Implementation Of An ED Surge Management Platform: A Study Protocol

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Study protocol

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Abstract

Background

Wait times and overcrowding are challenging emergency departments (EDs) around the world. To address these issues, a quality improvement program called SurgeCon was created to improve ED efficiency and patient satisfaction. This paper presents a framework for managing and evaluating the implementation of an ED surge management platform. Our framework builds on the Reach, Effectiveness, Adoption, Implementation, and Maintenance (RE-AIM) framework to structure our approach and the Consolidated Framework for Implementation Research (CFIR) to guide our choice of outcome variables and scalability.

Methods

Four hospital EDs will receive the SurgeCon quality improvement program. Using a stepped wedge cluster design, each ED will be randomised to one of four start dates. Data will be collected before, during, and after the implementation. Guided by CFIR, we will measure ED key performance indicators (KPI), patient reported outcomes, and implementation outcomes related to SurgeCon's scalability, adaptability, sustainability and overall costs. RE-AIM will be used to guide the assessment of SurgeCon. Participants in this study consist of patients who visit any of the four selected EDs during the study period, providers/staff, and health system managers. A mixed-methods approach will be utilized to evaluate implementation outcomes.

Discussion

This study will provide important insight into the implementation and evaluation techniques to enhance uptake of an ED surge-management platform. The proposed framework bridges research and practice by involving researchers, practitioners, and patients in the implementation and evaluation process, to produce an actionable framework that others can follow. We anticipate that the implementation approach would be generalizable to program implementations in other EDs.

Trial Registration:

Name of the registry: ClinicalTrials.gov

Trial registration number: NCT04789902

Date of registration: 03/10/2021

URL of trial registry record: https://clinicaltrials.gov/ct2/show/NCT04789902?cond=surgecon&draw=2&rank=1

Contributions

- This study presents an actionable, comprehensive guideline for the implementation of interventions within ED settings.
- The intervention builds on a combination of RE-AIM and CFIR to guide the choice of outcome variables.
- This study adds to the literature by using qualitative as well as quantitative strategies to comprehensively address all RE-AIM dimensions.
- This study involves a multi-disciplinary planning and implementation team who play significant roles in implementing and evaluating the intervention program.
- Patient engagement is fundamental to this research project. Patients are provided with a variety of opportunities to engage in different stages of the intervention.

Background

SurgeCon Program

Wait times and overcrowding are challenging emergency departments (EDs) around the world[1–3]. Such wait times are an issue because they increase the likelihood of patients leaving without being seen by an ED physician [4, 5]. Canada has one of the longest average ED wait times compared to peer-industrialized countries with steadily increasing median wait times from 2.8 hours in 2017-18, 3.2 hours in 2018-19, to 3.3 hours in 2019-20 [6, 1]. In Newfoundland and Labrador (NL), Canada, excessively long ED wait times have made the province a case in point for ED issues [7–9]. To address this issue, our team will implement and evaluate a quality improvement initiative called SurgeCon, which includes a protocol-driven software platform, to reduce wait times and improve the sustainability of NL's health system without major workforce changes. SurgeCon is designed to enable frontline healthcare workers to anticipate and mitigate surges in patient volume through a series of proactive steps and decision-making tools. We have chosen a stepped wedge randomized control trial design to evaluate the effects of SurgeCon on ED operations.

Rationale for the Implementation and Evaluation Framework

It is challenging to implement and evaluate complex interventions, such as SurgeCon, in a hospital setting. Hospitals have a unique context, process, system, and population, and hence they experience unique challenges. It is well-documented that many health services interventions fail to be fully implemented, produce effective changes, or be sustained for long-term. This is especially true when the innovation requires complex alterations in clinical practices such as improved communication and cooperation among clinicians, researchers, and administrators, or modifications in the organization of care [10–13]. These complex interventions "require process and impact evaluations to understand participation of organizations and individuals, intervention implementation, and long-term effects on institutions or individuals" [14]. Therefore, it is important to develop a framework to guide such implementation and evaluation. Following best practices [13], the framework suggested in this study was developed based on the accumulated evidence and experiences at a pilot site, Carbonear Hospital, NL [15, 16]. We are also guided by RE-AIM and CFIR [17, 18]. We selected these frameworks because they enable us to consider the

context which includes the needs of the population, the work practices, the culture, and the system as a single entity during implementation. We recognized that the intervention is not just the system; it is the other steps that are part of the implementation (training, documenting work practices/processes, etc.). We made a conscious effort to include these in our framework.

