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Benefits and Limitations of Business Process Model Notation in Modelling Patient Healthcare Trajectory: A Scoping Review Protocol

Running title: Modelling Patient Healthcare Trajectory using BPMN

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Abstract

Introduction: The adoption of business process model notation (BPMN) in modelling healthcare trajectory can enhance the efficiency and efficacy of healthcare organizations and ultimately improve patient outcomes while restraining costs. However, existing systematic reviews have been inconclusive regarding the effectiveness of BPMN in modelling healthcare trajectory. The aims of this scoping review are to map and aggregate existing evidence on the main benefits and limitations associated with BPMN in healthcare trajectory and highlight areas of improvement on using BPMN and its extensions in healthcare practices.

Methods and Analysis: The proposed scoping review will be performed in accordance with the methodological framework suggested by Arksey and O'Malley and further refined by Levac et al. A wide range of electronic databases and grey literature sources will be systematically searched using predefined keywords. The review will include any study design with a focus on the application of the BPMN approach applied for optimizing healthcare trajectories (e.g., diagnostic, and therapeutic processes, decision making, cost, and resources), published in either English or French from 2004 onwards. Two reviewers will independently screen titles, abstracts, and full-text articles and select studies meeting the inclusion criteria. A customised data extraction form will be used to extract data from the included studies. The results will be presented in tabular format developed iteratively by the research team.

Ethics and dissemination: Research ethics approval is not required as exclusively secondary data will be used. Review findings will be used to advance understanding about BPMN, its extensions, and its application in healthcare trajectory optimization. The review will develop recommendations about how to tailor BPMN strategies at optimising care pathways and decision-making processes. Our findings will be disseminated in peer-reviewed journals and presentations and through discussions with relevant organizations and stakeholders.

Keywords: Healthcare trajectory**,** healthcare management, business process modelling notation, healthcare processes, care pathways, scoping review

Strengths and limitations of this study

- This scoping review will provide a deeper understanding of how BPMN interventions improve organisational practices, clinical practices, and patient outcomes in healthcare organisations.
- The study will provide a synthesis of the existing evidence about how to implement BPMN consistently and effectively in care processes.
- Findings from this review will be used to elaborate recommendations about how to tailor BPMN interventions in healthcare trajectory optimisation.
- The quality appraisal of publications captured will not be assessed, as it is beyond the aim of a scoping review.
- Both peer-reviewed and grey literature will be considered to ensure a comprehensive coverage, but studies will be limited to those published in French and English.

INTRODUCTION

With the continuous challenges facing healthcare organisations in the past few years [1-3], many strategies have focused on process improvements with the objective of enhancing efficiency and efficacy to improve patient outcomes while controlling costs[4,5]. Through the years, health expenditure and financing has increased substantially in developed countries such as the United States (US) and Canada[6-9]. In 2019, Canada spent 10.8% of its gross domestic product on healthcare expenses according to the Organization for Economic Cooperation and Development (OECD, 2021)[9]. This ratio reached 17.7% at the same time in the US, where the national health spending is projected to reach $6.2 trillion by 2028, growing at an average annual rate of 5.4%[8,9]. However, compared with other OECD countries, the US perform poorly on process, outcome, and patient experience metrics, as well as life expectancy[10,11]. Life expectancy in the US was the lowest at 78.8 years compared with a range from 80.7 to 83.9 years for other OECD countries[10]. The infant mortality rate in the US was 5.8 per 1000 live births and the maternal mortality rate was 17.4 per 100 000 births in 2018, both higher than the mean rates for any OECD country[11-15]. Canada is another developed country performing poorly in terms of infant and maternal mortality, with 4.7 fatalities out of every 1,000 live births and 10.2 maternal deaths per 100 000 births[11,16].

The lack of control in processes used to deliver medical care is clearly a major problem in the context of preventable medical errors with lethal damages and high economic costs in many hospitals[17-19]. Since the released Crossing the Quality Chasm[20,21] by the Institute of Medicine (US), numerous national and international organizations including the Academies of Sciences[22]and the World Health Organization[23,24] have made repeated calls to develop a framework for advancing the quality of care, ensuring that care is safe, effective, efficient, patient-centred, timely, and equitable[20]. To do this, healthcare organizations and systems must develop solutions that enhance both efficiency and efficacy of improving healthcare organization and patient outcomes while restraining costs. Efforts to improve clinical and care pathways have shown such benefits[25-27]. Over the last decades, studies have revealed that mapping healthcare trajectories allowed to decrease the variation of professional practices and to standardise care processes[17-19]. This practice has many benefits such as improving the accessibility, fluidity, quality, performance, and sustainability of healthcare services[25,28].

In this context, several tools have been developed to support process improvement through process mapping. Among these methods, business process modelling notation (BPMN) is an approach that consists of representing processes as a network of activities and tasks[29-31]. This structured approach supported by the Object Management Group since 2005 and adopted as an

international standard by the International Organization for Standardization since 2012, is in its second version (BPMN 2.0) [30-32].

In recent years, a few reviews [33-36]have been conducted to analyse whether the BPMN approach can become a useful tool to improve the effectiveness and quality of healthcare processes. For instance, Loya et al.[33] used a service-oriented architecture in clinical decision support and provided evidence that BPMN was not commonly used for clinical decision support systems, despite being the preferred standard for business process modelling in healthcare. Mincarone et al.[34] demonstrated that BPMN provides a good level of formalisation, a standardised communication framework between multiple stakeholders, good user comprehensibility, and easier interprofessional analyses. Fernández et al.[35]suggested that BPMN is useful for standardising processes that have some variability due to its possibility to incorporate variations or changes. Moreover, Zarour et al.[36] analysed various BPMN extensions (e.g., decision modelling notation) that can be used to improve its efficiency in many domains, showing that healthcare was among the most targeted area. The overall conclusion of these reviews [33-36]is that BPMN seems to be increasingly used in healthcare organizations to the point of becoming a standard in process improvement methods. However, these studies[33-36] acknowledged the difficulties and challenges when implementing BPMN in the health sector. Indeed, a limitation of these studies[33-36] is that none of them put the use of BPMN to improve healthcare trajectories or patient care trajectory as its primary focus. Loya et al.[33] focused on the use of BPMN for supporting clinical decisions and stated that BPMN has potential to optimise clinical pathways, but they did not assess this possibility. The papers of Mincarone et al.[34] and Fernández et al.[35] mainly focused on clinical processes, briefly addressing healthcare trajectories, resulting in a shallow analysis on this subject. Finally, Zarour et al.[36] targeted many BPMN extensions that could improve its effectiveness, but their research was not exclusive to healthcare setting.

Our literature review builds on these previous reviews[33-36] by providing an in-depth analysis of the ability of BPMN to effectively improve the quality of clinical practices, the security, and the fluidity of the care process and to propose tangible results on the patient experience in a patient-centred care and services logic. Moreover, we will analyse the opportunities and limitations related to the integration of BPMN extension.

Considering the above gaps in the literature, the primary aim of this scoping review is to identify and map existing evidence on the main benefits and limitations associated with the use of BPMN in healthcare trajectory modelling. To do so, we will assess its ability to model key dimensions or concepts of the healthcare process and to meet the needs of stakeholders. The

review will also highlight the capacity of the BPMN approach and its extensions to support clinical activities and decision-making processes associated with the healthcare trajectory and propose a conceptual framework for improving the use of BPMN in healthcare practices.

METHODS AND ANALYSIS

We chose to undertake a scoping review as the best method to map the available evidence regarding the benefits and limitations of BPMN in modelling patient healthcare trajectory[37-39]. The present review will be conducted following the methodological frameworks described by Arksey and O'Malley[37], and improved by Levac et al.[38], and further refined by the Joanna Briggs Institute (JBI)[40]. The standardized methodology included six stages for scoping review: (1) Identifying the research question, (2) Identifying relevant studies and grey literature, (3) Selecting studies, (4) Charting the data, (5) Collating, summarizing, and reporting the data, and (6) Consulting with relevant stakeholders, thereby enabling knowledge translation. The Preferred Reporting Items for Systematic Reviews and Meta-Analysis Extension for Scoping Reviews (PRISMA-ScR)[39,41] has also been used to guide the reporting of this protocol and will also subsequently be used to structure the reporting of the full review. Furthermore, we will take an iterative and reflexive approach throughout the review process, particularly to refine our study selection and data extraction steps to the best target meeting our objective. This protocol is registered through the Open Science Framework[42].

Stage 1: Identifying the Research Question

As the focus of scoping reviews is on summarizing the breadth of evidence, the research questions should be broad while keeping in mind the review's main purpose[37,38,40,41]. Thus, we started with, ″What is known about the application of BPMN methodology in healthcare organization?″ A preliminary search was conducted through some electronic databases including International Prospective Register of Systematic Reviews, JBI Database of Systematic Reviews and Implementation Reports, Cochrane Database of Systematic Reviews, and National Center for Biotechnology Information, which revealed three systematic reviews of modelling healthcare processes using the BPMN methodology[33-36]. Although findings from these reviews[33-36] supported the use of BPMN as an effective methodology to optimise healthcare processes, no conclusion on the effectiveness were drawn. The reason may be that these reviews[33-36] were not mainly focused on the use of BPMN to improve healthcare trajectories.

In addition, we adopted the JBI's Population Concept and Context (PCC) framework[40] to formulate the objectives and research questions, and to conceptualise the study and report

characteristics in terms of eligibility criteria (**Table 1**). We then consulted with experienced colleagues[30] on our predefined set of questions to provide further input and feedback.

In line with our purpose to comprehensively map the extent, range and nature of evidence examining the use or application of BPMN within the healthcare trajectory, we formulated four specific research questions to guide this review.

1. What are the objectives for using BPMN in healthcare organization? What are the expected results and what are the needs to be met?
2. What are the key variables, elements, concepts, and dimensions targeted by the BPMN approach?
3. Can the BPMN approach meet these expectations in healthcare trajectory? Specifically,
   a. What are the strengths (advantages) and weaknesses (limitations) of the BPMN in modelling healthcare trajectory?
   b. What are the effectiveness of using BPMN approach and its extensions in modelling healthcare trajectory?
   c. What are their opportunities and constraints in modelling healthcare processes?
4. What are the improvements or alternatives proposed to optimizing healthcare trajectory?

For the purposes of this review, the term healthcare trajectory focuses on the patient's care pathway across the continuum of care. Thus, it can be the clinical pathway when it focuses on the organizational scale, but also the care pathway when it focuses on the systemic scale. It consists first of the patient's journey through the sequencing of tasks and activities at all points of contact[43,44]. It then integrates the professional actors involved in the care trajectory,[45,46] the operation management of care delivery processes[47,48], the coordination structures[49-51], the structural context of the system and organizations[52,53] as well as the information trajectory along the healthcare trajectory[54,55]. Thus, our understanding of the term healthcare trajectory is not limited to the operational aspect of the care process and to the pathophysiological process of a patient's disease state, but also refers to the organisation of all activities surrounding interactions between health care workers and patients, as well as the effectiveness of patient care processes and their effectiveness.

Therefore, our analysis will consider not only the operational outcomes of the application BPMN, but also its societal impact by assessing its potential to improve patient outcomes and experience. In addition, healthcare process mapping includes several different flows. On one hand, the main process follows the patient's journey through the process steps and the decision points guide the patient through the process[56]. On the other hand, the support processes and secondary flows include steps directly or indirectly linked to the main process such as

administrative processes, information flow, organizational processes, and examinations that do not require the presence of the patient (e.g., laboratory results, pathological tests). Thus, several flows can be present and impact the care process (e.g., information flow, drug flow, blood flow,).

Therefore, this scoping review will focus on the potential of the BPMN and all its components to impact the results of healthcare trajectories directly or indirectly. Finally, the review will also consider proposals for extensions to BPMN have been put forward to integrate evidence-based medicine and guidelines to support clinical decision making, including the Decision Modelling Notation proposed by both the Object Management Group[56,57] and the Computer Interpretable Guidelines[58,59].

