Exploring the potential of image diagnosis exams at home: The Health2Home project
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Participants*:* H. S. M. Kort (the Netherlands), L. J. Lorenzi (Brazil), P. C. Castro (Brazil). **ISSUE** Healthcare is undergoing a paradigm shift towards digitalization, with eHealth playing a pivotal role in delivering services, especially for older users. Despite the increase in the use and perception of the potential of home imaging diagnosis to assist in health care planning, a notable gap persists in recognizing the specific attributes of this service and understanding the perceptions of end users. Clearly defining these design concepts could help in their development and improvement and provide scientific evidence for the implementation of these services in public and private health, facilitating access to them. **CONTENT** Our symposium is designed to bring together speakers from the Netherlands and Brazil participants of Health2Home (H2H) project. H2H is a collaborative research activity and network between University of Applied Sciences (HU), Mobi Diagnostics (Mobimagem, 2023), Federal University of Paraná (UFPR) and Federal University of São Carlos (UFSCar), aiming to explore the potential of home care exams and image diagnosis, for older users. This project aims to understand the opinion and feasibility of eHealth services in the view of users and providers. As far as users and providers are concerned, the study hypothesizes that health2home services (mobile diagnostics and eHealth services) are cost-effective (lower costs when compared to outpatient services), and reliable, and they generate fewer insecurities by avoiding dislocation. There will be less exposure to other diseases, and older people have the comfort of examinations being performed at home. The speakers will highlight: (1) Literature review and exploration of the market, (2) User experience and centered design, and (3) Cost-Minimization Analysis. **STRUCTURE** This symposium proposal aims to present three papers associated with the H2H project, focusing on the design services, costs and user experience aspects. These papers draw insights from various research strands across the participating universities and companies. Kort will introduce the "Health2Home" project, a initiative centered on home-based imaging diagnostic services. She will also present preliminary results from a market review of companies that provide home diagnostic services in the countries that publish the most in the area around the world. Lorenzi will discuss user satisfaction with a home-based imaging diagnostic service in Brazil, exploring different facets of service satisfaction based on user feedback. Complementarily, Castro will present a Brazilian case study comparing the actual costs of diagnosing individuals at home after a fall versus at an urgent care facility.This symposium proposal aims to present three papers linked to the H2H project, addressing the area from a design and user experience perspective, combining insights from multiple research strands across the involved universities and companies. **CONCLUSION** The proposed symposium will offer a platform for sharing insights and fostering collaboration among researchers, practitioners, and stakeholders interested in leveraging image diagnosis in eHealth for older users. Through the presentation of the three linked papers, we aim to contribute to the advancement of knowledge and practice in the field of home-based diagnostic imaging services, ultimately enhancing the wellbeing and ageing-in-place of older adults.

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Keywords: diagnostic imaging; portable; residence; health services accessibility
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Health2Home – Mapping home-based diagnostic imaging services around the world: A market research

