial visits are excluded, there might be patients treated by the LMEMNÄ team that are in the low consumption group but should be in the service group. However, as mentioned earlier, the difference is

marginal. Thus, the question is, why the LMEMNÄ team has nearly all its contacts with the middle to high consumption groups, compared to the MMEMNÄ and FMEMNÄ teams having a more even distribution of contacts per sub-population? A possible answer is that the LMEMNÄ team is working under conditions similar to the old model, with two full-time nurses having more continuous contact with the patients providing continuous care, and feeling a responsibility for the patients. In addition, the nurses and physicians connected to the team have all worked in the old model, making them more prone to perform more contacts per patient. The fact that the LMEMNÄ team has an average of 7.5 contacts per unique patient and a total of 298 contacts further strengthens the image of the team working with the reasoning of the old model. A recommendation is for the mobile unit to reflect on and discuss the difference in the number of contacts per team and the number of contacts per team per sub-population, see table 4.4 and 4.8. Furthermore, the mobile unit should examine if the workload is evenly distributed across the teams to adhere to the working conditions of a sustainable healthcare system [30], and consider the previous recommendation of a combined model of mobile care.

5.3 Digital tools

The digital tools will aid the mobile unit in becoming a successful microsystem, providing continuous monitoring of the results [9, 35], i.e., what resources are saved by the mobile unit through the evaluation tool, as well as aiding the mobile unit in their goal of spreading awareness of the teams through the visual dashboard. During the tool development phase of this thesis, efforts were made to include all mobile unit staff in the process, performing a joint problem framing and a sense of co-creation to ensure successful tools [35]. However, since the teams are spread out across different locations, and most of the personnel work 50% with their mobile team, it was challenging to include all personnel in the process. The collaboration was thus limited to the working personnel that day during the morning meetings or in between their visits. Since the process leader works full-time with the mobile unit and is often available for physical and virtual meetings, the process leader was the only constant participant in all the stages of the tool development. The reason for this was two-folded. Firstly, the process leader has the most current information about the mobile unit. Secondly, the process leader could inform the remaining mobile unit staff of any updates and changes in the tool development. However, even though the process leader communicated any updates regarding the thesis and tool development to the personnel, there is a risk that the remaining personnel does not feel as included in the process as intended. Thus,

5.4 Collaboration in the meso- and macrosystem

Collaboration in the mesosystem

Primary unit and mobile teams

Currently, the primary care units and municipality care facilitates seem to have a low awareness of the mobile unit, as was seen in the number of referrals during the design of the visual dashboard. Moreover, as the point of the mobile unit is to be a successful microsystem, acting in an upstream manner by preventive measures [9,11], improved collaboration and communication with the primary unit would save resources by using the mobile unit instead of referring the patient to an unplanned hospital visit. Furthermore, for the primary and mobile care units to be successful microsystems, jointly formulated long-term goals for joint learning can effectively bridge the barriers between the two microsystems [9, 35]. In addition to the lack of awareness, there seems to be a misunderstanding of the mission and goal of the mobile unit from the primary care point of view.

Another key aspect in the collaboration between the mobile unit and primary care is the need of development of the MPCP concept. As was highlighted by a physician (ID 8), there is a vast difference from primary unit to primary unit in how they work with the role of MPCP. In some cases where the MPCP is not living up to the role, the municipality nurse contacts a mobile team directly without the involvement of the MPCP. Thus, it falls upon the contacted mobile team to contact the MPCP to re-coordinate the patient's care plan. Instead, the MPCP should contact the mobile unit, working as two shops or microsystems in the mesosystem. Thus, the collaboration and communication between the mobile and primary units must be improved to be a functioning mesosystem.

Lack of awareness

A reason for the lack of awareness of the new model of mobile care amongst the other microsystems (i.e., care providers–hospital wards, primary units, and municipality care) in the mesosystem is the turnover of personnel, making it hard to establish mobile care as an existing alternative. In addition to the high turnover of personnel, newly graduated nurses and physicians are not only lacking awareness of the mobile team, but their lack of experience and uncertainty may result in selecting a safe measure of admitting a patient to inpatient care rather than contacting the mobile unit, defeating the purpose of preventative measures. A suggestion is to incorporate the mobile unit as a rotation during the intern period and residency for physicians, creating an understanding and awareness of the mobile unit as a reliable resource.

Successful collaboration and improvement between microsystems in a healthcare context is facilitated in a shared data environment [9, 11, 34]. Thus, a future change that might facilitate collaboration in the mesosystem is the approval of a new law, 2021/22:SoU30, regarding the restriction of access and sharing of patient data between healthcare actors [52]. The law will enable all healthcare actors within the

same municipality area to share patient data and directly access the patient's journal from other care providers [53]. The law will come into effect from January 2023 [52]. Furthermore, there are works on a new healthcare registration and patient journal system, Millennium, that is planned to be deployed across VGR, enabling all healthcare actors on a regional level to access all patient information. Unfortunately, Millennium has been delayed to 2026, making it hard to estimate the impact on collaboration across the mesosystem. Nevertheless, it will hopefully facilitate the collaboration of the hospital, primary, and municipality care.

Collaboration in the macrosystem

The collaboration between mobile care models in the macrosystem, i.e., across regions, is a potential gold mine. Although healthcare actors from region to region are disconnected due to the current system and politics, the mobile units in each region all have a somewhat similar model and the same goal of reducing unplanned emergency and inpatient care. Although the models across the macrosystem have differences, most regions based have based their mobile care model on the old SHG model as it was a pioneer in home-based mobile care [1,3,54]. However, there are differences between the organization and working process of mobile care models across the macrosystem–regions. An interesting example is the Örebro region, where the mobile unit collaborates across the mesosystem with 1177, which is a Swedish national infrastructure that provides advice and services in healthcare [55], meaning that the 1177 unit can contact the mobile team in Örebro if they receive a call from a patient and make an assessment that mobile care would be the most suitable solution. Thus, the mobile care units across the macrosystem can learn from each other, providing valuable resources for developing the mobile care model. The SHG mobile unit can both provide other regions with key learnings from the old model and learn from others.

5.5 Future development and research areas of the new model

Effects of mobile care on healthcare costs

As the overarching goal of SHG is to decrease unplanned emergency- and inpatient care, the visit to patient G is an example where resources were saved. However, it is difficult to measure the cost and what resources had been used had the team not been contacted. The old model of mobile care proved to have a reduction in cost per capita and increased efficiency of resources, which was an important factor in showcasing the model's success. Thus, a future research topic is to examine the relation between the new model and the effect on cost and resources. As an outcome of this thesis, the evaluation tool will provide preliminary data that can be used as a starting point when the research question is examined.