Table 1: PCC framework[40] for illustrating the scope and defining inclusion and exclusion criteria of the review

	Inclusion	Exclusion
Population	Participants of interest are the healthcare stakeholders (knowledge users) involved directly or indirectly with the use of BPMN during the healthcare trajectory or clinical process. The healthcare stakeholders (knowledge users) will include patients, healthcare professionals (e.g., nurses, physicians, other professionals), administrators and decision-makers who were involved at least once in the healthcare trajectory or clinical processes (clinical or care pathways).	Literature that does not apply BPMN in health trajectory (e.g., healthcare process, clinical process, process of care, patient care process, healthcare trajectory, clinical pathways, patient care management). Since we are interested in the efficacy and limitations of BPMN in healthcare trajectory, this needs to be evidence-based (analyse a case clinical pathway) and not speculative.
Concept	The concept is the application of BPMN in healthcare trajectory and/or clinical processes to evaluate the capacity of BPMN to optimise healthcare performance. Studies that reported any healthcare intervention and/or clinical processes modelling with BPMN, including the improvement of the quality assessment and decision-making processes, the capacity to understand the internal clinical procedures, the ability to communicate those procedures in a standard manner, the ability to adjust to new internal challenges quickly and patients' outcomes will be included.	
Context	The context for this review will consider studies conducted in any clinical setting (e.g., inpatient, outpatient) or healthcare settings (e.g., hospitals, health centres, nursing homes). Studies conducted in any part of the world are eligible to be included in this review	Literature related to BPMN occurring outside of healthcare trajectory (e.g., clinical process, process of care, patient care process, patient trajectory, clinical pathways, patient care management)
Types of evidence	Reviews (e.g., systematic, or narrative reviews), peer-reviewed research articles, full-text articles are specific to modelling patient care trajectory incorporate the use of BPMN as a methodological approach and published in either English or French.	Studies published before 2004, not written in either English or French. Editorial articles, abstracts or posters, protocols for planned studies, strategy, or guidelines. Articles where full text is unavailable. Study do not indicate the use of BPMN as a methodological approach. Study focuses on other healthcare elements, such as professional development and performance management but not specifically on patient care trajectory.

Stage 2: Identifying Relevant Studies

A comprehensive search strategy was developed with the assistance of an experienced health sciences librarian (FB). The search strategy will follow the three-step approach recommended by JBI scoping review guidelines[40] and will target the retrieval of both published and unpublished articles from electronic searches databases, focusing to BPMN modelling of patient care trajectory. The first step of the scoping review guidelines has been completed in preparation of this protocol (**Table 1**), which involved an initial limited search on PubMed and ABI/Inform (ProQuest) databases, using the following selected keywords: "Healthcare Process" OR "Clinical Process " OR "Process of Care" OR "Clinical Pathways" OR "Patient care Process" OR "Healthcare trajectory" OR Patient Care Management" OR "Critical Pathways" OR "Clinical Healthcare Pathways" AND "Business Process Model" OR "Business Process Modelling Notation" OR "Business Process Model" OR "BPMN modelling" OR "Workflow" OR "Clinical Decision-Making" OR "Decision Support Systems" OR "Medical Process". The index words and the text words in the title and abstract of retrieved articles were analysed to identify search terms and refine the search strategy for the next step.

In the second step, the search strategy will be adapted and implemented for each included information source (PubMed, Embase (Embase.com), CINAHL(EBSCO), Web of Science, ABI/Inform (ProQuest), Academic Search Premier (EBSCO), and Google Scholar) for potential eligible studies published in either English or French language, from 2004, year when BPMN was initially developed by the Business Process Management Institute. In addition to the electronic database search, we will undertake a hand search of some relevant journals (e.g., Institute of Electrical and Electronics Engineers, Health Informatics Journal), search citations of relevant papers and scan the reference lists of relevant papers. The final search results will be exported to the Covidence systematic review software[60,61] where duplicates will be removed. The full detailed search strategy for peer review and grey literature sources is included in **online Supplementary Appendix I**.

Stage 3: Selecting Literature for Inclusion

All retrieved articles will undertake two levels of screening. First, two reviewers (KSA and JBG or LL) will independently screen titles and abstracts of each article against the established inclusion and exclusion criteria (**Table 1**). To increase the reliability of screening by the two reviewers (KSA and JBG or LL), a pilot test will be conducted on 50 titles and abstracts to evaluate reviewer agreement in the screening process. Discrepancies will be resolved through discussion between the two reviewers and where agreement could not be reached, a third reviewer (PL, CP, CL, or AC) will be consulted. Adjustments may also be made to the inclusion

criteria if necessary to ensure consistent interpretation and application of the criteria. The researchers will discuss their selection of articles after this first round of screening, to arrive at preliminary consensus on the list of eligible studies. In the second step, the two reviewers will screen the full-text articles independently to determine if they meet the inclusion criteria. Reasons for the exclusion of full-text articles will be noted in Covidence[61] by each reviewer. Reviewers will again discuss their selection of articles after this second round of screening, to arrive at a final list of eligible studies. Discrepancies will again be resolved through discussion between the two reviewers and where agreement could not be reached, a third reviewer will be consulted. The screening process will be documented using a PRISMA flowchart for scoping review[39,41] and by calculating the inter-rater reliability between reviewers using the Cohen's Kappa coefficient[62].

Stage 4: Charting of Information and Data

Data will be extracted from every eligible article using a data extraction chart (**Charting Table**) tailored to the research questions. Its aim is to maintain a manageable amount of data, while ensuring a wide approach and breadth of coverage to obtain existing evidence on the benefits and limitations associated with BPMN in patient care trajectory. Two researchers (KSA and JBG or LL) will independently extract the following study information: authorship, year of publication, country of origin, study purpose, patient care trajectory issues being addressed (e.g., diabetes, chronic obstructive pulmonary disease, coronary heart disease, clinical pathways for contraception), study population/target users (e.g., physicians, clinicians, nurses, pharmacists), setting/location of intervention (e.g., primary care, acute care, rehabilitation, home care, long-term care, community, hospital), methodological approach (qualitative, quantitative, or mixed study), expected results study findings (e.g., decreasing diagnostic delay, optimizing of quality care, cost, reducing medical errors, standardising the decision-making process), type of outcomes/dimension analysed (e.g., diagnostic times, waiting time for surgery, flexibility, improving key performance indicators, decision support systems).We will note the objectives and benefits, as well the limitations of using BPMN and BPMN-extension approach. The proposed Charting Table is shown in **online Supplementary Appendix II**. It will be trialled on five included studies and will be iteratively refined. Adjustments or expansions may also be made to the **Charting Table** if necessary to ensure that the research objectives or questions are well addressed. For instance, we may add additional categories of data deemed relevant to answer the research questions to the Charting Table.

Stage 5: Collating, Summarizing, and Reporting the Data

The main findings of the included studies will be summarised in Tabular format in a manner that reflects the objectives of the review. Following the PCC principles[40], a narrative summary will accompany the Tabular results and link the different findings to the review objective and questions and will identify any knowledge gaps in the literature. To ensure rigour in this stage, two reviewers (KSA and JBG or LL) will prepare a descriptive summary table of the extracted data and will highlight the key findings with input from the research team. The table will include a descriptive summary of the studies and a qualitative thematic analysis of the main results regarding characteristics of the BPMN approach used in each study (e.g., objective, benefit, challenges, target users, redesign the clinical process), type of patient trajectory, characteristics of the research designs, outcomes of interest used to measure the effectiveness of BPMN (e.g., reducing work time, and challenges and potential solutions learned). We will identify barriers or limitations of BPMN for achieving improvement of healthcare processes, support activities and decision-making processes, and use that information to address our main objectives. The consultation stage of the scoping review, described in the following section, will contribute to fulfilling that objective and to establish a conceptual framework for improving the use of BPMN in healthcare trajectory modelling. Finally, if the extracted data allow it, a qualitative analysis will be conducted to discuss or nuance the evidence of BPMN effectiveness considering potential barriers and enablers identified by the authors. We will use the PRISMA-ScR to guide the final reporting of our results.

Stage 6: Consultation with Stakeholders

The final consultation stage offers an ideal mechanism to enhance the validity of the study outcome while translating findings with the stakeholders or health professionals. Preliminary findings from this review will provide the background for workshop with the research team and stakeholders/knowledge users (e.g., healthcare professionals, patients, decision-makers, administrators). The objectives of the workshop are to present and discuss the interim results of the synthesis. The meeting will generate a list of key practice recommendations, dissemination strategy and research priority areas to inform future research. The workshop will be conducted with the research team with a focus on reviewing the results following feedback from the previous meeting, reviewing the final report, necessary modifications to findings and recommendations for precision and clarity. These consultations with all stakeholders, including clinicians, technicians, and patients, aim to materialise the findings of this review by discussing their applications in specific contexts.

ETHICS AND DISSEMINATION

This scoping review is exempt from ethics approval because the work carried out will be based on published documents. The aim of this project is to synthesise the literature about healthcare trajectory using BPMN approach to enhance conceptual clarity and understanding about key benefits and limitations and to extrapolate from this evidence base promising conceptual framework for improving the use of BPMN in healthcare trajectory. We anticipate the research will provide several key outputs including (1) a comprehensive review that will summarize existing literature on the BPMN approach; (2) an evidence base demonstrating the benefits and limitation of the BPMN approach in modelling patient trajectory; (3) a list of BPMN extensions that can be used to improve its efficiency in many domains; (4) a conceptual framework. Our findings will be disseminated in peer-reviewed journals and presentations and through discussions with relevant organisations and stakeholders. Our goal will be to disseminate our findings to a wide range of clinicians, leaders, and administrators in all sectors, to researchers and to students entering the healthcare professions to enhance understanding about key benefits and limitations of BPMN approach for optimising the patient trajectory. We believe the results will benefit clinicians by guiding their decision-making throughout the patient's trajectory, therefore reducing the medical error rate, optimising efficient resource management, and reducing the risks of complications due to poor clinical decisions. Those improvements should result in an optimisation of cost-efficiency for organisations and quality of care for patients.