RE-AIM was developed by Glasgow et al (1999) and has been used in over 400 studies as a means of improving the external validity of measures and the implementation of interventions in healthcare [17, 19, 20]. RE-AIM highlights not only the representativeness of participants but also the setting, as both have a critical role in public health interventions [17]. RE-AIM consists of five dimensions – reach, effectiveness, adoption, implementation, and maintenance, which have been used to guide the implementation of health care interventions. While RE-AIM provides researchers with a comprehensive plan for evaluating an intervention, CFIR, which is composed of five domains (i.e., intervention characteristics, outer setting, inner setting, characteristics of the individuals, and the process of implementation) “opens a ‘black box’ of the ‘I’ (implementation) component” [18]. These domains consist of a total of 39 constructs which reflect the evidence base of factors most likely to influence the implementation of interventions. CFIR has been utilized to explain and identify barriers and facilitators to adoption, implementation, and maintenance. These frameworks complement each other and have been applied successfully together - “combining frameworks judiciously enhanced our ability to develop testable, theory-informed implementation strategies” [21]. CFIR constructs can explain “why” implementation was successful or not, and RE-AIM describes outcomes in terms of “who, what, where, how and when” [17, 21]. To our knowledge, this paper presents one of the first comprehensive implementation and evaluation guidelines designed for the ED which uses both the RE-AIM and CFIR frameworks.

Methods

Aims and Objectives

The primary aim is to identify and describe the context in which implementation occurs and the factors that influence implementation [22, 23]. Based on the literature and our pilot assessment of SurgeCon, we have included a multi-faceted implementation strategy to help support the successful uptake of SurgeCon. Thus, our secondary implementation aim is to describe the use of these strategies in different ED contexts and identify any changes that can be made to improve the uptake and sustained use of SurgeCon.

Study Setting

EDs with 24/7 on-site physician support in the Eastern Health (EH) region of NL were selected in this clinical trial: (1) Health Sciences Centre (Urban/Tertiary), (2) St. Clare’s Mercy Hospital (Urban/Tertiary), (3) Dr. G.B. Cross Memorial Hospital (Rural/Secondary), and (4) Burin Peninsula Health Care Centre (Rural/Secondary)[9]. Participants of this study consist of patients who visit any of the four selected EDs during the study period, providers/staff, and health system managers.

Implementation Team Composition

The planning and implementation team for this study is multi-disciplinary, including qualitative and quantitative researchers, clinical trial experts, implementation scientists, healthcare economists, health informatics researchers, healthcare professionals, health system managers, frontline healthcare staff, and patients, all of whom play significant roles as patient research partners, facilitators, site coordinators, champions, and members of various working groups and committees (Implementation, Innovative Clinical Trial, Patient Engagement, Steering, Executive) in implementing and evaluating the intervention program (see Table 1).

