Bridging the Gap in Rural Emergency Care: A Scoping Review of Living Lab Hospitals and their Potential in Rural Healthcare

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Abstract

Background. Rural Canadian hospitals are increasingly vulnerable to service reductions and emergency department closures, compromising the emergency care access for the 6 million residents (20% of the population) living in these areas. Current standards for rural emergency care in Canada are outdated, necessitating innovative, locally adapted solutions. The Living Lab concept, a collaborative, real-world innovation ecosystem involving patients, citizens, healthcare professionals, learners and researchers, may address this gap. In 2020, we initiated a rural Living Lab hospital project in Charlevoix, Québec, where no prior studies on such hospitals existed. Our research aims to assess the current state of literature on rural Living Lab hospitals.

Objectives. Our specific goal was to examine and characterize the existing research on Living Lab Hospitals in rural settings while precisely identifying areas where further research is required.

Methodology. Our scoping review was conducted through a structured five-stage process: [1] problem formulation, [2] literature search, across five databases: PubMed, MEDLINE, EMBASE, CINAHL, and Web of Sciences, [3] data evaluation and analysis, [4] data collection and summary, and [5] presentation.

Results. A total of 212 studies from Embase, 134 from MEDLINE, 91 from CINAHL, 10 from Web of Science, and 4 from PubMed were initially part of our analysis. After eliminating 169 duplicate entries, our team scrutinized 282 titles and abstracts. Given our primary aim of identifying living labs based in rural hospital settings, only our original publication, “A Canadian Rural Living Lab Hospital: Implementing solutions for improving rural emergency care”, was found.

Conclusion: This scoping review indicates a stark research deficit on Living Lab hospitals in rural contexts, with only one relevant study identified. This highlights a critical need for further investigation into the adoption and impact of Living Lab models in rural healthcare. Given the risks faced by rural emergency services, it is vital to prioritize research in this area to improve and innovate care for vulnerable populations.

INTRODUCTION

Rural emergency departments (EDs) in Canada, despite being a vital safety net for approximately 6 million rural residents (constituting 20% of the population), remain significantly understudied [1, 2]. In contrast to their urban counterparts, rural populations are older, have a higher burden of disease and are more vulnerable to trauma, a leading cause of mortality in Canada [2–7]. Over the past decade, our research team has conducted widespread investigations into rural emergency healthcare, covering more than 300 hospitals and the care of thousands of patients across Canada.

Our early work underscored the critical role of rural EDs in the Canadian healthcare landscape. Notably, these facilities contend with limited resources, as exemplified by the absence of local access to surgery in 74% of Canadian EDs and the lack of CT scans in 80% of these institutions [8–10]. Our studies

unveiled alarming disparities between rural and urban mortality rates as a result of limited access to health services. Patients treated in rural hospitals in Canada face a 20% higher risk of mortality from stroke compared to those treated in urban settings [11]. Furthermore, trauma patients in rural Quebec exhibited pre-hospital and ED mortality rates 3.4 times higher than patients from urban settings [12, 13]. These findings are part of a growing body of evidence revealing nationwide and international disparities in access to services and health outcomes between rural and urban areas [6, 14–16].

Despite these disparities, knowledge on how to enhance care within rural EDs remains limited. As a response to this gap, in 2020, we launched a pioneering rural living lab within the hospitals in the Charlevoix region of the province of Quebec. Living labs, serving as collaborative research and innovation ecosystems, bring together real-world users, businesses, and researchers to co-create, evaluate, and refine novel products, services, or technologies [17, 18]. The overarching aim of our Living Lab Charlevoix project was threefold. First, we aimed to foster a culture of innovation. Second our goal was to attract and train prospective healthcare professionals and leaders. Third we sought to work in partnership with citizens, healthcare experts, and decision-makers. Through these collaborative efforts, our goal was to engage local stakeholders to co-design, prioritize, and trial solutions to enhance their rural emergency care.

We started with a local limited-scale approach with the intention to expand the adoption of the Living Lab concept other rural areas. Recognizing the unique geographical challenges encountered by rural EDs, we acknowledged the complexity of applying uniform standards across these facilities [19, 20]. Despite substantial advancements in the field of emergency medicine in the last 20 years, the Canadian Association of Emergency Physicians' recommendations for enhancing rural emergency care, were last updated a quarter-century ago and necessitate urgent revision [21]. As the Center for Optimizing Rural Health (CORH) said, "If you have seen one rural hospital, you have seen only one rural hospital," emphasizing the need for tailored interventions that consider the distinct characteristics of each region and facility [22]. The concept of living labs appears particularly well-suited to address this endeavor [18].