Contributors: KSA, JBG and AC led the design, search strategy and conceptualisation of this work and drafted the protocol. PL, FB, and CP were involved in the conceptualisation of the review design, inclusion and exclusion criteria and provided feedback on the methodology and the manuscript. KSA and LL were involved in data extraction forms. All authors provided feedback on the manuscript and approval to the publishing of this protocol manuscript**.**

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Supplementary materials – Databases search strategy

Medline (Ovid)

Date of the search: 09-12-2021
Database limit: No database limit has been apply

#	Search strategy	Results
1	("Business Process*" adj1 (Model* OR Method? OR management)).ti,ab,kw,kf OR "Decision Model* notation".ti,ab,kw,kf OR BPMN*.ti,ab,kw,kf OR BPM.ti,kw,kf	285
2	Critical Pathways/ OR Practice Guidelines as Topic/ OR Workflow/ OR Clinical Decision-Making/ OR Decision Support Systems, Clinical/ OR Patient Care Management/	163743
3	(Decision adj1 (making OR support)).ti,ab,kw OR ((clinical OR medical OR healthcare OR "health care") adj2 process*).ti,ab,kw OR ((healthcare OR clinical OR critical OR care) adj2 path*).ti,ab,kw OR guideline*.ti,ab,kw OR Workflow*.ti,ab,kw OR careflow*.ti,ab,kw OR "patient journey".ti,ab,kw	686144
4	2 or 3	769504
5	1 and 4	99
6	limit 5 to ed=20040101-20211209	85

Embase (Embase.com)

Date of the search: 09-12-2021
Database limit: No database limit has been apply

#	Search strategy	Results
1	("Business Process*" NEAR/1 (Model* OR Method$ OR management)):ti,ab,kw OR "Decision Model* notation":ti,ab,kw OR BPMN*:ti,ab,kw OR BPM:ti,kw	368
2	'practice guideline'/de OR 'clinical pathway'/de OR 'clinical protocol'/de OR 'workflow'/de OR 'decision support system'/exp OR 'clinical decision making'/de	681,799
3	(Decision NEAR/1 (making OR support)):ti,ab,kw OR ((clinical OR medical OR healthcare OR "health care" OR "Patient care") NEAR/2 process*):ti,ab,kw OR ((healthcare OR clinical OR critical OR care) NEAR/2 path*):ti,ab,kw OR guideline*:ti,ab,kw OR Workflow*:ti,ab,kw OR careflow*:ti,ab,kw OR "patient journey":ti,ab,kw OR "Healthcare trajectory":ti,ab,kw	1,040,782
4	#2 OR #3	1,381,760
5	#1 AND #4	117
6	#5 AND [01-01-2004]/sd	112

Academic Search Premier

Date of the search: 09-12-2021
Database limit: No database limit has been apply

#	Search strategy	Results
1	TI ("Business Process*" N1 (Model* OR Method# OR management)) OR TI "Decision Model* notation" OR TI BPMN* OR TI BPM OR AB ("Business Process*" N1 (Model* OR Method# OR management)) OR AB "Decision Model* notation" OR AB BPMN* OR KW ("Business Process*" N1 (Model* OR Method# OR management)) OR KW "Decision Model* notation" OR KW BPMN* OR KW BPM	2,229
2	DE GUIDELINES OR DE "DECISION support systems" OR DE "DECISION making" OR DE "MEDICAL protocols" OR DE "WORKFLOW" OR DE "PATIENT management"	180,673
3	TI (Decision N1 (making OR support)) OR TI ((clinical OR medical OR healthcare OR "health care" OR "Patient care") N2 process*) OR TI ((healthcare OR clinical OR critical OR care) N2 path*) OR TI guideline* OR TI Workflow* OR TI careflow* OR TI "patient journey" OR TI "Healthcare trajectory" OR AB (Decision N1 (making OR support)) OR AB ((clinical OR medical OR healthcare OR	596,181

	"health care" OR "PaABent care") N2 process*) OR AB ((healthcare OR clinical OR criABcal OR care) N2 path*) OR AB guideline* OR AB Workflow* OR AB careflow* OR AB "paABent journey" OR AB "Healthcare trajectory" OR KW (Decision N1 (making OR support)) OR KW ((clinical OR medical OR healthcare OR "health care" OR "PaKWent care") N2 process*) OR KW ((healthcare OR clinical OR criKWcal OR care) N2 path*) OR KW guideline* OR KW Workflow* OR KW careflow* OR KW "paKWent journey" OR KW "Healthcare trajectory"	
4	S2 OR S3	664,934
5	S1 AND S4	390
6	S5 AND DT 20040101-20211209	359

ABI/Inform (ProQuest)

Date of the search: 09-12-2021

Database limit: peer review publications only limit has been apply

#	Search strategy	Results
1	TI,AB(("Business Process*" NEAR/1 (Model* OR Method? OR management)) OR "Decision Model* notation" OR BPMN*) OR TI(BPM)	3 110
2	SU("Patient care planning") OR SU("Guidelines") OR SU("Decision support systems") OR SU("Decision making")	305 337
3	TI,AB(Decision NEAR/1 (making OR support)) OR TI,AB((clinical OR medical OR healthcare OR "health care" OR "Patient care") NEAR/2 process*) OR TI,AB((healthcare OR clinical OR critical OR care) NEAR/2 path*) OR TI,AB(guideline*) OR TI,AB(Workflow*) OR TI,AB(careflow*) OR TI,AB("patient journey") OR TI,AB("Healthcare trajectory")	229 017
4	2 OR 3	447 323
5	1 AND 4	668
6	5 AND YR(2004-2021)	553
7	*Peer review publications only limit*	311

Web of Science

Date of the search: 09-12-2021

Database limit: publications between 01-01-2004 to 09-12-2021 limit has been apply

#	Search strategy	Results
1	TS=("Business Process*" NEAR/1 (Model* OR Method$ OR management)) OR TS="Decision Model* notation" OR TS=BPMN* OR TI=BPM OR KP=BPM OR AK=BPM	9,832
2	TS=("patient decision" NEAR/1 (making OR support)) OR TS=((clinical OR medical OR healthcare OR "health care" OR "Patient care") NEAR/2 process*) OR TS=((healthcare OR clinical OR critical OR care) NEAR/2 path*) OR TS=(guideline*) OR TS=(careflow*) OR TS=("patient journey") OR TS=("Healthcare trajectory")	692,475
3	#1 AND #2	475

Google Scholar (https://harzing.com/resources/publish-or-perish)

Date of the search: 09-12-2021

Database limit: only up to the 20 first results per string have been considered; publications between 2004 and 2021 limit has been apply ; citations and patents options have been removed

#	Search	# Results screened
1	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling") AND "patient journey"	20
2	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR	20

	"Business Process management") AND "clinical pathways"	
3	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND "critical pathways"	20
4	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND "healthcare pathways"	20
5	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND "clinical process"	20
6	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND "medical process"	20
7	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND "healthcare process"	20
8	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND "health care process"	20
9	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND guideline	20
10	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND guidelines	20
11	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND "decision support"	20
12	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND "Healthcare trajectory"	1
	Total number of results	221

Supplementary Appendix II- Charting Table

References				Study description						Business Process Modeling Notation (BPMN)						Study results		
First Author	Authors' affiliation	Year of publication	Country's study affiliation	Study design	Type Health Trajectory	Study setting/ setting intervention	Key variable dimension analyzed	Aims/ Objective of the study	Expected Results	Objective of BPMN	Benefit/advantage of using BPMN	Limit of using BPMN	Opportunities	Alternatives	BPMN Model Extension / BPMN Linking Extension	Study findings	Study outcomes	Study limitation

BMJ Open

Benefits and Limitations of Business Process Model Notation in Modelling Patient Healthcare Trajectory: A Scoping Review Protocol

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Keywords:	Quality in health care < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Health informatics < BIOTECHNOLOGY & BIOINFORMATICS, Organisation of health services < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Protocols & guidelines < HEALTH SERVICES ADMINISTRATION & MANAGEMENT

Benefits and Limitations of Business Process Model Notation in Modelling Patient Healthcare Trajectory: A Scoping Review Protocol

Running title: Modelling Patient Healthcare Trajectory using BPMN

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Abstract

Introduction: The adoption of business process model notation (BPMN) in modelling healthcare trajectory can enhance the efficiency and efficacy of healthcare organizations, improve patient outcomes while restraining costs. Existing systematic reviews have been inconclusive regarding the effectiveness of BPMN in modelling healthcare trajectory. The aims of this scoping review are to map and aggregate existing evidence on the benefits and limitations associated with BPMN in healthcare trajectory, highlighting areas of improvement on BPMN and its extensions in healthcare. We will assess BPMN's ability to model key dimensions or concepts of the healthcare process and to meet the needs of stakeholders. The review will highlight the advantages of this approach to support clinical activities and decision-making processes associated with the healthcare trajectory, proposing a conceptual framework for improving the use of BPMN in healthcare.

Methods and Analysis: This study will be performed in accordance with the methodological framework suggested by Arksey and O'Malley. A wide range of electronic databases and grey literature sources will be systematically searched using predefined keywords. The review will include any study design focusing on the application of the BPMN approach for optimising healthcare trajectories, published in either English or French from January 2004 to December 2021. Two reviewers will independently screen titles, abstracts, and full-text articles and select articles meeting the inclusion criteria. A customised data extraction form will be used to extract data. The results will be presented using descriptive statistics and thematic analysis on qualitative data.

Ethics and dissemination: Research ethics approval is not required. Review findings will be used to advance understanding about BPMN, its extensions and application in healthcare trajectory optimisation. The review will develop recommendations on tailoring BPMN strategies for optimising care pathways and decision-making processes. Findings will be disseminated in peer-reviewed journals, conferences and discussions with relevant organizations and stakeholders.

Keywords: Healthcare trajectory**,** healthcare management, business process modelling notation, healthcare processes, care pathways, scoping review

Strengths and limitations of this study

- This is the first scoping review that will analyse how BPMN interventions improve organizational practices, clinical practices, and patient outcomes in healthcare organizations.
- Our scoping review will conform to the rigorous methodology indicated by Arksey and O'Malley, and improved by Levac et al. and further refined by the Joanna Briggs Institute (JBI)
- Both peer-reviewed and grey literature will be considered to ensure a comprehensive coverage.
- The studies were selected limiting them to French and English language and we consider only the studies published between 2004 and 2021.
- The quality appraisal of publications captured will not be assessed, as it is beyond the aim of a scoping review.

INTRODUCTION

With the continuous challenges facing healthcare organizations in the past few years [1-3], many strategies have focused on process improvements with the objective of enhancing efficiency and efficacy to improve patient outcomes while controlling costs[4,5]. Through the years, health expenditure and financing has increased substantially in developed countries such as the United States (US) and Canada[6-9]. In 2019, Canada spent 10.8% of its gross domestic product on healthcare expenses according to the Organization for Economic Cooperation and Development (OECD, 2021)[9]. This ratio reached 17.7% at the same time in the US, where the national health spending is projected to reach $6.2 trillion by 2028, growing at an average annual rate of 5.4%[8,9]. However, compared with other OECD countries, the US perform poorly on process, outcome, and patient experience metrics, as well as life expectancy[10,11]. Life expectancy in the US was the lowest at 78.8 years compared with a range from 80.7 to 83.9 years for other OECD countries[10]. The infant mortality rate in the US was 5.8 per 1000 live births and the maternal mortality rate was 17.4 per 100 000 births in 2018, both higher than the mean rates for any OECD country[11-15]. Canada is another developed country performing poorly in terms of infant and maternal mortality, with 4.7 fatalities out of every 1,000 live births and 10.2 maternal deaths per 100 000 births[11,16].

The lack of control in processes used to deliver medical care is clearly a major problem in the context of preventable medical errors with lethal damages and high economic costs in many hospitals[17-19]. Since the released Crossing the Quality Chasm[20,21] by the Institute of Medicine (US), numerous national and international organizations including the Academies of Sciences[22]and the World Health Organization[23,24] have made repeated calls to develop a framework for advancing the quality of care, ensuring that care is safe, effective, efficient, patient-centred, timely, and equitable[20]. To do this, healthcare organizations and systems must develop solutions that enhance both efficiency and efficacy of improving healthcare organization and patient outcomes while restraining costs. Efforts to improve clinical and care pathways have shown such benefits[25-27]. Over the last decades, articles have revealed that mapping healthcare trajectories allowed to decrease the variation of professional practices and to standardise care processes[17-19]. This practice has many benefits such as improving the accessibility, fluidity, quality, performance, and sustainability of healthcare services[25,28].

In this context, several tools have been developed to support process improvement through process mapping. Among these methods, business process modelling notation (BPMN) is an approach that consists of representing processes as a network of activities and tasks[29-31]. This structured approach supported by the Object Management Group since 2005 and adopted as an

international standard by the International Organization for Standardization since 2012, is in its second version (BPMN 2.0) [30-32].