Table 1
Implementation Personnel List

	Implementation Personnel	Explanation
1	SurgeCon facilitator	The facilitator is a member of the Implementation Working Group who was involved in the development of SurgeCon in Carbonear. The facilitator will be designated to be one of the main points of contact for local teams during the implementation process.
2	Site coordinator	Site coordinators are nurses who will be performing on-site research-related tasks and assisting with the interview recruitment.
3	Frontline SurgeCon Champions	Once the site assessment is complete, ED management will be asked to select a member of the local ED frontline team who will receive additional training either in-person or remotely. That individual will then be an ongoing point of contact for ED staff at their site who have any questions related to SurgeCon. They will also liaise with the research team at regular intervals to discuss any practical or technical issues with using SurgeCon. Also, observation will be utilized by champions to collect information during the readiness assessment period to ongoing implementation evaluation
4	Implementation working group	The SurgeCon Implementation Working Group is responsible for overseeing and guiding the implementation of the intervention at each of the selected sites.
5	Innovative Clinical Trial (iCT) working group	The iCT Working Group supports the team with their expertise in methodology and ensures the validity and precision of the study.
6	Patient Engagement Working Group	The Patient Engagement Working Group will oversee and guide patient engagement and patient-oriented research in all sites.
7	Executive Committee	The Executive Committee (all Steering Committee members, plus the patient advisor, payer representative, key strategic area leaders, and a policymaker), will oversee the whole project and have the authority to determine priorities and supervise the general course of operations.
8	Steering Committee	The Steering Committee (nominated PI, clinician PI, SurgeCon facilitator, research manager) will manage daily operations to ensure the project adheres to the Rewarding Success agreement and that the highest standards of scientific rigour are maintained.
9	Patient Research Partners	Patient Research Partners are patients who are also members of the research team. Patient research partners provide their perspective and help guide decisions to ensure the research produces outcomes and knowledge that can be used to help address the needs and priorities of the local populations they represent.
10	ED Team	The ED team includes all physicians, nurses, allied health, and other personnel who work at the four selected EDs. They will participate through interviews and report questions, concerns, and issues to site coordinators and champions.

We involve stakeholder groups (e.g., patients, decision makers, researchers, clinicians, etc.) in all stages of SurgeCon's implementation. Collaboration is not limited to the providers and managers, as the role of

patients is crucial. Through our implementation framework, we contribute to the literature by guiding researchers on how to engage patients in a systematic way to redefine and reassess intervention programs to make them more culturally and contextually relevant. We also used four essential pillars to shape our patient engagement strategy [24]: (1) Patient Initiation (allowing patients to participate in the research process), (2) Building Reciprocal Relationships (all individuals being treated as equal partners), (3) Co-learning (researchers and patients learning from each other), and (4) Re-assessment & Feedback (routinely consulting with patients and making improvements accordingly). Our framework gives patients a variety of opportunities to engage in the implementation and evaluation process, ranging from limited commitment (e.g., surveys, interviews, etc.) to full, ongoing participation through team membership.

Data Collection

Implementation outcomes will be collected through a mixed-methods approach, including 1) semi-structured, in-depth interviews, 2) observation by researchers and champions, 3) survey instruments, 4) wait times data, and 5) data from SurgeCon's dashboard system and evaluated by patients, providers/staff, health system managers.

Semi-structured, in-depth interviews (conducted via phone, digitally recorded, and lasting 45 to 60 minutes) and observation will be utilized to collect information during the exploration period to ongoing implementation evaluation (e.g., assessing ED's physical layout, barriers, and enablers to SurgeCon adoption and sustained use, and examining ED contextual constructs and factors).

In the first stages of qualitative data collection, purposeful sampling will be applied to maximize the chance of obtaining rich data for central research topics from "Information-rich cases" which will subsequently be followed by theoretical sampling [25]. However, theoretical sampling will indicate that the sample is "not selected from the population based on certain variables prior to the study; rather the initial sample is determined to examine the phenomena where it is found to exist" [26].

Quantitative data for this study includes primary and secondary data. Primary data will be collected using a survey instrument via telephone interview. Secondary data will be provided to our team by the Newfoundland and Labrador Centre for Health Information (NLCHI). Additional details on quantitative data collection and analysis are available via other works published by our team [27].

Individuals selected to be site coordinators will be responsible for assisting with the scheduling and coordination of interviews with ED staff. Staff members who indicate that they do not want to participate in the study will not be contacted. The site coordinator will facilitate the pre-interview process for staff members who have expressed interest in completing the interview (e.g., consent form, selecting a private location for the interview to be conducted) or will provide contact information of staff members to the research team. The research team member will then complete a web-conference/telephone interview with the participant in a private setting. Recruitment will continue until data saturation has been achieved.