Healthcare consumption

A future research area is how healthcare consumption has decreased for each identified sub-populations. For example, would it be probable that the mobile unit reduced the healthcare consumption for the service group? Considering that 398 patients in the t-test adhere to the service group and that a significant number of patients in the t-test have zero difference in unplanned contacts, see figure 4.5, is it thus likely that the healthcare consumption has decreased for the service group? Furthermore, with 20 patients from the service group being excluded from the t-test (i.e., outliers having a high number of unplanned emergency- and inpatient care contacts before or after the single contact with the mobile team), the question is what kind of patients are in the 20 excluded, and can the mobile unit adapt their provided care for these patients as they are only having one contact with the mobile teams? Therefore, examining the data would be valuable in studying the correlation between the difference in healthcare consumption and the sub-populations.

Another aspect to examine is whether the mobile unit has decreased patient care consumption from the primary unit. The potential effect on primary care has not been examined within this thesis, partly as it has been outside this thesis's scope and partly because of limited access to data from the primary unit. Therefore, a future research question would be how the mobile team affects patients' healthcare consumption from a primary unit perspective.

Value creation for elderly with multiple diseases

An initial goal for the thesis was to identify if the 0.2% group of elderly patients with complex healthcare need from the old model still exists in the new model and if the created value in the old model was preserved. However, the group could not be identified as the data only contained information that would meet three of the six criteria in table 1.1:

1. Minimum of three hospital admission/three inpatient care visits during the last 12 months

2. Three or more diagnosis codes classified as chronic diseases

5. Age higher than 75 years

However, criteria 2 causes issues as it relies on correct registrations of diagnosis codes. Thus, one patient could, at three unique visits stretching over a period of two months, gain and lose diagnoses of chronic diseases, which is not medically probable. An additional issue was the lack of expertise from the author's side regarding the classification of chronic diseases based on the diagnosis codes, further destabilizing the validation of criteria 2. Furthermore, considering that the old model was based on a patient-by-patient evaluation, it is not equivalent to only consider three criteria. Therefore, further work is needed to identify if the 0.2% group is covered in the new model, how they handled the transition from the old to the new model, and if the

created value in the old model was and still is preserved both from a qualitative and quantitative aspect.

Using input from patients and care providers for future improvement

There would be a high value in interviewing patients and their relatives from each sub-population in the new model. Identifying what kind of value is experienced by the patients in the different sub-populations and what kind of value (i.e., goals) the mobile unit want to set for the different sub-populations is key for further development of the microsystem [9,34]. Another aspect that can create value for the mobile unit is interviewing the physicians and nurses who refer patients to the mobile teams. The basis for the interviews should be the reasoning behind the referral of patients to the mobile teams. It would be of value to identify what type of patients that are not referred to the mobile teams and the reasoning behind it, i.e., could there exist patients that would benefit from mobile care that are undetected?

Covid-19 impact

The Covid-19 pandemic has not gone undetected by any healthcare actor. The mobile unit has, since the implementation of the new model, been operating during the pandemic. A difficult question is whether the pandemic has affected the number of patients covered by the mobile unit. For example, are there patients who have refrained from contacting the healthcare system for issues due to fear of the pandemic that the mobile unit could address in the patients' home?

Whether this question will be possible to examine depends on multiple factors: do these patients exist? Can the difference be monitored, considering that the expansion of the mobile unit and work to spread awareness increases the number of patients and that the restrictions of the pandemic are decreasing? Thus, a future research question is to examine the impact of the Covid-19 pandemic on the mobile care, emanating from the questions above.

6

Conclusion

In Sweden, the mobile care concept is growing. The previous model of SHG has and is, to some extent, still used as a role model for mobile care. Thus, the aim of this thesis was to examine and develop the new model of mobile care at SHG. The documentation of the new model, the findings of reduction in healthcare consumption (p-value$<$0.05), identification of patient groups, and the development of digital tools will help the mobile unit understand and visualize their impact and further assist them in improving the next generation of mobile care. In conclusion, the new model of mobile care is creating value for its patients by reducing unplanned emergency- and inpatient care visits and facilitating their path to care. The digital tools will assist the mobile unit in their daily work regarding the expansion of the mobile care concept and create data for quantitative evaluation of their impact. Furthermore, the tools will, together with the remaining findings, enable the unit to define long-term goals for the mobile care concept. Lastly, these findings and tools can improve collaboration between healthcare actors within the region, mainly primary units, municipality care units, and the mobile unit, and be used for learning and knowledge exchange between mobile units across the regions.

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A

Appendix: Concepts of the evaluation tool

Besöksutvärdering närsjukvårdsteam - ja/nej version

Utvärderingsverktyg för besök/insats hos patient - Baserat på resonemanget "vad hade hänt"
- Var hade patient fått vård om du/teamet inte varit där?
- Vad ersatte besöket?

* This form will record your name, please fill your name.

1. När gjordes besöket?

Please input date (M/d/yyyy)

2. Vilket team åkte ut?

- FMEMNÄ
- LMEMNÄ
- MMEMNÄ
- SMEMNÄ

3. Närsjukvårdteamet tar med/skickar in patient till sjukhus

- Ja
- Nej

4. Vad ersatte besöket?

Om teamet inte åkt ut hade patient fått vård av/genom

	Ja	Nej
Vårdcentral	◯	◯
Öppenvård	◯	◯
Ambulans	◯	◯
Akutmottagning	◯	◯
Slutenvård	◯	◯

5. Kommentar/Övrigt

Tack för att du tog dig tid, det är viktigt för utvecklingen av närsjukvården!

Figure A.1: Concept yes and no option

Besöksutvärdering för Närsjukvårdsteam

Utvärderingsverktyg för besök/insats hos patient - Baserat på resonemanget "vad hade hänt"
- Var hade patient fått vård om du/teamet inte varit där?
- Vad ersatte besöket?

* Required

* This form will record your name, please fill your name.

1. När gjordes besöket

Please input date (M/d/yyyy)

2. Vilket team åkte ut?

- FMEMNÄ
- LMEMNÄ
- MMEMNÄ
- SMEMNÄ

3. Närsjukvårdteamet tar med/skickar in patient till sjukhus
direkt/inlägg - om ja ignorera nästa fråga och skicka in

- Ja
- Nej

4. **Var hade patient fått vård om du/teamet inte varit där?** *

Välj hur sannolikt/stor chans att patienten fått vård av följande på en skala 0 - 3.