In recent years, a few reviews [33-36]have been conducted to analyse whether the BPMN approach can become a useful tool to improve the effectiveness and quality of healthcare processes. For instance, Loya et al.[33] used a service-oriented architecture in clinical decision support and provided evidence that BPMN was not commonly used for clinical decision support systems, despite being the preferred standard for business process modelling in healthcare. Mincarone et al.[34] demonstrated that BPMN provides a good level of formalisation, a standardised communication framework between multiple stakeholders, good user comprehensibility, and easier interprofessional analyses. Fernández et al.[35]suggested that BPMN is useful for standardising processes that have some variability due to its possibility to incorporate variations or changes. Moreover, Zarour et al.[36] analysed various BPMN extensions (e.g., decision modelling notation) that can be used to improve its efficiency in many domains, showing that healthcare was among the most targeted area. The overall conclusion of these reviews [33-36]is that BPMN seems to be increasingly used in healthcare organizations to the point of becoming a standard in process improvement methods. However, these articles[33-36] acknowledged the difficulties and challenges when implementing BPMN in the health sector. Indeed, a limitation of these articles[33-36] is that none of them put the use of BPMN to improve healthcare trajectories or patient care trajectory as its primary focus. Loya et al.[33] focused on the use of BPMN for supporting clinical decisions and stated that BPMN has potential to optimise clinical pathways, but they did not assess this possibility. The papers of Mincarone et al.[34] and Fernández et al.[35] mainly focused on clinical processes, briefly addressing healthcare trajectories, resulting in a shallow analysis on this subject. Finally, Zarour et al.[36] targeted many BPMN extensions that could improve its effectiveness, but their research was not exclusive to healthcare setting.

Our literature review builds on these previous reviews[33-36] by providing an in-depth analysis of the ability of BPMN to effectively improve the quality of clinical practices, the security, and the fluidity of the care process and to propose tangible results on the patient experience in a patient-centred care and services logic. Moreover, we will analyse the opportunities and limitations related to the integration of BPMN extension.

Considering the above gaps in the literature, the primary aim of this scoping review is to identify and map existing evidence on the main benefits and limitations associated with the use of BPMN in healthcare trajectory modelling. To do so, we will assess its ability to model key dimensions or concepts of the healthcare process and to meet the needs of stakeholders. The

review will also highlight the capacity of the BPMN approach and its extensions to support clinical activities and decision-making processes associated with the healthcare trajectory and propose a conceptual framework for improving the use of BPMN in healthcare practices.

METHODS AND ANALYSIS

We chose to undertake a scoping review as the best method to map the available evidence regarding the benefits and limitations of BPMN in modelling patient healthcare trajectory[37-39]. The present review will be conducted following the methodological frameworks described by Arksey and O'Malley[37], and improved by Levac et al.[38], and further refined by the Joanna Briggs Institute (JBI)[40]. The standardized methodology included six stages for scoping review: (1) Identifying the research question, (2) Identifying relevant articles and grey literature, (3) Selecting articles, (4) Charting the data, (5) Collating, summarizing, and reporting the data, and (6) Consulting with relevant stakeholders, thereby enabling knowledge translation. The Preferred Reporting Items for Systematic Reviews and Meta-Analysis Extension for Scoping Reviews (PRISMA-ScR)[39,41] has also been used to guide the reporting of this protocol and will also subsequently be used to structure the reporting of the full review. Furthermore, we will take an iterative and reflexive approach throughout the review process, particularly to refine our study selection and data extraction steps to the best target meeting our objective. This protocol is registered through the Open Science Framework[42].

Stage 1: Identifying the Research Question

As the focus of scoping reviews is on summarizing the breadth of evidence, the research questions should be broad while keeping in mind the review's main purpose[37,38,40,41]. Thus, we started with, ″What is known about the application of BPMN methodology in healthcare organization?″ A preliminary search was conducted through some electronic databases including International Prospective Register of Systematic Reviews, JBI Database of Systematic Reviews and Implementation Reports, Cochrane Database of Systematic Reviews, and National Center for Biotechnology Information, which revealed three systematic reviews of modelling healthcare processes using the BPMN methodology[33-36]. Although findings from these reviews[33-36] supported the use of BPMN as an effective methodology to optimise healthcare processes, no conclusion on the effectiveness were drawn. The reason may be that these reviews[33-36] were not mainly focused on the use of BPMN to improve healthcare trajectories.

In addition, we adopted the JBI's Population Concept and Context (PCC) framework[40] to formulate the objectives and research questions, and to conceptualise the study and report

characteristics in terms of eligibility criteria (**Table 1**). We then consulted with experienced colleagues[30] on our predefined set of questions to provide further input and feedback.

In line with our purpose to comprehensively map the extent, range and nature of evidence examining the use or application of BPMN within the healthcare trajectory, we formulated four specific research questions to guide this review.

1. What are the objectives for using BPMN in healthcare organization? What are the expected results and what are the needs to be met?
2. What are the key variables, elements, concepts, and dimensions targeted by the BPMN approach?
3. Can the BPMN approach meet these expectations in healthcare trajectory? Specifically,
   a. What are the strengths (advantages) and weaknesses (limitations) of the BPMN in modelling healthcare trajectory?
   b. What are the effectiveness of using BPMN approach and its extensions in modelling healthcare trajectory?
   c. What are their opportunities and constraints in modelling healthcare processes?
4. What are the improvements or alternatives proposed to optimising healthcare trajectory?

For the purposes of this review, the term healthcare trajectory focuses on the patient's care pathway across the continuum of care. Thus, it can be the clinical pathway when it focuses on the organizational scale, but also the care pathway when it focuses on the systemic scale. It consists first of the patient's journey through the sequencing of tasks and activities at all points of contact[43,44]. It then integrates the professional actors involved in the care trajectory,[45,46] the operation management of care delivery processes[47,48], the coordination structures[49-51], the structural context of the system and organizations[52,53] as well as the information trajectory along the healthcare trajectory[54,55]. Thus, our understanding of the term healthcare trajectory is not limited to the operational aspect of the care process and to the pathophysiological process of a patient's disease state, but also refers to the organization of all activities surrounding interactions between health care workers and patients, as well as the effectiveness of patient care processes and their effectiveness.

Therefore, our analysis will consider not only the operational outcomes of the application BPMN, but also its societal impact by assessing its potential to improve patient outcomes and experience. In addition, healthcare process mapping includes several different flows. On one hand, the main process follows the patient's journey through the process steps and the decision points guide the patient through the process[56]. On the other hand, the support processes and secondary flows include steps directly or indirectly linked to the main process such as

administrative processes, information flow, organizational processes, and examinations that do not require the presence of the patient (e.g., laboratory results, pathological tests). Thus, several flows can be present and impact the care process (e.g., information flow, drug flow, blood flow,).

Therefore, this scoping review will focus on the potential of the BPMN and all its components to impact the results of healthcare trajectories directly or indirectly. Finally, the review will also consider proposals for extensions to BPMN have been put forward to integrate evidence-based medicine and guidelines to support clinical decision making, including the Decision Modelling Notation proposed by both the Object Management Group[56,57] and the Computer Interpretable Guidelines[58,59].

Table 1: PCC framework[40] for illustrating the scope and defining inclusion and exclusion criteria of the review

	Inclusion	Exclusion
Population	Participants of interest are the healthcare stakeholders (knowledge users) involved directly or indirectly with the use of BPMN during the healthcare trajectory or clinical process. The healthcare stakeholders (knowledge users) will include patients, healthcare professionals (e.g., nurses, physicians, other professionals), administrators and decision-makers who were involved at least once in the healthcare trajectory or clinical processes (clinical or care pathways).	Literature that does not apply BPMN in health trajectory (e.g., healthcare process, clinical process, process of care, patient care process, healthcare trajectory, clinical pathways, patient care management). Since we are interested in the efficacy and limitations of BPMN in healthcare trajectory, this needs to be evidence-based (analyse a case clinical pathway) and not speculative.
Concept	The concept is the application of BPMN in healthcare trajectory and/or clinical processes to evaluate the capacity of BPMN to optimise healthcare performance. Articles that reported any healthcare intervention and/or clinical processes modelling with BPMN, including the improvement of the quality assessment and decision-making processes, the capacity to understand the internal clinical procedures, the ability to communicate those procedures in a standard manner, the ability to adjust to new internal challenges quickly and patients' outcomes will be included.	
Context	The context for this review will consider articles conducted in any clinical setting (e.g., inpatient, outpatient) or healthcare settings (e.g., hospitals, health centres, nursing homes). Articles conducted in any part of the world are eligible to be included in this review	Literature related to BPMN occurring outside of healthcare trajectory (e.g., clinical process, process of care, patient care process, patient trajectory, clinical pathways, patient care management)
Types of evidence	Reviews (e.g., systematic, or narrative reviews), peer-reviewed research articles, full-text articles are specific to modelling patient care trajectory incorporate the use of BPMN as a methodological approach and published in either English or French.	Articles published before 2004, not written in either English or French. Editorial articles, abstracts or posters, protocols for planned articles, strategy, or guidelines. Articles where full text is unavailable. Study do not indicate the use of BPMN as a methodological approach. Study focuses on other healthcare elements, such as professional development and performance management but not specifically on patient care trajectory.

Stage 2: Identifying Relevant Articles

A comprehensive search strategy was developed with the assistance of an experienced health sciences librarian (FB). The search strategy will follow the three-step approach recommended by JBI scoping review guidelines[40] and will target the retrieval of both published and unpublished articles from electronic searches databases, focusing to BPMN modelling of patient care trajectory. The first step of the scoping review guidelines has been completed in preparation of this protocol (**Table 1**), which involved an initial limited search on PubMed and ABI/Inform (ProQuest) databases, using the following selected keywords: "Healthcare Process" OR "Clinical Process " OR "Process of Care" OR "Clinical Pathways" OR "Patient care Process" OR "Healthcare trajectory" OR Patient Care Management" OR "Critical Pathways" OR "Clinical Healthcare Pathways" AND "Business Process Model" OR "Business Process Modelling Notation" OR "Business Process Model" OR "BPMN modelling" OR "Workflow" OR "Clinical Decision-Making" OR "Decision Support Systems" OR "Medical Process". The index words and the text words in the title and abstract of retrieved articles were analysed to identify search terms and refine the search strategy for the next step.

In the second step, the search strategy will be adapted and implemented for each included information source (PubMed, Embase (Embase.com), CINAHL(EBSCO), Web of Science, ABI/Inform (ProQuest), Academic Search Premier (EBSCO), and Google Scholar) for potential eligible articles published in either English or French language, from 2004, year when BPMN was initially developed by the Business Process Management Institute, until December 2021. In addition to the electronic database search, we will undertake a backward snowballing[60] search that will involve hand-searching the reference lists of the identified reviews[33-36,61] in order to find other relevant articles. We will also perform a hand search of some relevant journals (e.g. Institute of Electrical and Electronics Engineers, Health Informatics Journal, IOS Press - Studies in Health Technology and Informatics, Journal of Digital Imaging, Lecture Notes in Artificial Intelligence, Springer Procedia Computer Science, Recent Advances in Computer Engineering, Information Systems Journal , European Journal of Information System, Lecture Notes in Business Information Processing), search citations of relevant papers and scan the reference lists of relevant papers. The final search results will be exported to the Covidence systematic review software[62,63] where duplicates will be removed. The full detailed search strategy for peer review and grey literature sources is included in **online Supplementary Appendix I**.

Stage 3: Selecting Literature for Inclusion

All retrieved articles will undertake two levels of screening. First, two reviewers (KSA and JBG or LL) will independently screen titles and abstracts of each article against the established inclusion and exclusion criteria (**Table 1**). To increase the reliability of screening by the two reviewers (KSA and JBG or LL), a pilot test will be conducted on 50 titles and abstracts to evaluate reviewer agreement in the screening process. Discrepancies will be resolved through discussion between the two reviewers and where agreement could not be reached, a third reviewer (PL, CP, CL, or AC) will be consulted. Adjustments may also be made to the inclusion criteria if necessary to ensure consistent interpretation and application of the criteria. The researchers will discuss their selection of articles after this first round of screening, to arrive at preliminary consensus on the list of eligible articles. In the second step, the two reviewers will screen the full-text articles independently to determine if they meet the inclusion criteria. Reasons for the exclusion of full-text articles will be noted in Covidence[63] by each reviewer. Reviewers will again discuss their selection of articles after this second round of screening, to arrive at a final list of eligible articles. Discrepancies will again be resolved through discussion between the two reviewers and where agreement could not be reached, a third reviewer will be consulted. The screening process will be documented using a PRISMA flowchart for scoping review[39,41] and by calculating the inter-rater reliability between reviewers using the Cohen's Kappa coefficient[64].