Data Analysis

Qualitative data from interviews and observations will be analysed based on Straussian Grounded Theory (GT) (1990) [28]. During the open coding process, the first stage of data analysis is to break down collected data into concepts, their dimensions, thoughts, and ideas. This provides an opportunity for the researcher to find similarities and differences to categorize similar occurrences and behaviours into the same group. Data generated during the open coding process that resemble one another are subdivided into different codes. This subdividing of data assists in the development of a comprehensive explanation of the phenomenon, which is the purpose of axial coding, the second stage of the open coding process. The extraction of a core category from this initial two-stage process is the task of the investigator during selective coding. All these stages in the coding process will be conducted by a qualitative researcher. Codes and categories will then be reviewed by members of the Implementation Working Group to reach a consensus. At the end of the study, the credibility of results will be enhanced by member checking, data triangulation, and peer debriefing.

COVID-19 Impact on Research Operations

Due to the pandemic, staff training and research team meetings will be delivered or carried out through web-conferencing/a virtual platform. Additionally, some of the data collection was originally intended to be carried out by the research team; however, we changed the plan by involving hospital employees. For instance, hospital employees will utilize observation to collect information during the ongoing implementation evaluation. Also, the coordination of research operations at each of the sites will be completed by EH staff since the intervention sites are restricted to Eastern Health personnel. Eastern Health employees responsible for research related tasks will be jointly supervised by the research team and Eastern Health managers. Additionally, the SurgeCon platform and research instruments will be adjusted to capture and report COVID-19 data.

Implementation and Evaluation

ED Implementation and Evaluation Framework

SurgeCon's implementation plan include an iterative improvement process that is divided into four stages: 1.) Exploration; 2.) Adoption; 3.) Active Implementation; 4.) Sustainment [29]. For each stage, we applied the RE-AIM framework and CFIR domains to identify the criteria that applied to our context. Table 2 provides details on the evaluation and timelines according to the implementation stages. All measures, including how each domain is mapped in the RE-AIM framework are provided. We have expanded RE-AIM's implementation outcomes to include outcomes recommended by CFIR [30].

Table 2
Implementation frameworks used to evaluate implementation outcomes

Dimensions/ Variables Description	Implementation Stage (Time Period)			
	Exploration Months 1–10 at all hospitals	**Adoption 2 Months at each hospital (months 11-12, 17–18, 23–24, 29-30)**	**Implementation Evaluation/iCT Months 13–31**	**Sustainment Months 17–48**
Reach **(RE-AIM Framework)** **Who is intended to benefit and who actually participates or is exposed to the intervention?**				
Exclusions: The percentage of eligible ED sites that are excluded pre-randomization.	✓	✓	✓	
Participation rate: The number of EDs that participate divided by all EDs that meet the eligibility criteria.		✓	✓	
Characteristics of the participant sites and non- participants sites: Assessment of the following variables: the average number of patients, the average number of staff, staff mix, staff characteristics (age, sex, years of practice) and patient characteristics (age, sex, CTAS score). This will also include assessment of potential moderating factors such as organization readiness for change.	✓	✓	✓	✓
Understand Barriers and Enablers to Reach	✓	✓	✓	✓
Effectiveness **(RE-AIM Framework)** **What is the most important benefit you are trying to achieve and what is the likelihood of negative outcomes?**				

Dimensions/ Variables Description	Implementation Stage (Time Period)			
Health System Level • Length of Stay • Time Until Physician Initial Assessment • Left Without Being Seen			✓	
Patient-reported Level • Satisfaction • Patient reported experiences of ED service			✓	
Understand Barriers and Enablers to Effectiveness			✓	
Adoption **(RE-AIM Framework)** **Where is the program or policy applied? Who applied it?**				
The proportion of Health Care Providers who engage in SurgeCon activities among those who agreed to participate in the study (Acceptability, appropriateness)	✓	✓	✓	
Understand Barriers and Enablers to Adoption	✓	✓	✓	
Implementation **(RE-AIM Framework)** **How consistently is the program or policy delivered? How will it be adapted? How much will it cost? Why will the results come about?**				
Fidelity of staff training			✓	
Fidelity of intervention delivery			✓	
Adaptations			✓	
Implementation Cost				✓