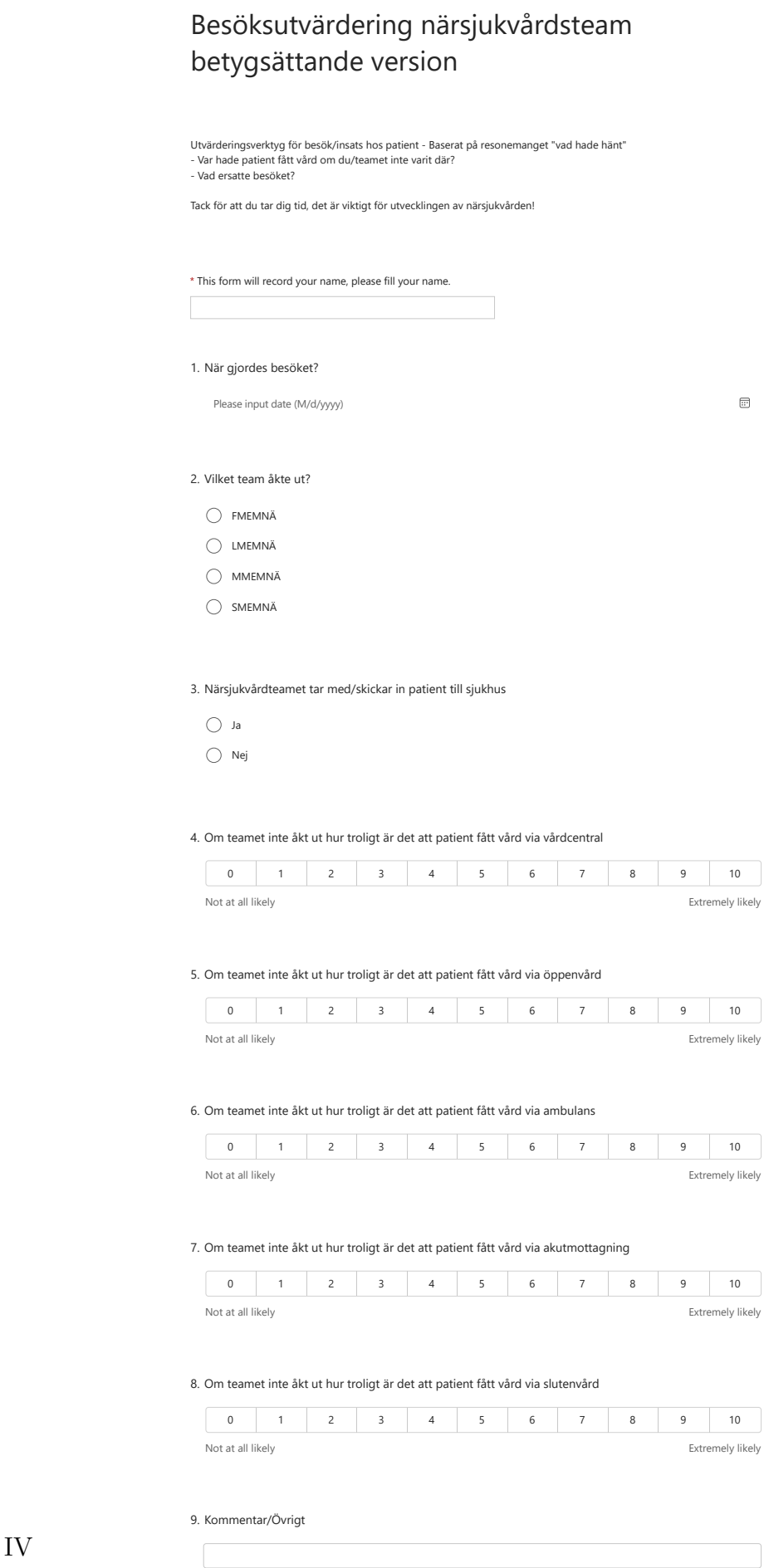
0 = Hade inte hänt
1 = Hade troligen inte hänt
2 = Hade kanske hänt
3 = Hade troligen hänt

Flera alternativ samtidigt är möjligt, för exempel se längst ned

	0	1	2	3
Vårdcentral	◯	◯	◯	◯
Öppenvård	◯	◯	◯	◯
Ambulans	◯	◯	◯	◯
Akutmottagning	◯	◯	◯	◯
Slutenvård	◯	◯	◯	◯

5. Kommentar/Övrigt

Figure A.2: Concept 0 to 3 option



Besöksutvärdering närsjukvårdsteam
betygsättande version

Utvärderingsverktyg för besök/insats hos patient - Baserat på resonemanget "vad hade hänt"
- Var hade patient fått vård om du/teamet inte varit där?
- Vad ersatte besöket?

Tack för att du tar dig tid, det är viktigt för utvecklingen av närsjukvården!

* This form will record your name, please fill your name.

1. När gjordes besöket?

Please input date (M/d/yyyy)

2. Vilket team åkte ut?

- FMEMNÄ
- LMEMNÄ
- MMEMNÄ
- SMEMNÄ

3. Närsjukvårdteamet tar med/skickar in patient till sjukhus

- Ja
- Nej

4. Om teamet inte åkt ut hur troligt är det att patient fått vård via vårdcentral

0	1	2	3	4	5	6	7	8	9	10

Not at all likely — Extremely likely

5. Om teamet inte åkt ut hur troligt är det att patient fått vård via öppenvård

0	1	2	3	4	5	6	7	8	9	10

Not at all likely — Extremely likely

6. Om teamet inte åkt ut hur troligt är det att patient fått vård via ambulans

0	1	2	3	4	5	6	7	8	9	10

Not at all likely — Extremely likely

7. Om teamet inte åkt ut hur troligt är det att patient fått vård via akutmottagning

0	1	2	3	4	5	6	7	8	9	10

Not at all likely — Extremely likely

8. Om teamet inte åkt ut hur troligt är det att patient fått vård via slutenvård

0	1	2	3	4	5	6	7	8	9	10

Not at all likely — Extremely likely

9. Kommentar/Övrigt

Figure A.3: Concept 0 to 10 option

B

Appendix: Split of hospital wards for the visual dashboard

Lidköping hospital:
Internmedicin - 53011-101 was split into:

- Hematologisk vård 53011-108
- Kardiologisk vård 53011-231
- Lungsjukvård 53011-111
- Gastroenterologi 53011-105
- Internmedicin 53011-101

Intagnings-/Akutverksamhet 53011-046 was split into:

- Ambulansverksamhet – 53011-045
- Intagnings-/Akutverksamhet 53011-046

Skövde hospital:
Internmedicin - 53013-101 was split into:

- Hematologisk vård 53013-108
- Internmedicin 53013-101

Intagnings-/Akutverksamhet 53013-046 was split into:

- Ambulansverksamhet 53013-045
- Intagnings-/Akutverksamhet 53013-046

C

Appendix: Diagnosis codes sectional level

Diacode 1 section	Diacode 1 section description	N
I30-I52	Other forms of heart disease	462
C81-C96	Malignant neoplasms, stated or presumed to be primary, of lymphoid, haematopoietic and related tissue	155
Z80-Z99	Persons with potential health hazards related to family and personal history and certain conditions influencing health status	133
D37-D48	Neoplasms of uncertain or unknown behaviour [see note, page 226]	108
D60-D64	Aplastic and other anaemias	101
L80-L99	Other disorders of the skin and subcutaneous tissue	76
T80-T88	Complications of surgical and medical care, not elsewhere classified	55
J40-J47	Chronic lower respiratory diseases	53
C15-C26	Malignant neoplasms, stated or presumed to be primary, of specified sites, except of lymphoid, haematopoietic and related tissue: Digestive organs	37
U00-U49	Provisional assignment of new diseases of uncertain etiology	37
E10-E14	Diabetes mellitus	29
N17-N19	Renal failure	24
C30-C39	Malignant neoplasms, stated or presumed to be primary, of specified sites, except of lymphoid, haematopoietic and related tissue: Respiratory and intrathoracic organs	23
M80-M85	Osteopathies and chondropathies: Disorders of bone density and structure	21
R50-R69	General symptoms and signs	21
R10-R19	"Symptoms and signs involving the digestive system and	20
A30-A49	Other bacterial diseases	17
U98-U99	Codes for specific national needs	16
C60-C63	Malignant neoplasms, stated or presumed to be primary, of specified sites, except of lymphoid, haematopoietic and related tissue: Male genital organs	15
C64-C68	Malignant neoplasms, stated or presumed to be primary, of specified sites, except of lymphoid, haematopoietic and related tissue: Urinary tract	15
C76-C80	Malignant neoplasms of ill-defined, secondary and unspecified sites	13
I10-I15	Hypertensive diseases	13
N30-N39	Other diseases of urinary system	13
C43-C44	Malignant neoplasms, stated or presumed to be primary, of specified sites, except of lymphoid, haematopoietic and related tissue: Skin	12
C50-C50	Malignant neoplasms, stated or presumed to be primary, of specified sites, except of lymphoid, haematopoietic and related tissue: Breast	12
D80-D89	Certain disorders involving the immune mechanism	11
L20-L30	Dermatitis and eczema	11
D50-D53	Nutritional anaemias	10
I20-I25	Ischaemic heart diseases	10
R00-R09	Symptoms and signs involving the circulatory and respiratory systems	10
G35-G37	Demyelinating diseases of the central nervous system	9
I80-I89	Diseases of veins, lymphatic vessels and lymph nodes, not elsewhere classified	9
Z70-Z76	Persons encountering health services in other circumstances	9
C51-C58	Malignant neoplasms, stated or presumed to be primary, of specified sites, except of lymphoid, haematopoietic and related tissue: Female genital organs	8
K20-K31	Diseases of oesophagus, stomach and duodenum	8
Z00-Z13	Persons encountering health services for examination and investigation	7
F30-F39	Mood [affective] disorders	6
F40-F48	Neurotic, stress-related and somatoform disorders	6
F00-F09	Organic, including symptomatic, mental disorders	5
L40-L45	Papulosquamous disorders	5
Q80-Q89	Other congenital malformations	5
B85-B89	Pediculosis, acariasis and other infestations	4
E20-E35	Disorders of other endocrine glands	4
E70-E90	Metabolic disorders	4
F20-F29	Schizophrenia, schizotypal and delusional disorders	4
I70-I79	Diseases of arteries, arterioles and capillaries	4
K50-K52	Noninfective enteritis and colitis	4
M15-M19	Arthropathies: Arthrosis	4
M30-M36	Systemic connective tissue disorders	4
R40-R46	"Symptoms and signs involving cognition, perception,	4
B35-B49	Mycoses	3
C45-C49	Malignant neoplasms, stated or presumed to be primary, of specified sites, except of lymphoid, haematopoietic and related tissue: Mesothelial and soft tissue	3
D65-D69	Coagulation defects, purpura and other haemorrhagic conditions	3
G40-G47	Episodic and paroxysmal disorders	3
G80-G83	Cerebral palsy and other paralytic syndromes	3
K55-K64	Other diseases of intestines	3
K70-K77	Diseases of liver	3
L55-L59	Radiation-related disorders of the skin and subcutaneous tissue	3
M05-M14	Arthropathies: Inflammatory polyarthropathies	3
M50-M54	Dorsopathies: Deforming dorsopathies	3
Q60-Q64	Congenital malformations of the urinary system	3