Stage 4: Charting of Information and Data

Data will be extracted from every eligible article using a data extraction chart (**Charting Table**) tailored to the research questions. Its aim is to maintain a manageable amount of data, while ensuring a wide approach and breadth of coverage to obtain existing evidence on the benefits and limitations associated with BPMN in patient care trajectory. Two researchers (KSA and JBG or LL) will independently extract the following study information: authorship, year of publication, country of origin, study purpose, patient care trajectory issues being addressed (e.g., diabetes, chronic obstructive pulmonary disease, coronary heart disease, clinical pathways for contraception), study population/target users (e.g., physicians, clinicians, nurses, pharmacists), setting/location of intervention (e.g., primary care, acute care, rehabilitation, home care, long-term care, community, hospital), methodological approach (qualitative, quantitative, or mixed study), expected results study findings (e.g., decreasing diagnostic delay, optimising of quality care, cost, reducing medical errors, standardising the decision-making process), type of outcomes/dimension analysed (e.g., diagnostic times, waiting time for surgery, flexibility, improving key performance indicators, decision support systems).We will note the objectives and benefits, as well the limitations of using BPMN and

BPMN-extension approach. The proposed Charting Table is shown in **online Supplementary Appendix II**. It will be trialled on five included articles and will be iteratively refined. Adjustments or expansions may also be made to the **Charting Table** if necessary to ensure that the research objectives or questions are well addressed. For instance, we may add additional categories of data deemed relevant to answer the research questions to the Charting Table.

Stage 5: Collating, Summarizing, and Reporting the Data

The main findings of the included articles will be summarised in Tabular format in a manner that reflects the objectives of the review. Following the PCC principles[40], a narrative summary will accompany the Tabular results and link the different findings to the review objective and questions and will identify any knowledge gaps in the literature. To ensure rigour in this stage, two reviewers (KSA and JBG or LL) will prepare a descriptive summary table of the extracted data and will highlight the key findings with input from the research team. The table will include a descriptive summary of the articles and a qualitative thematic analysis of the main results regarding characteristics of the BPMN approach used in each study (e.g., objective, benefit, challenges, target users, redesign the clinical process), type of patient trajectory, characteristics of the research designs, outcomes of interest used to measure the effectiveness of BPMN (e.g., reducing work time, and challenges and potential solutions learned). We will identify barriers or limitations of BPMN for achieving improvement of healthcare processes, support activities and decision-making processes, and use that information to address our main objectives. The consultation stage of the scoping review, described in the following section, will contribute to fulfilling that objective and to establish a conceptual framework for improving the use of BPMN in healthcare trajectory modelling. Finally, if the extracted data allow it, a qualitative analysis will be conducted to discuss or nuance the evidence of BPMN effectiveness considering potential barriers and enablers identified by the authors. We will use the PRISMA-ScR to guide the final reporting of our results.

Stage 6: Consultation

The final consultation stage offers an ideal mechanism to enhance the validity of the study outcome while translating findings with the stakeholders or health professionals and patients[38]. Preliminary findings from this review will provide the background for workshop with the research team and stakeholders/knowledge users (e.g., healthcare professionals, patients, decision-makers, administrators). The objectives of the workshop are to present and discuss the interim results of the synthesis. The meeting will generate a list of key practice recommendations, dissemination strategy and research priority areas to inform future research.

The workshop will be conducted with the research team with a focus on reviewing the results following feedback from the previous meeting, reviewing the final report, necessary modifications to findings and recommendations for precision and clarity. These consultations with all stakeholders, including clinicians, technicians, and patients, aim to materialise the findings of this review by discussing their applications in specific contexts. Therefore, despite Arksey and O'Malley[37] stated that consultation is optional, we find that our study is a fundamental step. Consequently, we plan to organise a workshop with all stakeholders in order to get their feedback on the findings and to develop next steps in research and practice. The feedback from the stakeholder workshop and the results of the scoping review will be combined to clearly indicate the available evidence, gaps in research and future research priorities for improving the use of BPMN in healthcare trajectory modelling.

Patient and public involvement

In this study, patient and public involvement will be performed at the consultation stage and dissemination. Patients will be recruited from the Institut Universitaire de Cardiologie et de Pneumologie de Québec - Université Laval (IUCPQ-UL). We will work together with the IUCPQ-UL patient office for the recruitment and consultation of patient partners. Our consultation strategy comprises involving not only patients with specific health trajectory but also caregivers, healthcare and social professionals, and policymakers at different levels. It is expected that their contribution in the discussion of the scoping review results will inform the next steps of the project regarding the ability of BPMN to effectively improve the quality of clinical practices, the security, and the fluidity of the care process. Therefore, our analysis will consider not only the operational outcomes of the application BPMN, but also its societal impact by considering the patient's health trajectory in healthcare organization.

ETHICS AND DISSEMINATION

This scoping review is exempt from ethics approval because the work carried out will be based on published documents. The involvement of relevant study participants does not imply personal data collection, rather, we seek to have the key persons feedback on the information gathered through the bibliographic review. The aim of this project is to synthesise the literature about healthcare trajectory using BPMN approach to enhance conceptual clarity and understanding about key benefits and limitations and to extrapolate from this evidence base promising conceptual framework for improving the use of BPMN in healthcare trajectory. During the development of the scoping review a patient-partner will be engaged as a consultant and knowledge user. We anticipate the research will provide several key outputs including (1) a comprehensive review that will summarize existing literature on the BPMN approach; (2) an

evidence base demonstrating the benefits and limitation of the BPMN approach in modelling patient trajectory; (3) a list of BPMN extensions that can be used to improve its efficiency in many domains; (4) a conceptual framework. Our findings will be disseminated in peer-reviewed journals, workshop, seminars, and presentations and through discussions with relevant organizations, study participants and stakeholders. Our goal will be to disseminate our findings to a wide range of clinicians, leaders, and administrators in all sectors, to researchers and to students entering the healthcare professions to enhance understanding about key benefits and limitations of BPMN approach for optimising the patient trajectory. We believe the results will benefit clinicians by guiding their decision-making throughout the patient's trajectory, therefore reducing the medical error rate, optimising efficient resource management, and reducing the risks of complications due to poor clinical decisions. Those improvements should result in an optimisation of cost-efficiency for organizations and quality of care for patients.

Contributors: KSA, JBG and AC led the design, search strategy and conceptualisation of this work and drafted the protocol. PL, FB, CL and CP were involved in the conceptualisation of the review design, inclusion and exclusion criteria and provided feedback on the methodology and the manuscript. KSA and LL were involved in data extraction forms. All authors provided feedback on the manuscript and approval to the publishing of this protocol manuscript**.**

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Competing interests: The authors declare no potential conflict of interest

Patient and public involvement: A patient-partner will be engaged throughout the study acting as a consultant and knowledge user.

Patient consent for publication: Not required.

Ethics approval: Research ethics approval is not required for a scoping review.

Provenance and peer review: Not commissioned; externally peer reviewed**.**

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Supplementary materials – Databases search strategy

Medline (Ovid)

Date of the search: 09-12-2021
Database limit: No database limit has been applied

#	Search strategy	Results
1	("Business Process*" adj1 (Model* OR Method? OR management)).ti,ab,kw,kf OR "Decision Model* notation".ti,ab,kw,kf OR BPMN*.ti,ab,kw,kf OR BPM.ti,kw,kf	285
2	Critical Pathways/ OR Practice Guidelines as Topic/ OR Workflow/ OR Clinical Decision-Making/ OR Decision Support Systems, Clinical/ OR Patient Care Management/	163743
3	(Decision adj1 (making OR support)).ti,ab,kw OR ((clinical OR medical OR healthcare OR "health care") adj2 process*).ti,ab,kw OR ((healthcare OR clinical OR critical OR care) adj2 path*).ti,ab,kw OR guideline*.ti,ab,kw OR Workflow*.ti,ab,kw OR careflow*.ti,ab,kw OR "patient journey".ti,ab,kw	686144
4	2 or 3	769504
5	1 and 4	99
6	limit 5 to ed=20040101-20211209	85

Embase (Embase.com)

Date of the search: 09-12-2021
Database limit: No database limit has been applied

#	Search strategy	Results
1	("Business Process*" NEAR/1 (Model* OR Method$ OR management)):ti,ab,kw OR "Decision Model* notation":ti,ab,kw OR BPMN*:ti,ab,kw OR BPM:ti,kw	368
2	'practice guideline'/de OR 'clinical pathway'/de OR 'clinical protocol'/de OR 'workflow'/de OR 'decision support system'/exp OR 'clinical decision making'/de	681,799
3	(Decision NEAR/1 (making OR support)):ti,ab,kw OR ((clinical OR medical OR healthcare OR "health care" OR "Patient care") NEAR/2 process*):ti,ab,kw OR ((healthcare OR clinical OR critical OR care) NEAR/2 path*):ti,ab,kw OR guideline*:ti,ab,kw OR Workflow*:ti,ab,kw OR careflow*:ti,ab,kw OR "patient journey":ti,ab,kw OR "Healthcare trajectory":ti,ab,kw	1,040,782
4	#2 OR #3	1,381,760
5	#1 AND #4	117
6	#5 AND [01-01-2004]/sd	112

Academic Search Premier

Date of the search: 09-12-2021
Database limit: No database limit has been applied

#	Search strategy	Results
1	TI ("Business Process*" N1 (Model* OR Method# OR management)) OR TI "Decision Model* notation" OR TI BPMN* OR TI BPM OR AB ("Business Process*" N1 (Model* OR Method# OR management)) OR AB "Decision Model* notation" OR AB BPMN* OR KW ("Business Process*" N1 (Model* OR Method# OR management)) OR KW "Decision Model* notation" OR KW BPMN* OR KW BPM	2,229
2	DE GUIDELINES OR DE "DECISION support systems" OR DE "DECISION making" OR DE "MEDICAL protocols" OR DE "WORKFLOW" OR DE "PATIENT management"	180,673
3	TI (Decision N1 (making OR support)) OR TI ((clinical OR medical OR healthcare OR "health care" OR "Patient care") N2 process*) OR TI ((healthcare OR clinical OR critical OR care) N2 path*) OR TI guideline* OR TI Workflow* OR TI careflow* OR TI "patient journey" OR TI "Healthcare trajectory" OR AB (Decision N1 (making OR support)) OR AB ((clinical OR medical OR healthcare OR	596,181

	"health care" OR "PaABent care") N2 process*) OR AB ((healthcare OR clinical OR criABcal OR care) N2 path*) OR AB guideline* OR AB Workflow* OR AB careflow* OR AB "paABent journey" OR AB "Healthcare trajectory" OR KW (Decision N1 (making OR support)) OR KW ((clinical OR medical OR healthcare OR "health care" OR "PaKWent care") N2 process*) OR KW ((healthcare OR clinical OR criKWcal OR care) N2 path*) OR KW guideline* OR KW Workflow* OR KW careflow* OR KW "paKWent journey" OR KW "Healthcare trajectory"	
4	S2 OR S3	664,934
5	S1 AND S4	390
6	S5 AND DT 20040101-20211209	359

ABI/Inform (ProQuest)