Dimensions/ Variables Description	Implementation Stage (Time Period)			
Understanding Implementation • Acceptability • Appropriateness • Feasibility • Barriers and Enablers				✓
Maintenance **(RE-AIM Framework)** **When will the initiative become operational; how long will it be sustained (setting level); and how long are the results sustained (individual level)?**				
Institutionalization: long- term adoption of SurgeCon				✓
Cost of maintaining the intervention				✓
Sustainability - Barriers and Enablers			✓	✓
Scalability **(CFIR Framework)**				
Intervention Characteristics (e.g. stakeholders' perception, complexity of intervention)		✓	✓	
Outer Setting (health system policy, patients' needs)	✓	✓	✓	✓
Inner Setting (resources, leadership)	✓	✓	✓	✓
Characteristics of Individuals Involved (knowledge, attitude)		✓	✓	✓
Process of Implementation (planning, training)		✓	✓	

Stage 1: Exploration (Site assessment)

The working group will complete five activities during the exploration phase including: delivering a virtual presentation to inform ED staff (paramedics, nurses, and physicians) and management of upcoming operational changes; observing the ED's physical layout to make improvements necessary for the implementation; recording the clinical and a demographic characteristics of EDs and patients, collect information related to the ED's organizational and workflow structures; conducting patient telephone interviews to capture their live experiences and feedbacks; and conducting semi-structured interviews to

clarify barriers and key performance issues. Since there is a high degree of variability that exists between EDs, the information collected during the site assessment allows for the customization of SurgeCon's underlying protocols and determines whether certain components of the intervention are appropriate or applicable for implementation. Information collected during the site assessment will allow the SurgeCon Implementation Working Group to tailor components of the intervention to address site specific needs (see Table 3).

Table 3
Description of activities during the exploration phase

Activity	Objective	Target groups (ED, Staff, Patients, patient advisors)	Measurement tool and method	Outcome of interest
1. Deliver a presentation	Prepare staff for upcoming changes	ED staff	Virtual presentation	Improved understanding of SurgeCon and obtaining the highest level of support possible.
2. Observing the ED's physical layout	To gain insight into the best next steps to improve layout and gain the greatest efficiency	ED	Qualitative Observational Method/site assessment checklist	Improved area of operations
3- Recording the clinical and demographic characteristics of hospitals and patients	To assess ED's organizational and workflow structures	ED	Site assessment checklist	Understanding ED characteristics
4-Conducting patient-reported experiences and Patient Satisfaction telephone interviews	To consult with patients, get feedback from them, study their lived-experiences	ED patients	Patient-reported experiences and patient Satisfaction survey	Develop strategies to overcome the challenges of poor patient satisfaction
5-Conducting interview about barriers and enablers to Reach	To study the organizational climate of the ED before the intervention and consult with ED staff to gauge interest in implementing a new ED management system.	ED staff	Semi-structured interview	Resolve potential contextual barriers to successful implementation

Stage2: Adoption (SurgeCon Installation)

During the adoption stage, the working group will complete eight activities, which will be initiated by the SurgeCon initialization across the four study sites in a stepwise manner to help ED staff (paramedics, nurses and physicians) manage their actions to actively reduce patient surges and wait times and increase patients' access to emergency medical care. To test SurgeCon's digital whiteboard application, we will validate information extracted from the platform's data repository and analyze end user feedback to help inform iterative software updates. SurgeCon staff training will occur during this stage, while additional training and support will be made available to all sites throughout the study period. The installation of hardware and software assets for the intervention's e-Health component as well as training will be carried out a month in advance of the adoption phase start date. We also plan to post department level data in a prominent area of the ED monthly (depending on the discretion of the sites) and also circulate individual provider key performance indicator (KPI) data anonymously. This will give physicians and also individual nurse practitioners the opportunity to know their monthly physician's initial assessment (PIA) times compared to the ED average and targets set by ED management. Providing this data may increase physician motivation to use components of SurgeCon flow education since it will demonstrate the intervention's capacity to reduce their door-to-doctor time – a key metric for health standards of care. At this stage, the SurgeCon facilitator who will assist local ED teams with the development of clear roles, goals, and communication strategies. The Facilitator will review SurgeCon process improvement activities, usage of the whiteboard application, and adherence to the protocol. Local champions who are leading internal change initiatives along with members of the Implementation Working Group will help prepare EDs for the Active Implementation stage of the study. Improving the overall appearance of physical spaces in the ED (e.g., waiting room, fast-track zone, examination rooms, treatment space, etc.) to improve patient satisfaction is another goal in this stage. In consultation with our local patient partners, we will renovate, redecorate, and declutter ED spaces (see Table 4).