M30-M34	Dorsopathies: Deforming dorsopathies	3
Q60-Q64	Congenital malformations of the urinary system	3
R20-R23	"Symptoms and signs involving the skin and subcutaneous	3
Z40-Z54	Persons encountering health services for specific procedures and health care	3
B25-B34	Other viral diseases	2
D70-D77	Other diseases of blood and blood-forming organs	2
E50-E64	Other nutritional deficiencies	2
I60-I69	Cerebrovascular diseases	2
K90-K93	Other diseases of the digestive system	2
L00-L08	Infections of the skin and subcutaneous tissue	2
M70-M79	Soft tissue disorders: Other soft tissue disorders	2
N10-N16	Renal tubulo-interstitial diseases	2
R30-R39	Symptoms and signs involving the urinary system	2
S00-S09	Injuries to the head	2
S40-S49	Injuries to the shoulder and upper arm	2
S80-S89	Injuries to the knee and lower leg	2
A00-A09	Intestinal infectious diseases	1
B00-B09	Viral infections characterized by skin and mucous membrane lesions	1
B50-B64	Protozoal diseases	1
C73-C75	Malignant neoplasms, stated or presumed to be primary, of specified sites, except of lymphoid, haematopoietic and related tissue: Thyroid and other endocrine glands	1
D10-D36	Benign neoplasms	1
D55-D59	Haemolytic anaemias	1
E00-E07	Disorders of thyroid gland	1
F10-F19	Mental and behavioural disorders due to psychoactive substance use	1
F70-F79	Mental retardation	1
F99-F99	Unspecified mental disorder	1
G20-G26	Extrapyramidal and movement disorders	1
G30-G32	Other degenerative diseases of the nervous system	1
G70-G73	Diseases of myoneural junction and muscle	1
G90-G99	Other disorders of the nervous system	1
H15-H22	Disorders of sclera, cornea, iris and ciliary body	1
H40-H42	Glaucoma	1
I26-I28	Pulmonary heart disease and diseases of pulmonary circulation	1
J00-J06	Acute upper respiratory infections	1
J09-J18	Influenza and pneumonia	1
J20-J22	Other acute lower respiratory infections	1
J80-J84	Other respiratory diseases principally affecting the interstitium	1
K00-K14	Diseases of oral cavity, salivary glands and jaws	1
K40-K46	Hernia	1
K80-K87	Disorders of gallbladder, biliary tract and pancreas	1
L10-L14	Bullous disorders	1
M40-M43	Dorsopathies: Deforming dorsopathies	1
M65-M68	Soft tissue disorders: Disorders of synovium and tendon	1
M86-M90	Osteopathies and chondropathies: Other osteopathies	1
N20-N23	Urolithiasis	1
N70-N77	Inflammatory diseases of female pelvic organs	1
R70-R79	Abnormal findings on examination of blood, without diagnosis	1
S30-S39	Injuries to the abdomen, lower back, lumbar spine and pelvis	1
S50-S59	Injuries to the elbow and forearm	1
S70-S79	Injuries to the hip and thigh	1
T08-T14	Injuries to unspecified parts of trunk, limb or body region	1
T36-T50	Poisoning by drugs, medicaments and biological substances	1
Z20-Z29	Persons with potential health hazards related to communicable diseases	1

D

Appendix: Diagnosis codes detailed level

Diacode 1	Diacode 1 description	N
I509	Heart failure, unspecified	302
Z941	Heart transplant status	100
D469	Myelodysplastic syndrome, unspecified	81
D649	Anaemia, unspecified	80
I500	Congestive heart failure	65
J449	Chronic obstructive pulmonary disease, unspecified	40
C920	Acute myeloblastic leukaemia [AML]	36
L893	Stage IV decubitus ulcer	36
I330	Acute and subacute infective endocarditis	35
T827	Infection and inflammatory reaction due to other cardiac and vascular devices, implants and grafts	33
C911	Chronic lymphocytic leukaemia of B-cell type	32
U071	COVID-19, virus identified	32
C900	Multiple myeloma	31
C833	Diffuse large B-cell lymphoma	25
I489	Atrial fibrillation and atrial flutter, unspecified	24
E119	Type 2 diabetes mellitus without complications	20
U999	Missing diagnosis information	16
Z940	Kidney transplant status	16
C619	Malignant neoplasm of prostate	15
C349B	Malignant neoplasm of bronchus and lung	13
C509	Malignant neoplasm, breast, unspecified	12
C946	Myelodysplastic and myeloproliferative disease, not elsewhere classified	12
A499	Bacterial infection, unspecified	11
D619	Aplastic anaemia, unspecified	11
L979X	Ulcer of lower limb, not elsewhere classified	11
M819	Osteoporosis, unspecified	11
R600C	Localized oedema	11
D509	Iron deficiency anaemia, unspecified	10
I420	Dilated cardiomyopathy	10
L984A	Chronic ulcer of skin, not elsewhere classified	10
C649	Malignant neoplasm of kidney, except renal pelvis	9
C880	Waldenstrom macroglobulinaemia	9
G359	Multiple sclerosis	9
L209	Atopic dermatitis, unspecified	8
L892	Stage III decubitus ulcer	8
M809	Unspecified osteoporosis with pathological fracture	8
T814	Infection following a procedure, not elsewhere classified	8
T818	Other complications of procedures, not elsewhere classified	8
C795	Secondary malignant neoplasm of bone and bone marrow	7
I872	Venous insufficiency (chronic)(peripheral)	7
J459	Asthma, unspecified	7
L899	Decubitus ulcer and pressure area, unspecified	7
N185	Chronic kidney disease, stage 5	7
R119A	Nausea and vomiting	7

R119A	Nausea and vomiting	7
C259	Malignant neoplasm, pancreas, unspecified	6
C435	Malignant melanoma of trunk	6
D464	Refractory anaemia, unspecified	6
E117	Type 2 diabetes mellitus with multiple complications	6
I482	Chronic atrial fibrillation	6
R060	Dyspnoea	6
R104X	Abdominal and pelvic pain	6
Z711	Person with feared complaint in whom no diagnosis is made	6
A469	Erysipelas	5
C186	Malignant neoplasm, descending colon	5
C188	Malignant neoplasm, overlapping lesion of colon	5
C679	Malignant neoplasm, bladder, unspecified	5
D841	Defects in the complement system	5
I109	Essential (primary) hypertension	5
I120	Hypertensive renal disease with renal failure	5
N184	Chronic kidney disease, stage 4	5
N390	Urinary tract infection, site not specified	5
B869	Scabies	4
C187	Malignant neoplasm, sigmoid colon	4
C349C	Malignant neoplasm of bronchus and lung	4
C519	Malignant neoplasm, vulva, unspecified	4
D462	Refractory anaemia with excess of blasts	4
D466	Myelodysplastic syndrome with isolated del(5q) chromosomal abnormality	4
D471	Chronic myeloproliferative disease	4
D609	Acquired pure red cell aplasia, unspecified	4
D611	Drug-induced aplastic anaemia	4
D869	Sarcoidosis, unspecified	4
F319	Bipolar affective disorder, unspecified	4
I259	Chronic ischaemic heart disease, unspecified	4
I480	Paroxysmal atrial fibrillation	4
I501	Left ventricular failure	4
J441	Chronic obstructive pulmonary disease with acute exacerbation, unspecified	4
M161	Other primary coxarthrosis	4
N179	Acute renal failure, unspecified	4
N398	Other specified disorders of urinary system	4
Q850	Neurofibromatosis (nonmalignant)	4
R074	Chest pain, unspecified	4
R559	Syncope and collapse	4
C189	Malignant neoplasm, colon, unspecified	3
C349	Malignant neoplasm, bronchus or lung, unspecified	3
C569	Malignant neoplasm of ovary	3
C819	Hodgkin lymphoma, unspecified	3
D377	Neoplasm of uncertain or unknown behaviour, other digestive organs	3
F259	Schizoaffective disorder, unspecified	3
F419	Anxiety disorder, unspecified	3
G409	Epilepsy, unspecified	3
I129	Hypertensive renal disease without renal failure	3
I214	Acute subendocardial myocardial infarction	3
I389	Endocarditis, valve unspecified	3
I702	Atherosclerosis of arteries of extremities	3
K210	Gastro-oesophageal reflux disease with oesophagitis	3
K318	Other specified diseases of stomach and duodenum	3
L400	Psoriasis vulgaris	3
L570	Actinic keratosis	3
L979	Ulcer of lower limb, not elsewhere classified	3
M549	Dorsalgia, unspecified	3
N183	Chronic kidney disease, stage 3	3
N189	Chronic kidney disease, unspecified	3
Q612	Polycystic kidney, autosomal dominant	3
R119	Nausea and vomiting	3
R429	Dizziness and giddiness	3
U119	Need for immunization against COVID-19, unspecified	3

