A Comprehensive Framework for Hospital@Home Care Models

Kerstin DENECKE[a,1] Andre W. KUSHNIRUK[b] and Elizabeth M. BORYCKI[b]

[a] *Institute Patient-centered Digital Health, Bern University of Applied Sciences, Switzerland*

[b] *School of Health Information Science, University of Victoria, Canada*

ORCiD ID: Kerstin Denecke, https://orcid.org/0000-0001-6691-396X

ORCiD ID: Andre W. Kushniruk, https://orcid.org/0000-0002-2557-9288

ORCiD ID: Elizabeth M. Borycki, https://orcid.org/0000-0003-0928-8867

Abstract. Hospital@home is a healthcare approach, where patients receive active treatment from health professionals in their own home for conditions that would normally necessitate a hospital stay. Objective: To develop a framework of relevant features for describing hospital@home care models. Methods: The framework was developed based on a literature review and thematic analysis. We considered 42 papers describing hospital@home care approaches. Extracted features were grouped and aggregated in a framework. Results: The framework consists of nine dimensions: Persons involved, target patient population, service delivery, intended outcome, first point of contact, technology involved, quality, and data collection. The framework provides a comprehensive list of required roles, technologies and service types. Conclusion: The framework can act as a guide for researchers to develop new technologies or interventions to improve hospital@home, particularly in areas such as tele-health, wearable technology, and patient self-management tools. Healthcare providers can use the framework as a guide or blueprint for building or expanding upon their hospital@home services.

Keywords. Hospital at home, Care model, Patient at home, Innovation, Framework

1. Introduction

Hospital@home is a healthcare approach, where patients receive active treatment from health professionals in their own home for conditions that would normally necessitate a hospital stay [1]. This model often involves a comprehensive care team providing a range of services, as follow up after an early hospital discharge or after a patient visit to the emergency room that does not require inpatient hospitalization. The array of services in hospital@home programs include home-based intravenous treatments, remote health monitoring, chemotherapy or laboratory tests [2]. Additionally, hospital@home services include home visits from a variety of healthcare professionals such as doctors, nurse practitioners, nurses, and other health professionals such as social workers, physiotherapists, and pharmacists. There is considerable evidence of hospital@home's effectiveness, but the evidence is of low quality and has to be

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[1] Corresponding Author: Kerstin Denecke, Bern University of Applied Sciences, Quellgasse 21, 2502 Biel / Switzerland, kerstin.denecke@bfh.ch.

interpreted with caution [3]. This care model is gaining traction as an alternative to traditional inpatient care for certain populations and conditions (e.g. like pneumonia, chronic obstructive pulmonary disease, or heart conditions). However, despite its long history of use in countries such as the United States [3] or Spain, its growing popularity and implementation in countries such as Switzerland, the hospital@home approach lacks a comprehensive framework that encapsulates the multifaceted nature of hospital@home services (including their use of technology supports). This paper aims to introduce a framework of features of hospital@home care models. Such a framework could assist in understanding, evaluating and optimizing hospital@home care models as well as in developing education programs. The main objectives of this paper are to identify a list of features (i.e., dimensions and items) that could be used to describe and compare hospital@home care models (i.e., identify relation between hospital@home features).

2. Framework Development

We reviewed the literature using the preferred items for systematic review and meta-analysis (PRISMA) statements approach [4]. Our focus was on the practical aspects and real-world applications of homecare, rather than only the individual technologies that make it possible. Therefore, we deliberately chose not to collect information from technical databases such as IEEE® Xplore or the ACM® Digital Library. We searched only PubMed®, which specializes in health-related articles, and is not limited to technical details. To identify the relevant literature, we developed a search string that included "hospital@home" and its main equivalents (i.e., "hospital at home" OR "home care" OR "patient at home"). The results of the searches for the period of 2013 to 2022 were considered. A complete search strategy can be found in another paper [see 5] in which the results were used for studying the strengths, weaknesses, opportunities and threats to hospital@home. Out of 1371 retrieved articles, 82 were considered for full-text review. Forty-two papers were included in the qualitative synthesis of that review. These papers were analyzed thematically [6] to aggregate the results into a framework. The objective of the thematic analysis was to answer the research question: "How can we characterize the component elements of current hospital@home approaches?". The information available about the hospital@home approaches was extracted from the papers and grouped into themes. All the collected information was aggregated in the hospital@home framework. There was one topic added to the framework that was intentionally excluded from the literature review due to its specific nature, which palliative care.

3. A Framework for Hospital@Home Care

Based on our research question (i.e., to identify relevant component elements to characterize hospital@home care models and our literature review), we propose a framework that covers differing attributes or features of hospital@home care models. Figure 1 illustrates these dimensions, described in depth below:

Persons Involved: This dimension captures the human resources involved with hospital@home models. They include (a non-exhaustive list):

- The patient as the primary recipient of care.
- Informal caregivers, relatives and friends (who provide non-professional support).

- Healthcare providers: A wide range of professionals such as doctors, clinicians, paramedics, dieticians, physiotherapists, psychotherapists, pharmacists, telemedicine institutes, physician assistants, nurses, wound specialists, and advanced nurse practitioners. It also includes psychologists.
- Technology-related staff: Professionals who provide technical support for the technologies used such as electronic health records and medical, remote monitoring and telehealth devices (i.e., medical/health informatics professionals, information technology professionals, biomedical engineers).