Table 4: Description of activities during the adoption phase

Activity	Objective	Target (ED, Staff, Patients, patient advisors)	Measurement tool and method	Outcome of interest
1- Installing SurgeCon's digital whiteboard application	To advise when to use volume-based staffing (shifting staff between areas of the hospital based on workload), appropriate and timely involvement of hospital management, and overcapacity protocols, which may otherwise be overlooked by distracted frontline ED staff.	ED	Protocol-driven software platform	Online Illustration of ED organization and wait time
2- Data collection	To enhance the platform and update ED staff	ED	SurgeCon platform and ED secondary data	Enhancing ED functioning
3-Training frontline SurgeCon Champions	To provide ongoing learning related to using the new system and the successful uptake and adoption of SurgeCon	ED staff	Participant observation	Solving practical or technical issues with using SurgeCon
4- Staff Training	To encourage ED staff to become active participants in the	ED staff	Interactive Simulation Course[11], SurgeCon eHealth Platform Training[12], and	Facilitating the implementation of quality improvement

	improvement process		Patient Centeredness Training[13]	
5- Site Assessment	To determine whether the site is capable of implementing the platform as intended given the level of resources and staff commitment	ED staff	Champion observation and site coordinator reports	Assisting ED staff in development of SurgeCon
6- Establishing a Patient-Centric ED Environment	To improve the overall appearance of physical spaces in the ED	ED	Patient advisors' observation and Site assessment checklist	To improve patient satisfaction
7-Conducting patient-reported experiences and Patient Satisfaction telephone interviews	To consult with patients, get feedback from them, study their lived-experiences	ED patients	Patient-reported experiences and patient Satisfaction survey	Develop strategies to overcome the challenges of poor patient satisfaction
8-Conducting interviews about barriers and enablers	To study the organizational climate of the ED before the intervention and consult with ED staff to gauge interest in implementing a new ED management system.	ED staff	Semi-structured interviews	Resolving potential contextual barriers to successful implementation

Stage 3: Active Implementation (SurgeCon monitoring and evaluation)

During the implementation phase, five activities will be completed to evaluate the intervention and to determine whether implementation efforts made are sufficient to overcome barriers to a successful

implementation of the intervention and produce improved outcomes. This includes fidelity of intervention (i.e., the degree to which the intervention was implemented as intended) and fidelity of training. Furthermore, we will examine contextual constructs and factors influence the intervention. For instance, mediators (factors that increase the intervention's effectiveness in terms of producing positive outcomes), moderators (factors that influence the degree of change in targeted outcomes), and underlying mechanisms that lead to sustained organizational changes at all levels of EH's organization [31, 32]. The ultimate goal is to culturally embed SurgeCon in each ED if it can produce consistently positive results. Adaptations will also be made to the intervention by the research team during the study period. This process will identify intervention components and implementation methods that produce the best response in staff and management in terms of intervention acceptability, commitment to change, and improved performance. Local ED teams and champions will work closely with the research team to ensure all parts of the intervention are applied as intended and evaluated appropriately. We will outline the parameters of operational processes developed during the adoption stage of the implementation plan (see Table 5).

Table 5
Description of activities during the active implementation phase

Activity	Objective	Target (ED, Staff, Patients, patient advisors)	Measurement tool and method	Outcome of interest
1-Measuring fidelity of training	To determine if the staff are trained to a well-defined performance criteria	ED staff	Training evaluation survey	Trained/Competent staff
2- Measuring fidelity of intervention delivery	To determine if the sites have implemented SurgeCon as intended	ED	Software platform and champion participant observation	Successful implementation
3- Examining contextual constructs and factors	To identify and describe the context in which the intervention occurs and the factors that influence implementation.	ED staff	Champion observation, Site coordinator report	Understanding contextual constructs and factors to develop a plan for overcoming the challenges and ensuring successful implementation
4-Conducting patient-reported experiences and Patient Satisfaction telephone interviews	To consult with patients, get feedback from them, study their lived-experiences	ED patients	Patient-reported experiences and patient Satisfaction survey	Develop strategies to overcome the challenges of poor patient satisfaction
5-Conducting interview about barriers and enablers	To study organizational climate of ED before, during and after the intervention and consult with ED staff to gauge interest in newly implemented ED management system.	ED staff	Semi-structured interview	Resolving potential contextual barriers to successful implementation