Z851	Personal history of malignant neoplasm of trachea, bronchus and lung	3
Z966F	Presence of other functional implants	3
B349	Viral infection, unspecified	2
B359	Dermatophytosis, unspecified	2
C169	Malignant neoplasm, stomach, unspecified	2
C170	Malignant neoplasm, duodenum	2
C209	Malignant neoplasm of rectum	2
C250	Malignant neoplasm, head of pancreas	2
C349A	Malignant neoplasm of bronchus and lung	2
C445E	Malignant neoplasm, skin of trunk	2
C449	Malignant neoplasm of skin, unspecified	2
C492	Malignant neoplasm, connective and soft tissue of lower limb, including hip	2
C780	Secondary malignant neoplasm of lung	2
C851	B-cell lymphoma, unspecified	2
D372	Neoplasm of uncertain or unknown behaviour, small intestine	2
D709C	Neutropenic unspecified	2
D868	Sarcoidosis of other and combined sites	2
E107	Type 1 diabetes mellitus with multiple complications	2
E271	Primary adrenocortical insufficiency	2
E611	Iron deficiency	2
F067	Mild cognitive disorder	2
G825	Tetraplegia, unspecified	2
I219	Acute myocardial infarction, unspecified	2
I429	Cardiomyopathy, unspecified	2
I501X	Heart failure	2
I693	Sequelae of cerebral infarction	2
J448	Other specified chronic obstructive pulmonary disease	2
K297	Gastritis, unspecified	2
K509	Crohn's disease, unspecified	2
K528	Other specified noninfective gastroenteritis and colitis	2
L309X	Other dermatitis	2
M059L	Seropositive rheumatoid arthritis	2
M313	Wegener's granulomatosis	2
N329	Bladder disorder, unspecified	2
R104	Other and unspecified abdominal pain	2
R539	Malaise and fatigue	2
S022	Fracture of nasal bones	2
S4200	Fracture of clavicle, closed	2
T835	Infection and inflammatory reaction due to prosthetic device, implant and graft in urinary system	2
T845F	Complications of internal orthopaedic prosthetic devices, implants and grafts	2
U072	COVID-19, virus not identified	2
Z038W	Medical observation and evaluation for suspected diseases and conditions	2
Z098	Follow-up examination after other treatment for other conditions	2
Z713	Dietary counselling and surveillance	2
Z850C	Personal history of malignant neoplasm	2
Z950	Presence of cardiac pacemaker	2
A047	Enterocolitis due to Clostridium difficile	1
A402	Sepsis due to streptococcus, group D	1
B029	Zoster without complication	1
B378D	Candidiasis	1
B519	Plasmodium vivax malaria without complication	1
C154	Malignant neoplasm, middle third of oesophagus	1
C162	Malignant neoplasm, body of stomach	1
C166	Malignant neoplasm, greater curvature of stomach, unspecified	1
C210	Malignant neoplasm, anus, unspecified	1
C239	Malignant neoplasm of gallbladder	1
C269	Malignant neoplasm, ill-defined sites within the digestive system	1
C349E	Malignant neoplasm of bronchus and lung	1
C443	Malignant neoplasm, skin of other and unspecified parts of face	1
C447	Malignant neoplasm, skin of lower limb, including hip	1
C496	Malignant neoplasm, connective and soft tissue of trunk, unspecified	1
C549	Malignant neoplasm, corpus uteri, unspecified	1
C659	Malignant neoplasm of renal pelvis	1
C739	Malignant neoplasm of thyroid gland	1
C772	Secondary and unspecified malignant neoplasm, intra-abdominal lymph nodes	1