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Purpose There is a growing demand for telemedicine, e-health and remote or out-of-hospital healthcare, with home imaging diagnostic services being important as an essential alternative in care. However, there are still no scientific design guidelines or protocol guidelines on how to provide these services and a lack of mapping on where to access these services (WHO, 2021). Therefore, it is important to analyze the characterization of companies that offer these services, detailing the procedures adopted. The aim of this paper was to map all countries that have home diagnostic imaging services and companies that perform these services as case studies. **Method** The present study was carried out based on a list of countries previously selected through a scoping review of the literature, in accordance with the PRISMA-ScR extension for scoping reviews, registered in Open Science Framework (Costa et al 2023). To analyze which countries published the most studies in diagnostic imaging services at home, the Rayyan software was used. To identify companies that perform diagnostic imaging services at home, the following search strategy was developed: “image diagnosis” AND (mobile OR portable OR “at home”) AND company AND “country name” and data such as website were searched or social network with information about the company, identification of the company, field of activity, nature of the service, types of mobile diagnostics performed, professionals who work in the company and professionals who are involved in the practical implementation of these services, target audience, services that the company carries out and other observations. After carrying out the research, we analyzed the results presented on the Google search page and selected the first company that offers diagnostic imaging services at home. **Results and Discussion** 1,471 studies were identified, of which 198 abstracts were included. The 10 countries that published the most studies on carrying out diagnostic imaging exams at home were the United States, United Kingdom, Germany, Canada, China, Japan, Italy, Switzerland, Australia, and the Netherlands (Figure 1). Within the 10 most published countries, we found 5 of them that have companies that offer diagnostic imaging services at home: United States, United Kingdom, Canada, Italy and Australia. Looking deeper into the countries, we can see that companies that offer this type of service have a branch of activity either in mobile diagnostics or home diagnostics. Furthermore, the types of diagnostic imaging exams that companies in these countries offer are radiography, ultrasound, electrocardiogram, computed tomography, and echocardiogram. These companies offer services for people of all ages, including older people, and their professional and diagnostic teams count on Quality Advisor, Radiologists, Ultrasound Doctor, Vascular Ultrasound Doctor; Ultrasonographer, Infectious Diseases and Palliative Pain Doctor. The findings of this study hold significant implications for policymakers, healthcare systems, companies, and researchers involved in the development and enhancement of diagnostic imaging services for global health systems. By demonstrating the potential for implementation in various locations, including home-based settings, this research can contribute to greater accessibility to such services for individuals worldwide. Moving forward, our next steps will involve analyzing additional countries, particularly those with low and middle-income statuses and lesser publication coverage. By expanding our scope in this manner, we aim to broaden the identification of diagnostic imaging services in these regions, facilitating further advancements in global healthcare accessibility and equity.

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Figure 1. Geographic distribution of studies found by country

User satisfaction with an imaging diagnostic service performed at home

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Purpose Human aging is a natural and multifactorial process. The document "United Nations Decade of Healthy Aging (2021-2030)" highlights the importance of healthy aging, with guaranteed access to health services for all individuals. Therefore, it is important to improve access to diagnostic services for the early detection of health conditions, such as by carrying them out at home using portable equipment (Karako et al, 2020). However, it is essential to verify the satisfaction of these individuals who are treated at home in order to provide scientific evidence for the implementation of these services in public and private health. The present study aims to identify user satisfaction with the care provided during an imaging diagnosis service performed at home. **Methods** This is an observational, cross-sectional study, with a quantitative approach. The study is in partnership with the company Mobi Diagnostics, located in Brazil, which operates in the home care service, performing imaging diagnosis using portable equipment. The data for this study are from a company database of satisfaction surveys on services they carried out with customers from February 2022 to June 2023. Satisfaction questions could be answered with scores from 0 to 10, with 10 being the highest satisfaction score. The questions were about six topics: satisfaction with the scheduling sector, response time for service, professional cordiality, professional attention and care for the patient, professional hygiene and attire and general satisfaction with the service. The data were analyzed descriptively and was calculated using mean, relative and absolute frequency, median, 1st and 3rd quartile. **Results and Discussion** The company performs the following types of imaging diagnostic at home: electrocardiogram, holter, ambulatory blood pressure monitoring (ABPM), ultrasound, echocardiogram and radiography with specific state of the art mobile equipment (Figure1). In the period analyzed, 1,045 services provided at home were identified. All satisfaction topics analyzed had a score mean above 9.6, which are 9,69; 9,7; 9,93; 9,94; 9,92; 9,89 respectively in the order of the topics mentioned in the methods and the median, 1st and 3rd quartile were 10.0 for all topics. The topics satisfaction with the scheduling sector and response time for service had scores with a value of 1.0, being four and two respectively, and scores with a value of 3.0, being 3 and 2 respectively. These low scores are due to the fact that some individuals who responded to the survey did not schedule the exam and some reported delays in receiving care. The other satisfaction topics had a minimum score of 6.0, with more than 91% of the scores being 10.0. It is then verified that the provision of diagnostic imaging services at home has high satisfaction. Regarding this, a study by Toppenberg, Nielsen and Damsgaard (2022), despite having only analyzed the provision of mobile x-ray services at home, also identified a high user satisfaction. Therefore, these mobile services are a viable strategy for carrying out these types of diagnostics for all individuals, promoting early detection of health conditions and consequently promoting the prevention and reducing the worsening of diseases.