While no published reports existed on the topic of rural Living Lab hospitals at the launch of the Living Lab Charlevoix project, the broader literature on Living Labs has since experienced considerable growth, justifying a review of this expanding body of work. Our specific goal was to examine and characterize the existing research on Living Lab Hospitals in rural settings while precisely identifying areas where further research is required.

METHODOLOGY

As a literature review, this project did not require ethical approval.

All methods adheres to PRISMA guidelines (http://www.prisma-statement.org/) for reporting systematic reviews.

Our scoping review was conducted through a structured five-stage process: [1] problem formulation, [2] literature search, [3] data evaluation and analysis, [4] data collection and summary, and [5] presentation. The problem formulation stage was closely aligned with our specific research objectives. We followed the methodological guidelines recommended by the Joanna Briggs Institute (JBI) to ensure the comprehensive and rigorous integration of diverse research evidence throughout the scoping review.

This scoping review aimed to address the following question: "What is the current status of the literature regarding Living Lab hospitals in rural settings?"

Given our anticipation that the literature on this topic would be limited and scarce, we engaged the expertise of two independent health sciences librarians from different universities. We tasked them with designing and executing comprehensive search strategies using databases aligned with their expert choice to explore the above question. Following this, two members of our team methodically reviewed and refined the search strategies proposed by the librarians, ensuring their inclusivity and comprehensiveness. Until July 24th 2023, our systematic research was then carried out across five databases: PubMed, MEDLINE, EMBASE, CINAHL, and Web of Sciences.

Considering the extensive range of articles generated when attempting to expand the concept of a living lab using synonyms, we found ourselves drifting away from the fundamental essence of a living lab. This deviation was not conductive to the type of study we intended to conduct. Following discussions with the medical librarians, we narrowed down the terms related to rurality, deliberately excluding terms like "remote" that provided information beyond our study's scope, thereby diluting our search. Since the term "hospital" is quite broad and we were interested in a wide array of studies relevant to the hospital domain, we incorporated a diverse range of terms, recognizing that these entities might not be referred to by the same name in other living labs. For the hospital concept, we used the following terms: health OR health care OR healthcare OR hospital OR hospitals OR clinic OR clinics OR medical OR medicine OR “emergency department”. Finally, we combine the keywords and concepts using Boolean operators to create search strings. The comprehensive details of our search strategy are outlined in annex 1.

Study inclusion and exclusion criteria

Since the idea of living labs in the field of medicine is a relatively recent development with limited available literature, we opted not to set limitations regarding language or publication date in order to encompass a more extensive spectrum of research. Similarly, we refrained from excluding papers based on their research design for the same purpose.

Study selection

We conducted a systematic two-step screening process for the selected studies using the Covidence platform. In the initial step, two trained reviewers individually evaluated the titles and, where accessible, abstracts, based on predefined inclusion criteria. The list of articles was then refined using the following criteria: [1] The study was conducted within a living lab or pertained to living lab research, [2] the study's

context related to healthcare or emergency services, or [3] the study's context focused on rural settings. In cases where both reviewers could not reach a consensus, the articles underwent another round of screening by both reviewers.

In the second step, the full text of articles categorized as either "include" or "unclear" underwent independent review using a standardized form and predetermined inclusion criteria. Any discrepancies that remained unresolved after discussion between the two reviewers were resolved by a third-party adjudicator.

RESULTS

Search outcomes

A total of 212 studies from Embase, 134 from MEDLINE, 91 from CINAHL, 10 from Web of Science, and 4 from PubMed were initially part of our analysis, as shown in Fig. 1. After eliminating 169 duplicate entries, our team examined 282 titles and abstracts. Among these, 246 were unrelated to our question, leaving 36 studies for further evaluation. With our primary aim of identifying living labs based in rural hospital settings, we refined our inclusion criteria to encompass studies that incorporated the elements related to rural settings, living labs, and hospitals. In the end, as shown in Table 1 only our original publication, “A Canadian Rural Living Lab Hospital: Implementing solutions for improving rural emergency care”, was found.

Number of studies identified through the search strategy, number of studies excluded and included in both primary and secondary screenings, and final number of studies included.

Table 1
Description of included article.