C797	Secondary malignant neoplasm of adrenal gland	1
C844	Peripheral T-cell lymphoma, not elsewhere classified	1
C884	Extranodal marginal zone B-cell lymphoma of mucosa-associated lymphoid tissue [MALT-lymphoma]	1
C910B	Lymphoid leukaemia	1
C931	Chronic myelomonocytic leukaemia	1
C950	Acute leukaemia of unspecified cell type	1
D229	Melanocytic naevi, unspecified	1
D410	Neoplasm of uncertain or unknown behaviour, kidney	1
D414	Neoplasm of uncertain or unknown behaviour, bladder	1
D474	Osteomyelofibrosis	1
D479	Neoplasm of uncertain or unknown behaviour of lymphoid, haematopoietic and related tissue, unspecified	1
D591	Other autoimmune haemolytic anaemias	1
D610	Constitutional aplastic anaemia	1
D630	Anaemia in neoplastic disease (C00-D48+)	1
D669	Hereditary factor VIII deficiency	1
D686B	Other coagulation defects	1
D693	Idiopathic thrombocytopenic purpura	1
E059	Thyrotoxicosis, unspecified	1
E104	Type 1 diabetes mellitus with neurological complications	1
E213	Hyperparathyroidism, unspecified	1
E230	Hypopituitarism	1
E802A	Disorders of porphyrin and bilirubin metabolism	1
E858A	Amyloidosis	1
E871B	Other disorders of fluid, electrolyte and acid-base balance	1
E875	Hyperkalaemia	1
F009	Dementia in Alzheimer's disease, unspecified (G30.9+)	1
F019	Vascular dementia, unspecified	1
F039	Unspecified dementia	1
F102A	Mental and behavioural disorders due to use of alcohol	1
F200	Paranoid schizophrenia	1
F313	Bipolar affective disorder, current episode mild or moderate depression	1
F329	Depressive episode, unspecified	1
F400	Agoraphobia	1
F410	Panic disorder [episodic paroxysmal anxiety]	1
F450	Somatization disorder	1
F791	Unspecified mental retardation, significant impairment of behaviour requiring attention or treatment	1
F999	Mental disorder, not otherwise specified	1
G209	Parkinson's disease	1
G309	Alzheimer's disease, unspecified	1
G710	Muscular dystrophy	1
G822	Paraplegia, unspecified	1
G958	Other specified diseases of spinal cord	1
H209	Iridocyclitis, unspecified	1
H409	Glaucoma, unspecified	1
I252	Old myocardial infarction	1
I269	Pulmonary embolism without mention of acute cor pulmonale	1
I471	Supraventricular tachycardia	1
I479	Paroxysmal tachycardia, unspecified	1
I481	Persistent atrial fibrillation	1
I493	Ventricular premature depolarization	1
I501A	Left ventricular failure	1
I700	Atherosclerosis of aorta	1
I831	Varicose veins of lower extremities with inflammation	1
I890	Lymphoedema, not elsewhere classified	1
J069	Acute upper respiratory infection, unspecified	1
J189	Pneumonia, unspecified	1
J229	Unspecified acute lower respiratory infection	1
J841	Other interstitial pulmonary diseases with fibrosis	1
K045	Chronic apical periodontitis	1
K440	Diaphragmatic hernia with obstruction, without gangrene	1
K573	Diverticular disease of large intestine without perforation or abscess	1
K579	Diverticular disease of intestine, part unspecified, without perforation or abscess	1
K610	Anal abscess	1
K703	Alcoholic cirrhosis of liver	1
K729	Hepatic failure, unspecified	1
K746	Other and unspecified cirrhosis of liver	1

K746	Other and unspecified cirrhosis of liver	1
K800	Calculus of gallbladder with acute cholecystitis	1
K900	Coeliac disease	1
K929	Disease of digestive system, unspecified	1
L030C	Cellulitis	1
L089	Local infection of skin and subcutaneous tissue, unspecified	1
L139	Bullous disorder, unspecified	1
L309	Dermatitis, unspecified	1
L408B	Psoriasis	1
L409	Psoriasis, unspecified	1
L891	Stage II decubitus ulcer	1
M059N	Seropositive rheumatoid arthritis	1
M329	Systemic lupus erythematosus, unspecified	1
M353	Polymyalgia rheumatica	1
M436	Torticollis	1
M674	Ganglion	1
M703	Other bursitis of elbow	1
M796G	Other soft tissue disorders, not elsewhere classified	1
M812	Osteoporosis of disuse	1
M859	Disorder of bone density and structure, unspecified	1
M866E	Other chronic osteomyelitis	1
N109	Acute tubulo-interstitial nephritis	1
N151	Renal and perinephric abscess	1
N178	Other acute renal failure	1
N199	Unspecified kidney failure	1
N200	Calculus of kidney	1
N309	Cystitis, unspecified	1
N394	Other specified urinary incontinence	1
N764	Abscess of vulva	1
Q828W	Other congenital malformations of skin	1
R119B	Vomiting	1
R189	Ascites	1
R223	Localized swelling, mass and lump, upper limb	1
R238	Other and unspecified skin changes	1
R238B	Belb(s)	1
R319	Unspecified haematuria	1
R339	Retention of urine	1
R413	Other amnesia	1
R509	Fever, unspecified	1
R529	Pain, unspecified	1
R568X	Convulsions, not elsewhere classified	1
R609	Oedema, unspecified	1
R798	Other specified abnormal findings of blood chemistry	1
S3210	Fracture of sacrum, closed	1
S5200	Fracture of upper end of ulna, closed	1
S7200	Fracture of neck of femur, closed	1
S8260	Fracture of lateral malleolus, closed	1
S8280	Fractures of other parts of lower leg, closed	1
T140A	Injury of unspecified body region	1
T509	Poisoning, other and unspecified drugs, medicaments and biological substances	1
T812	Accidental puncture and laceration during a procedure, not elsewhere classified	1
T832	Mechanical complication of graft of urinary organ	1
Z017	Laboratory examination	1
Z038J	Medical observation and evaluation for suspected diseases and conditions	1
Z089C	Follow-up examination after unspecified treatment for malignant neoplasm	1
Z208	Contact with and exposure to other communicable diseases	1
Z480	Attention to surgical dressings and sutures	1
Z489	Surgical follow-up care, unspecified	1
Z511	Chemotherapy session for neoplasm	1
Z768	Persons encountering health services in other specified circumstances	1
Z850	Personal history of malignant neoplasm of digestive organs	1
Z853	Personal history of malignant neoplasm of breast	1
Z854J	Personal history of malignant neoplasm	1
Z855	Personal history of malignant neoplasm of urinary tract	1
Z855D	Personal history of malignant neoplasm	1
Z902	Acquired absence of lung [part of]	1
Z921	Personal history of long-term (current) use of anticoagulants	1