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Figure 1. Portable equipment used by the company to carry out imaging diagnostic services at home

Carrying out imaging and chart exams at home: A cost analysis

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Purpose Imaging and graphic exams performed at home can offer comfort, safety, and less exposure to hospital contamination (Bokolo, 2021), in addition to reducing process costs for patients and healthcare providers (Kjelle et al, 2019). Cost analyzes are fundamental steps to validate the incorporation of health technologies, however, there are few studies in the literature on economic evaluations of performing diagnostic imaging exams at home. The aim of this study is to compare the costs between carrying out diagnostic imaging and graphic examinations at home compared to carrying out these examinations in public and private services. **Method** An economic cost-minimization assessment will be carried out to compare the costs of performing diagnostic imaging and graphic exams offered by a company that offers the service at home, with the costs of performing the same exams in the Unified Health System (SUS) in Brazil and in private hospitals. In Brazil, performing diagnostic imaging at home is regulated by the Resolution of the Collegiate Board No. 611, of March 9, 2022 (Brasil, 2022). The cost analysis will not only involve the direct costs of carrying out exams, such as human resources and supplies, but also indirect expenses. Descriptive analysis will be used to analyze the data and values, in addition to comparing parametric data in an absolute and associative manner, normality analysis and logistic regression analysis, considering $p \leq 0.05$. **Results and discussion** To date, a cost analysis has been carried out for a healthcare provider that hires home radiography services, comparing it with the costs of referring patients to private hospitals to carry out the same exams. 162 patients, with suspected fracture, between July 2021 and 2022, underwent x-rays at home, the cost of which is R$210 (U$41) per patient. On the other hand, the cost of going to the hospital to perform the same exam, per patient, varies between R$339.52 and R$694.25. After taking an x-ray at home, only 12 patients needed to go to the hospital due to a confirmed diagnosis of fracture. Thus, the amount spent by the healthcare provider was R$41,366.91, while the amount spent to send the 162 patients to the hospital for radiography would be R$63,892.02, representing a cost reduction of 35.25%, as described in Figure 1. The cost reduction was significant in the health operator's budget. For older patients, performing radiography at home avoids transportation costs and companion costs, as well as offering greater accessibility and safety, especially for frail and bedridden older people (Toppenberg et al., 2020). This type of service can be viable and promising in the care of older people, especially those in Home Care and institutionalized care (Toppenberg et al., 2020). Our hypothesis is that the implementation of diagnostic imaging and charting at home, in addition to offering benefits to the patient, can significantly reduce healthcare spending, both in the public and private spheres. Our next course of action involves conducting an economic assessment that takes into account the expenditures of both the Brazilian and Dutch public health systems. Through this analysis, we aim to determine the economic feasibility of implementing diagnostic imaging and graphic exams within primary care and home-based settings.

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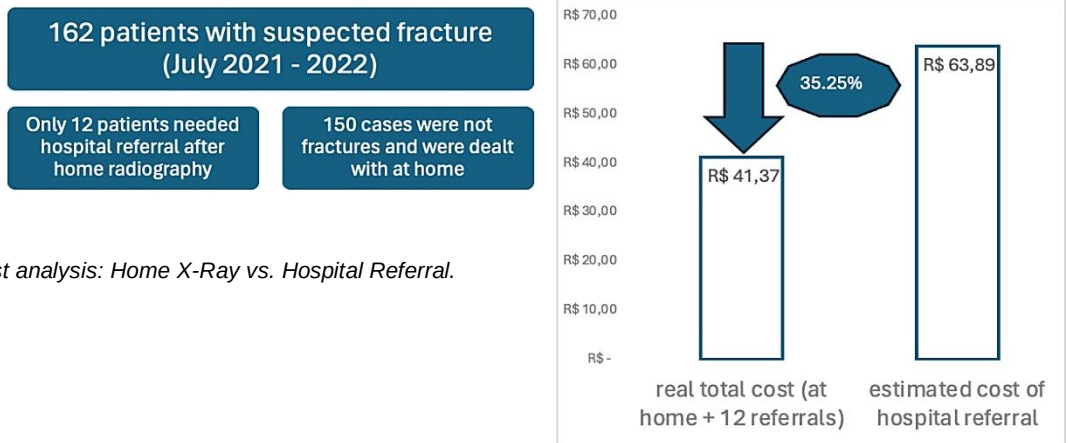

Figure 1. Cost analysis: Home X-Ray vs. Hospital Referral.