Stage 4: Sustainment (SurgeCon maintenance and sustainability)

During the sustainment phase, the extent to which SurgeCon has become institutionalized or part of routine ED practices and policies will be examined through five activities. We will measure (1) Institutionalisation: the long-term adoption of SurgeCon including if all elements of the intervention (e.g., the action-based protocol) and its implementation strategies (e.g., champions) were retained and changed from the pilot study in Carbonear, (2) Feasibility: the extent to which the intervention can be carried out in other ED departments besides Carbonear, and (3) Cost of maintaining the intervention (e.g., system updates, staff training, etc.) and maintaining the restructured ED and its patient-centred environment. Also, the perceived

barriers and enablers of Regional Health Authorities (RHA) managers and ED staff to the set-up and use of the SurgeCon intervention will be assessed. This will include an assessment of the different procedural components (e.g., site assessment) of SurgeCon, the day-to-day use of the different elements of SurgeCon (e.g., fast track zone, interaction with the technology and software), and the education, training, champion, and feedback strategies to determine if they were perceived to be enablers to implementation. We will use the CFIR guidelines to underpin the interview guides. We will create analytic matrices to conduct a cross-case analysis for identifying patterns of barriers and enablers and develop a collaborative approach to maintain and refine the platform over time to scale up. Additionally, to improve SurgeCon's sustainability, all participating EDs will meet quarterly by teleconference, sharing ED team success stories, and identifying barriers to implementation, as well as approaches used to mitigate negative outcomes. They will prepare a one-page summary for the SurgeCon Executive Committee which will include the following: how ED teams plan to maintain SurgeCon's use and operation, how to improve ED staff capacity and skills required to properly use the SurgeCon platform, and how SurgeCon can be better adapted to address general and site-specific needs. Furthermore, at this stage, it is important to identify individuals in leadership roles at both the system and hospital levels who can help drive SurgeCon's process improvement initiatives beyond this study (see Table 6).

Table 6
Description of activities during sustainability phase

Activity	Objective	Target (ED, Staff, Patients, patient advisors)	Measurement tool and method	Outcome of interest
1-Assessing scalability of SurgeCon	To identify the extent to which the intervention can be maintained and carried out in other ED departments	ED	RE-AIM scoring and CIFR instrument	Scalable SurgeCon Platform
2-Measuring the cost of implementing the intervention	To measure the cost of maintaining the intervention (e.g. system updates, staff training, etc.) and maintaining the restructured ED and its patient-centred environment	ED	Economic analysis	Cost of implementation
3- Assessing feasibility of maintaining SurgeCon	To identify the issues raised and their relevance to maintaining the intervention	ED	RE-AIM scoring instrument, champion observation, and site coordinator report	Making changes or resolving challenges as a result of intervention
4-Conducting patient-reported experiences and Patient Satisfaction telephone interviews	To consult with patients, get feedback from them, study their lived-experiences	ED patients	Patient-reported experiences and patient Satisfaction survey	Develop strategies to overcome the challenges of poor patient satisfaction
5-Conducting interviews about barriers and enablers to institutionalization	To study organizational climate of ED after the intervention implementation	ED staff	Semi-structured interview	Resolving potential contextual barriers to successful maintenance

[9] The Carbonear ED was excluded since it was the pilot site of the intervention and the Janeway Children's hospital ED was excluded since it only provides care to children and adolescents and did not have excessive wait times.

[11] Interactive Simulation Course. This module focuses on an ED improvement flow sustainability strategy. The aim will be to provide information on the rationale underpinning SurgeCon and how it works in the practice setting using case-based scenarios. It will be interactive allowing for questions and answers and ensuring the learning outcomes are achieved.