Title	Lead Author	Year	Country	Population	Aim
A Canadian Rural Living Lab Hospital: Implementing solutions for improving rural emergency care	Fleet, R.	2020	Canda	Rural population	Implementing solutions for improving rural emergency care

This article presented a plan to design and implement a Living Lab in a rural hospital (30 beds, 13 000 ED visist/year) located in Baie-Saint-Paul (Québec, Canada). It proposed a concept whereby “transformative, user-designed, point-of-care solutions would be co-developed, implemented and evaluated in a sustainable and scalable way” [23]. The paper justified the use of the living lab methodology and described how specific pilot projects, inspired by several years of rural emergency care research, would be implemented alongside local stakeholders. The Living Lab’s overarching objectives were rooted in the "Quadruple Aim" framework [24]. The objectives aimed to enhance the health and safety of rural populations, improve the quality and experience of care for patients and their families, elevating the

quality of work life and retention rates of healthcare professionals and optimizing healthcare costs [25–30]. The paper summarized how Local stakeholder and the Living Lab team collectively prioritized specific pilot projects.

While the paper outlined the plan for the living lab it was not specific on the process, the anticipated facilitators and barriers and no results were presented as the Living Lab Charlevoix was not yet in operation. The paper was part of a special issue on small rural hospitals published in Future Health Care journal. The paper was published before the pandemic hit the region and a few weeks before the Living Lab Charlevoix was officially launched (February 2020). A brief update on this project is provided in the discussion below.

DISCUSSION

This scoping review provides valuable insights into the limited literature landscape of rural living lab hospitals. Our objective was to identify existing research on Living Lab Hospitals in rural settings and highlight areas that warrant further exploration. In this context, we will discuss the significance of the Charlevoix Living Lab, the broader implications of living labs in rural healthcare, and the challenges and opportunities associated with their adoption.

1. The Charlevoix Living Lab

Our review establishes the Charlevoix Living Lab as the first published hospital-based living lab in a rural setting. Conceived as a model rural hospital to validate solutions studied over the past decade by the Research Chair for Emergency Medicine at Université Laval, the Charlevoix Living Lab was officially launched in February 2020. Initially planned for one hospital, a second site was added at La Malbaie (population 9000) Hospital (150 km for Quebec city). Compared to the rest of the health authority's jurisdiction and the province, the population of Charlevoix has a below average life expectancy, higher rates of premature mortality and preventable mortality, and poorer overall health [31]. Like many other rural facilities, Charlevoix contends with severe medical shortages, and elevated risk of trauma due to local industries with high accident rates (logging, agriculture, sports tourism, notably the ski hill). In the early stages of the pandemic, after lockdown easements Charlevoix received a record-breaking influx of tourists fleeing regions hit hard by COVID-19 – putting additional pressure on the already strained emergency department [32–34].

In March 2020 as the pandemic hit, the Living Lab team mobilized local stakeholders to ask what they could do to help. It was determined that bringing more clinical support and better linkage with academic centers would be a priority. Thus, an early solution was to bring residents in training form varied specialties. Inspired and supported by McGill University's International Master's for Health Leadership program, the Living Charlevoix Lab team designed a leadership and innovation in times of crisis training rotation for the residents. This 4 to 6 - week rotation had 5 pillars: Leadership, innovation (design thinking), rural medicine, wellness and pandemic management. Initially, students spent roughly 50% of

their time in virtual training sessions on these topics and the remaining time was spent on clinical duties/training helping local health care providers in the context of actual and threatened work-force shortages. Using design-thinking principals, trainees in the rotation were also required to lead an innovation project in collaboration with citizens, decision-makers and local healthcare providers, always in a user-driven spirit. The living Lab Charlevoix project has been in existence since February 2020. The leadership and innovation rotation is now at the core of the model for implementing innovations. It has trained 10 cohorts for a total of 70 students (residents, medical students, paramedics, allied health care professionals, decision-makers, citizens, artists). It is now in the scale and spread stages. Specific Living Lab initiatives and their impact have been presented at various scientific conferences and a website and YouTube channel describe these innovations. Scientific publications are in progress.

2. The broader implications of living labs in rural healthcare

While our review did not reveal additional rural living lab hospitals, it did find other living lab initiatives in rural settings. These findings provide a valuable understanding regarding the adaptability of the living lab approach to address specific healthcare challenges in rural settings. Notably, a living lab in Languedoc-Roussillon, France, targets fall-related issues among older adults in rural areas and provides a comprehensive care pathway for individuals affected by strokes, a condition often preceding fall. The Lozère region's stroke units and the integration of telehealth-based emergency services illustrate the flexibility of living labs in addressing healthcare challenges [35]. Additionally, our review identified initiatives like the usability assessment of Assistant on Care and Health Offline (ACHO), a voice assistant designed to enhance therapeutic adherence among elderly individuals in rural communities [36]. Furthermore, we highlighted a study that employed the living lab methodology to assess the feasibility of user groups designing content for a chatbot to support the mental well-being of individuals in rural areas [37]. Another European study used the living lab approach to establish a robust institutional and organizational foundation at regional and community levels, aiming to advance an integrated care model for elderly individuals in rural and remote areas of Low- and Middle-Income Countries [38].