E

Appendix: Quantitative data of contacts over time per team

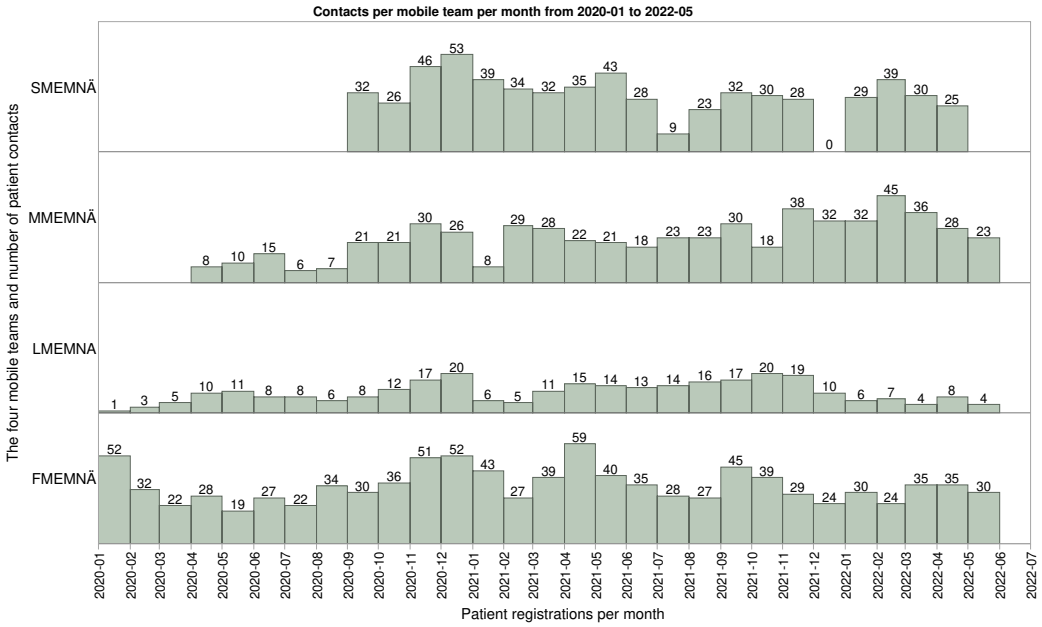


Figure E.1: Time distribution of the number of contacts with patient per mobile team over time

F

Appendix: Detailed list of data on sub-populations

Service group

- Number of patients: 640 | Number of visits: 640 | Registrations missing code: 410
- **Contacts per team and (%)**
  - FMEMNÄ 151 - 15%
  - LMEMNÄ 0
  - MMEMNÄ 99 - 17%
  - SMEMNÄ 390 - 64%
- **Types of contact**
  - FH 555 | H 36 | FT 19 | TÖ 12 | ET 7 | X 6
- **Main diagnose code section level**
  - I30-I52 - 23 - 10%
  - L80-L99 - 23 - 10%
  - C15-C26 - 15 - 6.5%
  - C81-C96 - 12 - 5.2%
  - U98-U99 - 11 - 4.8%

  - D37-D48 - 9 - 3.9%
  - U00-U49 - 9 - 3.9%

- **Main diagnose code**
  - I509 - 19 - 8.3%
  - L893 - 12 - 5.2%
  - U999 - 11 - 4.8%
  - U071 - 9 - 3.9%
  - D649 - 5 - 2.2%

- **Operational code**
  - AV034 - 52 - 23.5%
  - QXB10 - 22 - 9.9%
  - XS012 - 19 - 8.5%
  - DR029 - 17 - 7.6%
  - AV061 - 14 - 6.3%
  - SP021 - 14 - 6.3%
  - AV019 - 11 - 4.9%
  - DT016 - 10 - 4.5%
  - GB002 - 9 - 4.0%

Low consumption group

- Number of patients: 191 | Number of contacts: 441 | Registrations missing code: 127
- Age: median 78
- Contacts per team and (%) of all contacts
  - FMEMNÄ 186 - 19%

  - LMEMNÄ 27 - 9%
  - MMEMNÄ 136 - 23%
  - SMEMNÄ 92 - 15%

- Types of contact
  - FH = 273 | H = 107 | X = 25 | ET = 14 | TÖ = 12

- Diagnose codes sectional
  - I30-I52 - 58 - 18.4%
  - C81-C96 - 30 - 9.6%
  - Z80-Z99 - 29 - 9.2%
  - L80-L99 - 21 - 6.7%
  - D60-D64 - 20 - 6.4%
  - M80-M85 - 10 - 3.2%
  - C60-C63 - 9 - 2.9%
  - U00-U49 - 9 - 2.9%

- Diagnose codes
  - I509 - 34 - 10.8%
  - Z941 - 20 - 6.4%
  - D649 - 20 - 6.4%
  - C900 - 17 - 5.4%
  - I489 - 10 - 3.2%
  - L893 - 9 - 2.9%
  - C619 - 9 - 2.9%

- Operational codes
  - AV034 - 109 - 35.8%

  - DR029 - 36 - 11.8%
  - AV019 - 25 - 8.2%
  - SP021 - 21 - 6.9%
  - XS012 - 16 - 5.2%
  - GB002 - 14 - 4.6%

Middle consumption group

- Number of patients: 147 | Number of visits: 1140 | Registrations missing code: 200
- Age: median 76
- Contacts per team and (%) of all contacts
  - FMEMNÄ 586 - 59%
  - LMEMNÄ 172 - 58%
  - MMEMNÄ 262 - 44%
  - SMEMNÄ 120 - 20%
- Types of contact
  - FH 426 | H 510 | X 77 | ET 81 | TÖ 15
- Diagnose codes sectional
  - I30-I52 - 283 - 30.1%
  - C81-C96 - 112 - 11.9%
  - Z80-Z99 - 95 - 10.1%
  - D60-D64 - 56 - 6.0%
  - D37-D48 - 32 - 3.4%
  - J40-J47 - 32 - 3.4%
  - L80-L99 - 32 - 3.4%

- Diagnose codes
  - I509 - 187 - 19.9%
  - Z941 - 78 - 8.3%
  - D649 - 40 - 4.3%
  - I330 - 35 - 3.7%
  - C920 - 30 - 3.2%
  - I500 - 28 - 3.0%
- Operational codes
  - AV034 - 288 - 33.2%
  - DT016 - 92 - 10.6%
  - DR029 - 88 - 10.1%
  - XS012 - 63 - 7.2%
  - SP021 - 44 - 5.0%

High consumption group

- Number of patients: 8 | Number of visits: 282 20
- Age: median 71
- Types of contact
  - FH = 88 | H = 177 | X = 7 | ET = 4 | E = 15
- Contacts per team and (%) of all contacts
  - FMEMNÄ 71 - 7%
  - LMEMNÄ 99 - 33%
  - MMEMNÄ 101 - 17%
  - SMEMNÄ 11 - 2%

- Diagnose codes sectional
  - I30-I52 - 98 - 37.4%
  - D37-D48 - 63 - 24.0%
  - T80-T88 - 40 - 15.3%
  - D60-D64 - 20 - 7.6%
  - J40-J47 - 14 - 5.3%
  - R10-R19 - 13 - 5.0%
- Diagnose codes
  - I509 - 62 - 23.7%
  - D469 - 59 - 22.5%
  - I500 - 36 - 13.7%
  - T827 - 33 - 12.6%
  - D649 - 15 - 5.7%
  - J449 - 14 - 5.3%
  - ...
  - Z851 - 3 - 1.1%
- Operational codes
  - DT016 - 57 - 22.1%
  - AV019 - 39 - 15.1%
  - DR029 - 38 - 14.7%
  - SP021 - 34 - 13.2%
  - AV034 - 33 - 12.8%

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