Target population: This dimension focuses on the candidates' eligibility criteria for receiving hospital@home services and includes patient characteristics such as:

- Medical condition(s): The specific health conditions that can be effectively managed at home including severity of the condition and other characteristics.
- Demographics: Patient characteristics such as age, gender, socio-economic status, etc. that may influence the appropriateness for receiving hospital@home care.
- Literacy level: Health, eHealth and technology literacy of patients
- Social Support: Presence or absence of caregivers and a social network that can provide health supports and interact with health professionals providing care.

Service delivery: Hospital@home care models that deliver differing services. This dimension describes the range of services provided, such as:

- Monitoring and ongoing care.
- Prevention, acute treatment and rehabilitation (covering the different stages of care from prevention through to rehabilitation after treatment).
- Diagnosis and self-management: Helping patients to manage their health.
- Palliative care: Providing comfort in end-of-life situations.
- Accompanying services: Visits from social workers and patient education.
- Emergency handling directives and processes.

Intended outcomes: Hospital@home care models are designed for a specific purpose or intended outcome. These can include:

- Early discharge and avoidance of admission.
- Improving care and economic efficiency of care.
- Improving patient safety and satisfaction.

First point of contact: This dimension refers to the first contact point that the patient is interacting with to decide on inclusion in a hospital@home care model such as:

- The emergency department or hospital ware in a hospital
- Telephone triage

Reimbursement model: Several reimbursement models can be used to finance hospital@home programs, among them:

- Insurance coverage
- Bundled payments

Technology involved: This dimension describes the technological tools used to deliver care or to support care provision including monitoring, such as:

- Communication technologies: These technologies support interaction between patients and care providers for routine and emergent health situations.
- Wearables and sensors: Sensors in the patient's home to support monitoring of health status. Wearables worn by patients to collect data for monitoring purposes.
- Diagnostic instruments: Used to support patient assessments and monitoring; for example, point-of-care laboratory tests, ultrasound, ECG, vital signs monitors.

- Patient apps, and online audiovisual and communication platforms: To help support patient engagement, self-management, education, and decision making.
- Electronic health records (EHRs) and documentation systems for patient data.
- Data analytics platform: Helps in visualizing the collected data.
- Assistive technologies: Helps to analyze data collected from sensors or entered manually and provides assistance either to the patient (i.e., shall I call for help?) or for the care provider (e.g. medical alert systems, medication management system, decision support systems)

Quality: This dimension concerns aspects to ensure the effectiveness and safety of the care model:

- Ethics, accuracy, safety, and effectiveness: Adhering to ethical standards and ensuring the accuracy, safety and efficacy of treatments and technologies.
- User acceptability and cost-effectiveness: Assessing patient and provider acceptability and the economic viability of the model.

Data collection and outcomes: This dimension defines the information collected as part of the hospital@home care delivery and outcomes evaluation. We identified several different types of data collection:

- Surveys and EHR documentation: These include Patient Reported Outcomes and Experience measures (e.g. PROMs/ PREMs) or by healthcare providers (e.g. data entered into the EHR).
- Sensors and third-party monitoring systems: Automated data collection through sensors and integration with other healthcare systems.
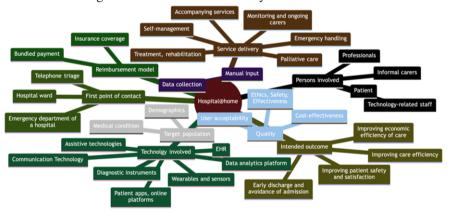

Figure 1. Framework for hospital@home care models

4. Discussion and Conclusion

In this paper, we introduced a framework comprising relevant features of hospital@home care models. Nine relevant dimensions were identified following the review of 42 scientific papers describing hospital@home care models. However, a comprehensive evaluation of the framework or validation by an expert panel is still pending. We plan to use a focus group to validate the literature derived framework. The experts can bring their domain knowledge and practical experience to ensure its applicability to the real world. Additionally, a scenario-based evaluation will be carried

out to demonstrate the utility of the framework. Our framework specifically includes technology and data collection in the context of hospital@home. Involving technology in these care models has been identified as key research issues in previous work [5,7]. In the following, we describe the envisioned use of the framework.

The framework acts as a guide to aid the decision making, planning, development and implementation of hospital@home care models. Researchers can use the framework to design studies that evaluate the effectiveness of hospital@home care for different dimensions retrieved from the framework, such as patient satisfaction, cost-effectiveness, and clinical outcomes. By comparing existing hospital@home models with the framework, researchers can identify gaps in services, use of technology, and/or patient populations served. The framework can help researchers to develop new technologies or interventions to improve hospital@home. This is the case particularly in areas such as telehealth, wearable technology, and patient self-management tools.

Policymakers can use the framework to develop policies and regulations that support the implementation and expansion of hospital@home-based health services. Hospital administrators can help to identify the aspects of hospital@home that require more investment and support, such as technology infrastructure, workforce training or patient education. Furthermore, policy makers and administrators can set standards and guidelines for hospital@home based on the framework's dimensions to ensure the quality, safety and consistency of care. Healthcare providers and administrators can use the framework as a blueprint for building or expanding hospital@home services. Our paper provides a list of required roles, technologies and service types. The paper can guide healthcare professional and support staff training in the delivery of hospital@home care, particularly in aspects such as technology use and ethical competencies related to hospital@home. Healthcare providers can use the dimensions of the framework to develop key performance indicators that help in monitoring and improving the quality of hospital@home care. This includes tracking patient outcomes, technology effectiveness and provider efficiency.

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