Date of the search: 09-12-2021

Database limit: peer review publications only limit has been applied

#	Search strategy	Results
1	TI,AB(("Business Process*" NEAR/1 (Model* OR Method? OR management)) OR "Decision Model* notation" OR BPMN*) OR TI(BPM)	3 110
2	SU("Patient care planning") OR SU("Guidelines") OR SU("Decision support systems") OR SU("Decision making")	305 337
3	TI,AB(Decision NEAR/1 (making OR support)) OR TI,AB((clinical OR medical OR healthcare OR "health care" OR "Patient care") NEAR/2 process*) OR TI,AB((healthcare OR clinical OR critical OR care) NEAR/2 path*) OR TI,AB(guideline*) OR TI,AB(Workflow*) OR TI,AB(careflow*) OR TI,AB("patient journey") OR TI,AB("Healthcare trajectory")	229 017
4	2 OR 3	447 323
5	1 AND 4	668
6	5 AND YR(2004-2021)	553
7	*Peer review publications only limit*	311

Web of Science

Date of the search: 09-12-2021

Database limit: publications between 01-01-2004 to 09-12-2021 limit has been applied

#	Search strategy	Results
1	TS=("Business Process*" NEAR/1 (Model* OR Method$ OR management)) OR TS="Decision Model* notation" OR TS=BPMN* OR TI=BPM OR KP=BPM OR AK=BPM	9,832
2	TS=("patient decision" NEAR/1 (making OR support)) OR TS=((clinical OR medical OR healthcare OR "health care" OR "Patient care") NEAR/2 process*) OR TS=((healthcare OR clinical OR critical OR care) NEAR/2 path*) OR TS=(guideline*) OR TS=(careflow*) OR TS=("patient journey") OR TS=("Healthcare trajectory")	692,475
3	#1 AND #2	475

Google Scholar (https://harzing.com/resources/publish-or-perish)

Date of the search: 09-12-2021

Database limit: only up to the 20 first results per string have been considered; publications between 2004 and 2021 limit has been applied; citations and patents options have been removed

#	Search	# Results screened
1	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling") AND "patient journey"	20

2	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND "clinical pathways"	20
3	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND "critical pathways"	20
4	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND "healthcare pathways"	20
5	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND "clinical process"	20
6	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND "medical process"	20
7	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND "healthcare process"	20
8	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND "health care process"	20
9	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND guideline	20
10	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND guidelines	20
11	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND "decision support"	20
12	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND "Healthcare trajectory"	1
	Total number of results	221

Supplementary Appendix II- Charting Table

References				Study description						Business Process Modeling Notation (BPMN)						Study results		
First Author	Authors' affiliation	Year of publication	Country's study affiliation	Study design	Type Health Trajectory	Study setting/ setting intervention	Key variable dimension analyzed	Aims/ Objective of the study	Expected Results	Objective of BPMN	Benefit/advantage of using BPMN	Limit of using BPMN	Opportunities	Alternatives	BPMN Model Extension / BPMN Linking Extension	Study findings	Study outcomes	Study limitation

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Benefits and Limitations of Business Process Model Notation in Modelling Patient Healthcare Trajectory: A Scoping Review Protocol

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Benefits and Limitations of Business Process Model Notation in Modelling Patient Healthcare Trajectory: A Scoping Review Protocol

Running title: Modelling Patient Healthcare Trajectory using BPMN

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Abstract

Introduction: The adoption of business process model notation (BPMN) in modelling healthcare trajectory can enhance the efficiency and efficacy of healthcare organizations, improve patient outcomes while restraining costs. Existing systematic reviews have been inconclusive regarding the effectiveness of BPMN in modelling healthcare trajectory. The aims of this scoping review are to map and aggregate existing evidence on the benefits and limitations associated with BPMN in healthcare trajectory, highlighting areas of improvement on BPMN and its extensions in healthcare. We will assess BPMN's ability to model key dimensions or concepts of the healthcare process and to meet the needs of stakeholders. The review will highlight the advantages of this approach to support clinical activities and decision-making processes associated with the healthcare trajectory, proposing a conceptual framework for improving the use of BPMN in healthcare.

Methods and Analysis: This study will be performed in accordance with the methodological framework suggested by Arksey and O'Malley. A wide range of electronic databases and grey literature sources will be systematically searched using predefined keywords. The review will include any study design focusing on the application of the BPMN approach for optimising healthcare trajectories, published in either English or French from January 1st, 2004 to December 9th, 2021. Two reviewers will independently screen titles, abstracts, and full-text articles and select articles meeting the inclusion criteria. A customised data extraction form will be used to extract data. The results will be presented using descriptive statistics and thematic analysis on qualitative data.

Ethics and dissemination: Research ethics approval is not required. Review findings will be used to advance understanding about BPMN, its extensions and application in healthcare trajectory optimisation. The review will develop recommendations on tailoring BPMN strategies for optimising care pathways and decision-making processes. Findings will be disseminated in peer-reviewed journals, conferences and discussions with relevant organizations and stakeholders.

Keywords: Healthcare trajectory**,** healthcare management, business process modelling notation, healthcare processes, care pathways, scoping review

Strengths and limitations of this study

- Stakeholders will be consulted and engaged throughout the study review process.
- Our scoping review will conform to the rigorous methodology indicated by Arksey and O'Malley, and improved by Levac et al. and further refined by the Joanna Briggs Institute (JBI)
- Both peer-reviewed and grey literature will be considered to ensure a comprehensive coverage.
- The search strategy in electronic databases considered articles published between January 2004 and December 2021, while abstracts and full-texts selection will be limited to French and English language.
- The quality appraisal of publications captured will not be assessed, as it is beyond the aim of a scoping review.

INTRODUCTION

With the continuous challenges facing healthcare organizations in the past few years [1-3], many strategies have focused on process improvements with the objective of enhancing efficiency and efficacy to improve patient outcomes while controlling costs[4,5]. Through the years, health expenditure and financing have increased substantially in developed countries such as the United States (US) and Canada[6-9]. In 2019, Canada spent 10.8% of its gross domestic product on healthcare expenses according to the Organization for Economic Cooperation and Development (OECD, 2021)[9]. This ratio reached 17.7% at the same time in the US, where the national health spending is projected to reach $6.2 trillion by 2028, growing at an average annual rate of 5.4%[8,9]. However, compared with other OECD countries, the US perform poorly on process, outcome, and patient experience metrics, as well as life expectancy[10,11]. Life expectancy in the US was the lowest at 78.8 years compared with a range from 80.7 to 83.9 years for other OECD countries[10]. The infant mortality rate in the US was 5.8 per 1000 live births and the maternal mortality rate was 17.4 per 100 000 births in 2018, both higher than the mean rates for any OECD country[11-15]. Canada is another developed country performing poorly in terms of infant and maternal mortality, with 4.7 fatalities out of every 1,000 live births and 10.2 maternal deaths per 100 000 births[11,16].

The lack of control in processes used to deliver medical care is clearly a major problem in the context of preventable medical errors with lethal damages and high economic costs in many hospitals[17-19]. Since the released Crossing the Quality Chasm[20,21] by the Institute of Medicine (US), numerous national and international organizations including the Academies of Sciences[22]and the World Health Organization[23,24] have made repeated calls to develop a framework for advancing the quality of care, ensuring that care is safe, effective, efficient, patient-centred, timely, and equitable[20]. To do this, healthcare organizations and systems must develop solutions that enhance both efficiency and efficacy of improving healthcare organization and patient outcomes while restraining costs. Efforts to improve clinical and care pathways have shown such benefits[25-27]. Over the last decades, articles have revealed that mapping healthcare trajectories allowed to decrease the variation of professional practices and to standardise care processes[17-19]. This practice has many benefits such as improving the accessibility, fluidity, quality, performance, and sustainability of healthcare services[25,28].

In this context, several tools have been developed to support process improvement through process mapping. Among these methods, business process modelling notation (BPMN) is an approach that consists of representing processes as a network of activities and tasks[29-31]. This

structured approach supported by the Object Management Group since 2005 and adopted as an international standard by the International Organization for Standardization since 2012, is in its second version (BPMN 2.0) [30-32].

In recent years, a few reviews [33-36]have been conducted to analyse whether the BPMN approach can become a useful tool to improve the effectiveness and quality of healthcare processes. For instance, Loya et al.[33] used a service-oriented architecture in clinical decision support and provided evidence that BPMN was not commonly used for clinical decision support systems, despite being the preferred standard for business process modelling in healthcare. Mincarone et al.[34] demonstrated that BPMN provides a good level of formalisation, a standardised communication framework between multiple stakeholders, good user comprehensibility, and easier interprofessional analyses. Fernández et al.[35]suggested that BPMN is useful for standardising processes that have some variability due to its possibility to incorporate variations or changes. Moreover, Zarour et al.[36] analysed various BPMN extensions (e.g., decision modelling notation) that can be used to improve its efficiency in many domains, showing that healthcare was among the most targeted area. The overall conclusion of these reviews [33-36]is that BPMN seems to be increasingly used in healthcare organizations to the point of becoming a standard in process improvement methods. However, these articles[33-36] acknowledged the difficulties and challenges when implementing BPMN in the health sector. Indeed, a limitation of these articles[33-36] is that none of them put the use of BPMN to improve healthcare trajectories or patient care trajectory as its primary focus. Loya et al.[33] focused on the use of BPMN for supporting clinical decisions and stated that BPMN has potential to optimise clinical pathways, but they did not assess this possibility. The papers of Mincarone et al.[34] and Fernández et al.[35] mainly focused on clinical processes, briefly addressing healthcare trajectories, resulting in a shallow analysis on this subject. Finally, Zarour et al.[36] targeted many BPMN extensions that could improve its effectiveness, but their research was not exclusive to healthcare setting.

Our literature review builds on these previous reviews[33-36] by providing an in-depth analysis of the ability of BPMN to effectively improve the quality of clinical practices, the security, and the fluidity of the care process and to propose tangible results on the patient experience in a patient-centred care and services logic. Moreover, we will analyse the opportunities and limitations related to the integration of BPMN extension.

Considering the above gaps in the literature, the primary aim of this scoping review is to identify and map existing evidence on the main benefits and limitations associated with the use of BPMN in healthcare trajectory modelling. To do so, we will assess its ability to model key

dimensions or concepts of the healthcare process and to meet the needs of stakeholders. The review will also highlight the capacity of the BPMN approach and its extensions to support clinical activities and decision-making processes associated with the healthcare trajectory and propose a conceptual framework for improving the use of BPMN in healthcare practices.

METHODS AND ANALYSIS

We chose to undertake a scoping review as the best method to map the available evidence regarding the benefits and limitations of BPMN in modelling patient healthcare trajectory[37-39]. The present review will be conducted following the methodological frameworks described by Arksey and O'Malley[37], and improved by Levac et al.[38], and further refined by the Joanna Briggs Institute (JBI)[40]. The standardized methodology included six stages for scoping review: (1) Identifying the research question, (2) Identifying relevant articles and grey literature, (3) Selecting articles, (4) Charting the data, (5) Collating, summarizing, and reporting the data, and (6) Consulting with relevant stakeholders, thereby enabling knowledge translation. The Preferred Reporting Items for Systematic Reviews and Meta-Analysis Extension for Scoping Reviews (PRISMA-ScR)[39,41] has also been used to guide the reporting of this protocol and will also subsequently be used to structure the reporting of the full review. Furthermore, we will take an iterative and reflexive approach throughout the review process, particularly to refine our study selection and data extraction steps to the best target meeting our objective. This protocol is registered through the Open Science Framework[42]. The development of the scoping review will start in May 2022 and it should be finalised in September 2022.

Stage 1: Identifying the Research Question

As the focus of scoping reviews is on summarizing the breadth of evidence, the research questions should be broad while keeping in mind the review's main purpose[37,38,40,41]. Thus, we started with, ″What is known about the application of BPMN methodology in healthcare organization?″ A preliminary search was conducted through some electronic databases including International Prospective Register of Systematic Reviews, JBI Database of Systematic Reviews and Implementation Reports, Cochrane Database of Systematic Reviews, and National Center for Biotechnology Information, which revealed three systematic reviews of modelling healthcare processes using the BPMN methodology[33-36]. Although findings from these reviews[33-36] supported the use of BPMN as an effective methodology to optimise healthcare processes, no conclusions on the effectiveness were drawn. The reason may be that these reviews[33-36] were not mainly focused on the use of BPMN to improve healthcare trajectories.