While the specific literature on rural living labs is currently limited, the very concept of living labs in health care carries substantial promise. An extensive literature review was conducted by Junghee Kim and colleagues, involving an analysis of 15 studies. They focused on the application of living lab principles and their effectiveness in addressing health concerns [18]. The research topics varied, including detecting and monitoring daily life, fall prevention and social support. All the studies applied multi-method approaches and a real-life setting. Use of the living lab approach appeared to improve the quality of life, physical and social health and cognitive function of the target populations. They concluded that the living lab approach proves highly beneficial when investigating health concerns affecting the elderly. Their findings underline the living lab approach as highly advantageous for tackling health concerns in this population. Moreover, they highlighted its potential in formulating health policies to alleviate disparities in vulnerable populations.

Table 2
Living Labs in Rural Emergency and Healthcare: Benefits and Challenges

Benefits	Challenges
Stakeholder Co-Creation: Encourages collaboration among healthcare professionals, patients, and tech experts, ensuring solutions meet rural-specific needs.	Cultural Dynamics: The effect of cultural beliefs on the acceptance of innovative strategies.
Tailored Solutions: Addresses rural-specific challenges, creating solutions adapted to isolation and resource limitations.	Capacity Building: A shortage of professionals familiar with living labs can limit adoption.
Iterative Testing: Allows for continuous refinement of solutions.	Stakeholder Engagement: Ensuring participation from local stakeholders can be challenging.
Overcoming Implementation Barriers: Identifies affordable solutions for rural areas.	Evaluation Difficulties: The absence of standardized metrics complicates success measurement.
Evidence-Based Decision Making: Provides evidence on the efficiency of healthcare solutions.	Supply Chain Issues: Logistic issues can disrupt supply chain operations.
Community Engagement: Fosters wider acceptance through local resident involvement.	Scalability: Success in one area might not ensure success in another
Cross-Disciplinary Collaboration: Unites different sectors for a comprehensive approach to challenges.	Collaboration Barriers: Challenges in partnering with vital institutions.
Knowledge Dissemination: Shares successful strategies across different rural settings.	Response Times: Limited resources can reduce adaptability.
	Data Concerns : Risk to patient trust due to insufficient data protection.
	Patient Demographics: Older population might resist tech-based solutions.
	Networking Limits:

Benefits	Challenges
	Isolation can hinder knowledge sharing and updates.

Thus, Living labs, used as innovative ecosystems, offer a dynamic platform for collaborative problem-solving, enabling the co-creation and testing of solutions that are specifically tailored to the distinct challenges encountered in rural healthcare settings. Table 2 summarizes potential benefits and challenges of Living Labs in Rural Healthcare.

By understanding and addressing these benefits and challenges, stakeholders can design more effective strategies to introduce and sustain living lab hospitals in rural areas. Collaboration, adaptation, and continuous feedback are critical for success.

CONCLUSION

This review reveals a significant gap in the literature regarding Living Lab hospitals in rural settings. Despite extensive searches across multiple databases, only our original publication addressed this innovative approach to improving rural emergency care in Canada. This paucity of research underscores the urgent need for comprehensive studies on the implementation and efficacy of Living Lab concepts in rural hospitals. Our findings suggest that there is substantial opportunity for growth and development in this field. It is imperative that future research focuses on these innovative ecosystems to enhance emergency healthcare services for rural populations, who are currently at risk of service limitations and department closures. The potential of Living Labs to provide tailored impactful solutions in these settings remains largely untapped, marking a critical area for future investigation and action.

Declarations

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CONFLICT OF INTEREST

All authors declared not having any financial or other conflicts of interest.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

CONSENT FOR PUBLICATION

Not applicable.

AVAILABILITY OF DATA AND MATERIALS

All articles are available on the databases used : PubMed, MEDLINE, EMBASE, CINAHL, and Web of Sciences.