[12] This module will help ED staff: (1) become familiar with the digital whiteboard application, (2) learn how the system collects and reports information, (3) learn how to interpret system generated notices and

warnings, (4) assign protocol tasks, and (5) learn effective response strategies to system notices and warnings.
[13] This module includes an educational session which reinforces the following topics: (1) providing quality ED care to all patients regardless of urgency, (2) treating all patients with respect, and (3) demonstrating that the patient's visit to an ED must always be considered necessary as they may have no other option.

Discussion

This study provides important insights into the effectiveness of implementation and evaluation techniques to enhance the uptake of an ED management program. The SurgeCon protocol will be a valuable guide for healthcare professionals and organizations that aim to design, plan, implement and evaluate interventions within complex healthcare settings.

It is important to consider that when applying innovations and interventions that aim to produce effective, sustainable, and enduring changes through the modification and improvement of clinical practices, organization of care, and cooperation among the implementation team, various barriers are encountered (e.g., barriers at the patient, provider, departmental, and institutional levels) [33]. This is due in part to the chaotic environment and complex setting of EDs (e.g., wait times, overcrowding, various healthcare professional team members, competing priorities among the staff, budget restrictions, staff turnover, etc.) [34]. This affirms the significance of carrying out this intervention with comprehensive actionable implementation and evaluation guidelines that translate research into practice and can be followed by researchers in their future implementation and intervention activities.

Additionally, various frameworks have been developed to facilitate the implementation planning process, and this study sought to utilize the RE-AIM and the CFIR frameworks for quality improvement within EDs to reduce wait times. This combination provides the researchers the opportunity to capture and address a "taxonomy of contextual" factors and processes (e.g., inner and outer setting) behind the results of five key dimensions of an intervention to facilitate data collection and analysis [20, 35].

Furthermore, using qualitative methods allows us to comprehensively address all RE-AIM dimensions and compare factors that are essential to the success or failure of the implementation that otherwise could not feasibly be captured. Applying the qualitative method also provides various opportunities for the participants to fully engage in all stages of implementation and evaluation of the intervention. This leads to a team-based approach that not only involves the multi-disciplinary team and relevant stakeholders (e.g., nurses, physicians, administers, etc.) in planning, implementing, and evaluating the intervention program, but also patients, who are provided with different opportunities (e.g., surveys, interviews, etc.) to engage with the team. Additionally, by involving four different hospitals of varying sizes and locations, this program aims to gain as much rich information as possible concerning the implementation challenges across different contexts.

Finally, one of the goals of the SurgeCon project are knowledge translation and transforming ED practice into an improved, more efficient system. Our partnership with the largest health authority in our province (EH) provides opportunities in both rural and urban ED environments for implementing our findings.

Abbreviations

ED: Emergency Department

RE-AIM: Reach, Effectiveness, Adoption, Implementation, and Maintenance

CFIR: Consolidated Framework for Implementation Research

NL: Newfoundland and Labrador

ICT: Innovative clinical Trial

GT: Grounded Theory

EH: Eastern Health

RHA: Regional Health Authority

PIA: Physician's Initial Assessment

KPI: Key Performance Indicator

Declarations

Ethics approval and consent participants

Ethical approval for the SurgeCon study was granted on March 19, 2020 by the Newfoundland and Labrador Health Research Ethics Board. Ethics approval will be renewed annually until the end of the study.

This study includes consent forms for patients and healthcare staff participating in the study.

HREB Reference #: 2019.264

Consent for publication

"Not applicable"

Availability of data and materials

"Not applicable"

Competing interest

"The authors declare that they have no competing interests"

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Among the funding agencies providing financial support, only Eastern Health is assisting with the collection of data. The design of the study, analysis, interpretation of data and manuscript preparation is/will be completed independently by the research team.

Author’s contributions

NRA, JJ, OH, HM, CY, PN, ChP, BW, HE, DS, ShA have made substantial contributions to the conception; design of the work; the creation of new software used in the work; drafting the work, and substantively revising it. All authors read and approved the final manuscript.

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