In addition, we adopted the JBI's Population Concept and Context (PCC) framework[40] to formulate the objectives and research questions, and to conceptualise the study and report characteristics in terms of eligibility criteria (**Table 1**). We then consulted with experienced colleagues[30] on our predefined set of questions to provide further input and feedback.

In line with our purpose to comprehensively map the extent, range and nature of evidence examining the use or application of BPMN within the healthcare trajectory, we formulated four specific research questions to guide this review.

1. What are the objectives for using BPMN in healthcare organization? What are the expected results and what are the needs to be met?
2. What are the key variables, elements, concepts, and dimensions targeted by the BPMN approach?
3. Can the BPMN approach meet these expectations in healthcare trajectory? Specifically,
   a. What are the strengths (advantages) and weaknesses (limitations) of the BPMN in modelling healthcare trajectory?
   b. What are the effectiveness of using BPMN approach and its extensions in modelling healthcare trajectory?
   c. What are their opportunities and constraints in modelling healthcare processes?
4. What are the improvements or alternatives proposed to optimising healthcare trajectory?

For the purposes of this review, the term healthcare trajectory focuses on the patient's care pathway across the continuum of care. Thus, it can be the clinical pathway when it focuses on the organizational scale, but also the care pathway when it focuses on the systemic scale. It consists first of the patient's journey through the sequencing of tasks and activities at all points of contact[43,44]. It then integrates the professional actors involved in the care trajectory,[45,46] the operation management of care delivery processes[47,48], the coordination structures[49-51], the structural context of the system and organizations[52,53] as well as the information trajectory along the healthcare trajectory[54,55]. Thus, our understanding of the term healthcare trajectory is not limited to the operational aspect of the care process and to the pathophysiological process of a patient's disease state, but also refers to the organization of all activities surrounding interactions between health care workers and patients, as well as the effectiveness of patient care processes and their effectiveness.

Therefore, our analysis will consider not only the operational outcomes of the application BPMN, but also its societal impact by assessing its potential to improve patient outcomes and experience. In addition, healthcare process mapping includes several different flows. On one hand, the main process follows the patient's journey through the process steps and the decision

points guide the patient through the process[56]. On the other hand, the support processes and secondary flows include steps directly or indirectly linked to the main process such as administrative processes, information flow, organizational processes, and examinations that do not require the presence of the patient (e.g., laboratory results, pathological tests). Thus, several flows can be present and impact the care process (e.g., information flow, drug flow, blood flow,).

Therefore, this scoping review will focus on the potential of the BPMN and all its components to impact the results of healthcare trajectories directly or indirectly. Finally, the review will also consider proposals for extensions to BPMN have been put forward to integrate evidence-based medicine and guidelines to support clinical decision making, including the Decision Modelling Notation proposed by both the Object Management Group[56,57] and the Computer Interpretable Guidelines[58,59].

Table 1: PCC framework[40] for illustrating the scope and defining inclusion and exclusion criteria of the review

	Inclusion	Exclusion
Population	Participants of interest are the healthcare stakeholders (knowledge users) involved directly or indirectly with the use of BPMN during the healthcare trajectory or clinical process. The healthcare stakeholders (knowledge users) will include patients, healthcare professionals (e.g., nurses, physicians, other professionals), administrators and decision-makers who were involved at least once in the healthcare trajectory or clinical processes (clinical or care pathways).	Literature that does not apply BPMN in health trajectory (e.g., healthcare process, clinical process, process of care, patient care process, healthcare trajectory, clinical pathways, patient care management). Since we are interested in the efficacy and limitations of BPMN in healthcare trajectory, this needs to be evidence-based (analyse a case clinical pathway) and not speculative.
Concept	The concept is the application of BPMN in healthcare trajectory and/or clinical processes to evaluate the capacity of BPMN to optimise healthcare performance. Articles that reported any healthcare intervention and/or clinical processes modelling with BPMN, including the improvement of the quality assessment and decision-making processes, the capacity to understand the internal clinical procedures, the ability to communicate those procedures in a standard manner, the ability to adjust to new internal challenges quickly and patients' outcomes will be included.	
Context	The context for this review will consider articles conducted in any clinical setting (e.g., inpatient, outpatient) or healthcare settings (e.g., hospitals, health centres, nursing homes). Articles conducted in any part of the world are eligible to be included in this review	Literature related to BPMN occurring outside of healthcare trajectory (e.g., clinical process, process of care, patient care process, patient trajectory, clinical pathways, patient care management)
Types of evidence	Reviews (e.g., systematic, or narrative reviews), peer-reviewed research articles, full-text articles are specific to modelling patient care trajectory incorporate the use of BPMN as a methodological approach and published in either English or French.	Articles published before 2004, not written in either English or French. Editorial articles, abstracts or posters, protocols for planned articles, strategy, or guidelines. Articles where full text is unavailable. Study do not indicate the use of BPMN as a methodological approach. Study focuses on other healthcare elements, such as professional development and performance management but not specifically on patient care trajectory.

Stage 2: Identifying Relevant Articles

A comprehensive search strategy was developed with the assistance of an experienced health sciences librarian (FB). The search strategy will follow the three-step approach recommended by JBI scoping review guidelines[40] and will target the retrieval of both published and unpublished articles from electronic searches databases, focusing to BPMN modelling of patient care trajectory. The first step of the scoping review guidelines has been completed in preparation of this protocol (**Table 1**), which involved an initial limited search on PubMed and ABI/Inform (ProQuest) databases, using the following selected keywords: "Healthcare Process" OR "Clinical Process " OR "Process of Care" OR "Clinical Pathways" OR "Patient care Process" OR "Healthcare trajectory" OR Patient Care Management" OR "Critical Pathways" OR "Clinical Healthcare Pathways" AND "Business Process Model" OR "Business Process Modelling Notation" OR "Business Process Model" OR "BPMN modelling" OR "Workflow" OR "Clinical Decision-Making" OR "Decision Support Systems" OR "Medical Process". The index words and the text words in the title and abstract of retrieved articles were analysed to identify search terms and refine the search strategy. In detail, we used an adjacency operator between the expression "Business Process" and terms (Model OR Method OR management) that seemed most relevant to us and consistent with previous published systematic literature reviews[33-36], as subject experts, in order to capture all potential articles using synonyms and words variations of the "Business Process Model Notation" concept, in addition to BPMN acronym. To find articles about patient "Healthcare Trajectory", a broad concept containing several components, we used a mix of general (e.g., Practice Guidelines as Topic OR Workflow OR Clinical Decision-Making) and specific terms (e.g., Patient Care Management OR Critical Pathways), both from controlled vocabulary (e.g., MeSH terms) and keywords to avoid missing articles. We used the Boolean operator AND to restrict our search to articles specifically related to these two concepts.

In the second step, the search strategy will be adapted and implemented for each included information source (PubMed, Embase (Embase.com), CINAHL(EBSCO), Web of Science, ABI/Inform (ProQuest), Academic Search Premier (EBSCO), and Google Scholar) for potential eligible articles from January 1st, 2004, year when BPMN was initially developed by the Business Process Management Institute, until December 9th, 2021. In addition to the electronic database search, we will undertake a backward snowballing[60] search that will involve hand-searching the reference lists of the identified reviews[33-36,61] in order to find other relevant articles. We will also perform a hand search of some relevant journals (e.g. Institute of Electrical and Electronics Engineers, Health Informatics Journal, IOS Press - Studies in Health

Technology and Informatics, Journal of Digital Imaging, Lecture Notes in Artificial Intelligence, Springer Procedia Computer Science, Recent Advances in Computer Engineering, Information Systems Journal , European Journal of Information System, Lecture Notes in Business Information Processing), search citations of relevant papers and scan the reference lists of relevant papers. The final search results will be exported to the Covidence® systematic review software[62,63] where duplicates will be removed. The full detailed search strategy for peer review and grey literature sources is included in **online Supplementary Appendix I**.

Stage 3: Selecting Literature for Inclusion

All retrieved articles will undertake two levels of screening. First, two reviewers (KSA and JBG or LL) will independently screen titles and abstracts of each article against the established inclusion and exclusion criteria (**Table 1**). To increase the reliability of screening by the two reviewers (KSA and JBG or LL), a pilot test will be conducted on 50 titles and abstracts to evaluate reviewer agreement in the screening process. Discrepancies will be resolved through discussion between the two reviewers and where agreement could not be reached, a third reviewer (PL, CP, CL, or AC) will be consulted. Adjustments may also be made to the inclusion criteria if necessary to ensure consistent interpretation and application of the criteria. The researchers will discuss their selection of articles after this first round of screening, to arrive at preliminary consensus on the list of eligible articles. In the second step, the two reviewers will screen the full-text articles independently to determine if they meet the inclusion criteria. Reasons for the exclusion of full-text articles will be noted in Covidence[63] by each reviewer. Reviewers will again discuss their selection of articles after this second round of screening, to arrive at a final list of eligible articles. Discrepancies will again be resolved through discussion between the two reviewers and where agreement could not be reached, a third reviewer will be consulted. The screening process will be documented using a PRISMA flowchart for scoping review[39,41] and by calculating the inter-rater reliability between reviewers using the Cohen's Kappa coefficient[64].

Stage 4: Charting of Information and Data

Data will be extracted from every eligible article using a data extraction chart (**Charting Table**) tailored to the research questions. Its aim is to maintain a manageable amount of data, while ensuring a wide approach and breadth of coverage to obtain existing evidence on the benefits and limitations associated with BPMN in patient care trajectory. Two researchers (KSA and JBG or LL) will independently extract the following study information: authorship, year of publication, country of origin, study purpose, patient care trajectory issues being addressed (e.g., diabetes, chronic obstructive pulmonary disease, coronary heart disease,

clinical pathways for contraception), study population/target users (e.g., physicians, clinicians, nurses, pharmacists), setting/location of intervention (e.g., primary care, acute care, rehabilitation, home care, long-term care, community, hospital), methodological approach (qualitative, quantitative, or mixed study), expected results study findings (e.g., decreasing diagnostic delay, optimising of quality care, cost, reducing medical errors, standardising the decision-making process), type of outcomes/dimension analysed (e.g., diagnostic times, waiting time for surgery, flexibility, improving key performance indicators, decision support systems).We will note the objectives and benefits, as well as the limitations of using BPMN and BPMN-extension approach. The proposed Charting Table is shown in **online Supplementary Appendix II**. It will be trialled on five included articles and will be iteratively refined. Adjustments or expansions may also be made to the **Charting Table** if necessary to ensure that the research objectives or questions are well addressed. For instance, we may add additional categories of data deemed relevant to answer the research questions to the Charting Table.

Stage 5: Collating, Summarizing, and Reporting the Data

The main findings of the included articles will be summarised in Tabular format in a manner that reflects the objectives of the review. Following the PCC principles[40], a narrative summary will accompany the Tabular results and link the different findings to the review objective and questions and will identify any knowledge gaps in the literature. To ensure rigour in this stage, two reviewers (KSA and JBG or LL) will prepare a descriptive summary table of the extracted data and will highlight the key findings with input from the research team. The table will include a descriptive summary of the articles and a qualitative thematic analysis of the main results regarding characteristics of the BPMN approach used in each study (e.g., objective, benefit, challenges, target users, redesign the clinical process), type of patient trajectory, characteristics of the research designs, outcomes of interest used to measure the effectiveness of BPMN (e.g., reducing work time, and challenges and potential solutions learned). We will identify barriers or limitations of BPMN for achieving improvement of healthcare processes, support activities and decision-making processes, and use that information to address our main objectives. The consultation stage of the scoping review, described in the following section, will contribute to fulfilling that objective and to establish a conceptual framework for improving the use of BPMN in healthcare trajectory modelling. Finally, if the extracted data allow it, a qualitative analysis will be conducted to discuss or nuance the evidence of BPMN effectiveness considering potential barriers and enablers identified by the authors. We will use the PRISMA-ScR to guide the final reporting of our results.