AUTHOR'S CONTRIBUTIONS

RF, FKT, DS and RJ actively contributed to the creation of the study design. RJ, DS and FKT developed the search strategy. FKT and RJ were in charge of the first and second screening with oversight by RF. RJ was responsible for data collection and drafting of the manuscript. FKT and DS participated in the supervision of data collection and contributed significantly to the data analysis and preparation of the manuscript. All authors read and approved the final manuscript. RF takes responsibility for the paper as a whole.

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Figures

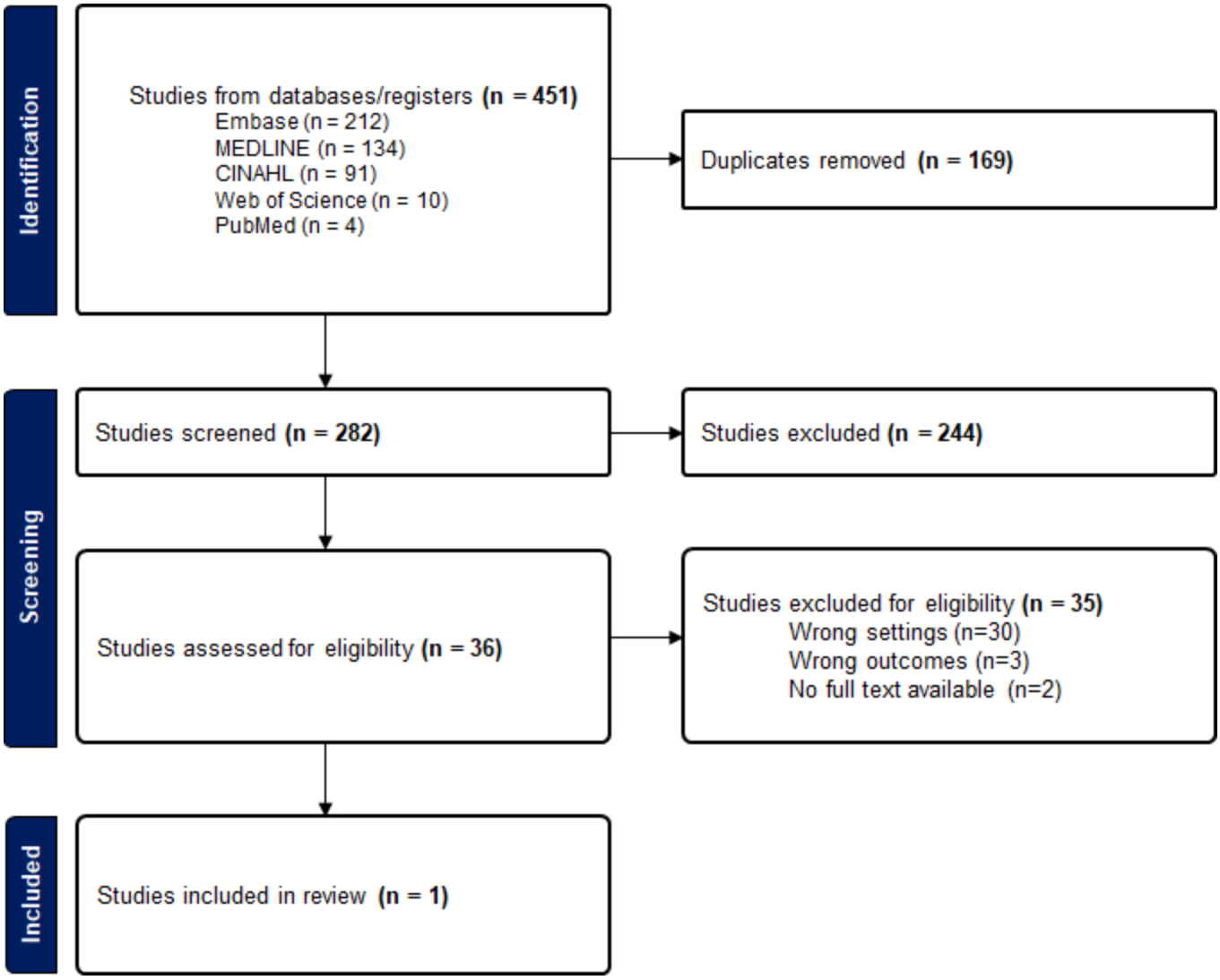

Figure 1

The Research Process

Number of studies identified through the search strategy, number of studies excluded and included in both primary and secondary screenings, and final number of studies included.

Supplementary Files

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- ANNEX1.docx
- PRISMA.docx