Stage 6: Consultation

The final consultation stage offers an ideal mechanism to enhance the validity of the study outcome while translating findings with the stakeholders or health professionals and patients[38]. Preliminary findings from this review will provide the background for workshop with the research team and stakeholders/knowledge users (e.g., healthcare professionals, patients, decision-makers, administrators). The objectives of the workshop are to present and discuss the interim results of the synthesis. The meeting will generate a list of key practice recommendations, dissemination strategy and research priority areas to inform future research.

The workshop will be conducted with the research team with a focus on reviewing the results following feedback from the previous meeting, reviewing the final report, necessary modifications to findings and recommendations for precision and clarity. These consultations with all stakeholders, including clinicians, technicians, and patients, aim to materialise the findings of this review by discussing their applications in specific contexts. Therefore, despite Arksey and O'Malley[37] stated that consultation is optional, we find that our study is a fundamental step. Consequently, we plan to organise a workshop with all stakeholders in order to get their feedback on the findings and to develop next steps in research and practice. The feedback from the stakeholder workshop and the results of the scoping review will be combined to clearly indicate the available evidence, gaps in research and future research priorities for improving the use of BPMN in healthcare trajectory modelling.

Patient and public involvement

In this study, patient and public involvement will be performed at the consultation stage and dissemination. Patients will be recruited from the Institut Universitaire de Cardiologie et de Pneumologie de Québec - Université Laval (IUCPQ-UL). We will work together with the IUCPQ-UL patient office for the recruitment and consultation of patient partners. Our consultation strategy comprises involving not only patients with specific health trajectory but also caregivers, healthcare and social professionals, and policymakers at different levels. It is expected that their contribution in the discussion of the scoping review results will inform the next steps of the project regarding the ability of BPMN to effectively improve the quality of clinical practices, the security, and the fluidity of the care process. Therefore, our analysis will consider not only the operational outcomes of the application BPMN, but also its societal impact by considering the patient's health trajectory in healthcare organization.

ETHICS AND DISSEMINATION

This scoping review is exempt from ethics approval because the work carried out will be based on published documents. The involvement of relevant study participants does not imply

personal data collection, rather, we seek to have the key persons feedback on the information gathered through the bibliographic review. The aim of this project is to synthesise the literature about healthcare trajectory using BPMN approach to enhance conceptual clarity and understanding about key benefits and limitations and to extrapolate from this evidence base promising conceptual framework for improving the use of BPMN in healthcare trajectory. During the development of the scoping review a patient-partner will be engaged as a consultant and knowledge user. We anticipate the research will provide several key outputs including (1) a comprehensive review that will summarize existing literature on the BPMN approach; (2) an evidence base demonstrating the benefits and limitation of the BPMN approach in modelling patient trajectory; (3) a list of BPMN extensions that can be used to improve its efficiency in many domains; (4) a conceptual framework. Our findings will be disseminated in peer-reviewed journals, workshop, seminars, and presentations and through discussions with relevant organizations, study participants and stakeholders. Our goal will be to disseminate our findings to a wide range of clinicians, leaders, and administrators in all sectors, to researchers and to students entering the healthcare professions to enhance understanding about key benefits and limitations of BPMN approach for optimising the patient trajectory. We believe the results will benefit clinicians by guiding their decision-making throughout the patient's trajectory, therefore reducing the medical error rate, optimising efficient resource management, and reducing the risks of complications due to poor clinical decisions. Those improvements should result in an optimisation of cost-efficiency for organizations and quality of care for patients.

Contributors: KSA, JBG and AC led the design, search strategy and conceptualisation of this work and drafted the protocol. PL, FB, CL and CP were involved in the conceptualisation of the review design, inclusion and exclusion criteria and provided feedback on the methodology and the manuscript. KSA and LL were involved in data extraction forms. All authors provided feedback on the manuscript and approval to the publishing of this protocol manuscript**.**

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Competing interests: The authors declare no potential conflict of interest

Patient and public involvement: A patient-partner will be engaged throughout the study acting as a consultant and knowledge user.

Patient consent for publication: Not required.

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Supplementary materials – Databases search strategy

Medline (Ovid)

Date of the search: 09-12-2021
Database limit: We limited the results to publications between 01-01-2004 and 09-12-2021

#	Search strategy	Results
1	("Business Process*" adj1 (Model* OR Method? OR management)).ti,ab,kw,kf OR "Decision Model* notation".ti,ab,kw,kf OR BPMN*.ti,ab,kw,kf OR BPM.ti,kw,kf	285
2	Critical Pathways/ OR Practice Guidelines as Topic/ OR Workflow/ OR Clinical Decision-Making/ OR Decision Support Systems, Clinical/ OR Patient Care Management/	163743
3	(Decision adj1 (making OR support)).ti,ab,kw OR ((clinical OR medical OR healthcare OR "health care") adj2 process*).ti,ab,kw OR ((healthcare OR clinical OR critical OR care) adj2 path*).ti,ab,kw OR guideline*.ti,ab,kw OR Workflow*.ti,ab,kw OR careflow*.ti,ab,kw OR "patient journey".ti,ab,kw	686144
4	2 or 3	769504
5	1 and 4	99
6	limit 5 to ed=20040101-20211209	85

Embase (Embase.com)

Date of the search: 09-12-2021
Database limit: We limited the results to publications between 01-01-2004 and 09-12-2021

#	Search strategy	Results
1	("Business Process*" NEAR/1 (Model* OR Method$ OR management)):ti,ab,kw OR "Decision Model* notation":ti,ab,kw OR BPMN*:ti,ab,kw OR BPM:ti,kw	368
2	'practice guideline'/de OR 'clinical pathway'/de OR 'clinical protocol'/de OR 'workflow'/de OR 'decision support system'/exp OR 'clinical decision making'/de	681,799
3	(Decision NEAR/1 (making OR support)):ti,ab,kw OR ((clinical OR medical OR healthcare OR "health care" OR "Patient care") NEAR/2 process*):ti,ab,kw OR ((healthcare OR clinical OR critical OR care) NEAR/2 path*):ti,ab,kw OR guideline*:ti,ab,kw OR Workflow*:ti,ab,kw OR careflow*:ti,ab,kw OR "patient journey":ti,ab,kw OR "Healthcare trajectory":ti,ab,kw	1,040,782
4	#2 OR #3	1,381,760
5	#1 AND #4	117
6	#5 AND [01-01-2004]/sd	112

Academic Search Premier

Date of the search: 09-12-2021
Database limit: We limited the results to publications between 01-01-2004 and 09-12-2021

#	Search strategy	Results
1	TI ("Business Process*" N1 (Model* OR Method# OR management)) OR TI "Decision Model* notation" OR TI BPMN* OR TI BPM OR AB ("Business Process*" N1 (Model* OR Method# OR management)) OR AB "Decision Model* notation" OR AB BPMN* OR KW ("Business Process*" N1 (Model* OR Method# OR management)) OR KW "Decision Model* notation" OR KW BPMN* OR KW BPM	2,229
2	DE GUIDELINES OR DE "DECISION support systems" OR DE "DECISION making" OR DE "MEDICAL protocols" OR DE "WORKFLOW" OR DE "PATIENT management"	180,673
3	TI (Decision N1 (making OR support)) OR TI ((clinical OR medical OR healthcare OR "health care" OR "Patient care") N2 process*) OR TI ((healthcare OR clinical OR critical OR care) N2 path*) OR TI guideline* OR TI Workflow* OR TI careflow* OR TI "patient journey" OR TI "Healthcare trajectory" OR AB (Decision N1 (making OR support)) OR AB ((clinical OR medical OR healthcare OR	596,181

	"health care" OR "PaABent care") N2 process*) OR AB ((healthcare OR clinical OR criABcal OR care) N2 path*) OR AB guideline* OR AB Workflow* OR AB careflow* OR AB "paABent journey" OR AB "Healthcare trajectory" OR KW (Decision N1 (making OR support)) OR KW ((clinical OR medical OR healthcare OR "health care" OR "PaKWent care") N2 process*) OR KW ((healthcare OR clinical OR criKWcal OR care) N2 path*) OR KW guideline* OR KW Workflow* OR KW careflow* OR KW "paKWent journey" OR KW "Healthcare trajectory"	
4	S2 OR S3	664,934
5	S1 AND S4	390
6	S5 AND DT 20040101-20211209	359

ABI/Inform (ProQuest)

Date of the search: 09-12-2021

Database limit: We limited the results to peer review publications between 01-01-2004 and 09-12-2021

#	Search strategy	Results
1	TI,AB(("Business Process*" NEAR/1 (Model* OR Method? OR management)) OR "Decision Model* notation" OR BPMN*) OR TI(BPM)	3 110
2	SU("Patient care planning") OR SU("Guidelines") OR SU("Decision support systems") OR SU("Decision making")	305 337
3	TI,AB(Decision NEAR/1 (making OR support)) OR TI,AB((clinical OR medical OR healthcare OR "health care" OR "Patient care") NEAR/2 process*) OR TI,AB((healthcare OR clinical OR critical OR care) NEAR/2 path*) OR TI,AB(guideline*) OR TI,AB(Workflow*) OR TI,AB(careflow*) OR TI,AB("patient journey") OR TI,AB("Healthcare trajectory")	229 017
4	2 OR 3	447 323
5	1 AND 4	668
6	5 AND YR(2004-2021)	553
7	*Peer review publications only limit*	311

Web of Science

Date of the search: 09-12-2021

Database limit: We limited the results to publications between 01-01-2004 and 09-12-2021

#	Search strategy	Results
1	TS=("Business Process*" NEAR/1 (Model* OR Method$ OR management)) OR TS="Decision Model* notation" OR TS=BPMN* OR TI=BPM OR KP=BPM OR AK=BPM	9,832
2	TS=("patient decision" NEAR/1 (making OR support)) OR TS=((clinical OR medical OR healthcare OR "health care" OR "Patient care") NEAR/2 process*) OR TS=((healthcare OR clinical OR critical OR care) NEAR/2 path*) OR TS=(guideline*) OR TS=(careflow*) OR TS=("patient journey") OR TS=("Healthcare trajectory")	692,475
3	#1 AND #2	475

Google Scholar (https://harzing.com/resources/publish-or-perish)

Date of the search: 09-12-2021

Database limit: only up to the 20 first results per string have been considered; publications between 2004 and 2021 limit has been applied; citations and patents options have been removed

#	Search	# Results screened
1	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling") AND "patient journey"	20

2	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND "clinical pathways"	20
3	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND "critical pathways"	20
4	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND "healthcare pathways"	20
5	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND "clinical process"	20
6	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND "medical process"	20
7	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND "healthcare process"	20
8	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND "health care process"	20
9	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND guideline	20
10	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND guidelines	20
11	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND "decision support"	20
12	("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR "Business Process management") AND "Healthcare trajectory"	1
	Total number of results	221

Supplementary Appendix II- Charting Table

References				Study description						Business Process Modeling Notation (BPMN)						Study results		
First Author	Authors' affiliation	Year of publication	Country's study affiliation	Study design	Type Health Trajectory	Study setting/ setting intervention	Key variable dimension analyzed	Aims/ Objective of the study	Expected Results	Objective of BPMN	Benefit/advantage of using BPMN	Limit of using BPMN	Opportunities	Alternatives	BPMN Model Extension / BPMN Linking Extension	Study findings	Study outcomes	Study limitation