

BMJ Open

BMJ Open is committed to open peer review. As part of this commitment we make the peer review history of every article we publish publicly available.

When an article is published we post the peer reviewers' comments and the authors' responses online. We also post the versions of the paper that were used during peer review. These are the versions that the peer review comments apply to.

The versions of the paper that follow are the versions that were submitted during the peer review process. They are not the versions of record or the final published versions. They should not be cited or distributed as the published version of this manuscript.

BMJ Open is an open access journal and the full, final, typeset and author-corrected version of record of the manuscript is available on our site with no access controls, subscription charges or pay-per-view fees (<http://bmjopen.bmj.com>).

If you have any questions on BMJ Open's open peer review process please email info.bmjopen@bmj.com

BMJ Open

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

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2021-060357
Article Type:	Protocol
Date Submitted by the Author:	19-Dec-2021
Complete List of Authors:	Kassim, Said; Universite Laval; Laval University Department of Management, Gartner, Jean-Baptiste; Université Laval, Département de management Labbé, Laurence; Laval University, Management Landa, Paolo; Laval University, Operations and Decision Systems Department Paquet, Catherine; Université Laval Département de management Bergeron, Frédéric; Université Laval Lemaire, Célia; EM Strasbourg Business School Côté, André; Universite Laval Departement de management, Département de management
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

SCHOLARONE™
Manuscripts

1 Benefits and Limitations of Business Process Model Notation in Modelling

2 Patient Healthcare Trajectory: A Scoping Review Protocol

3 Running title: Modelling Patient Healthcare Trajectory using BPMN

4 Kassim Said Abasse^{1,2,3,4,5}, Jean-Baptiste Gartner^{1,2,3,5}, Laurence Labbé^{1,2}, Paolo Landa^{6*},

5 Catherine Paquet^{3,8,9}, Frédéric Bergeron¹⁰, Célia Lemaire¹¹, André Côté^{1,2,3,4,5}.

6 ¹Département de management, Faculté des sciences de l'administration, Université Laval,
7 Québec, G1V 0A6, Canada.

8 ²Centre de recherche en gestion des services de santé, Université Laval, Québec, G1V 0A6,
9 Canada.

10 ³Centre de recherche du CHU de Québec, Université Laval, Québec, G1V 0A6, Canada

11 ⁴VITAM, Centre de recherche en santé durable, Université Laval, Québec, G1V 0A6, Canada.

12 ⁵Centre de recherche du CISSS de Chaudière-Appalaches, Québec, G1V 0A6, Canada.

13 ⁶Département d'opérations et systèmes de décision, Faculté des sciences de l'administration
14 Université Laval, Québec, G1K 7P4, Canada

15 ⁸Département de marketing, Faculté des sciences de l'administration, Université Laval,
16 Québec, G1V 0A6, Canada.

17 ⁹Centre NUTRISS-Nutrition, Santé et société Université Laval, Québec, G1V 0A6, Canada.

18 ¹⁰Bibliothèque, Direction des services-conseils, Université Laval, Québec, G1V 0A6, Canada

19 ¹¹Université de Strasbourg, EM Strasbourg-Business School, HuManiS, Strasbourg, France.

21 *Corresponding Author

22 Paolo Landa, Ph.D

23 Professeur Adjoint

24 Département d'opérations et systèmes de décision

25 Faculté des sciences de l'administration

26 Université Laval, Québec, QC, G1V 0A6, Canada

27 Local 2421, Tel :(+1)418-656-2131 (Ext. 413389)

28 Email: Paolo.Landa@fsa.ulaval.ca.

1
2
3 46 **Abstract**

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

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

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

70
71 **Keywords:** Healthcare trajectory, healthcare management, business process modelling
72 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.

114 INTRODUCTION

115 With the continuous challenges facing healthcare organisations in the past few years¹⁻³, many
116 strategies have focused on process improvements with the objective of enhancing efficiency
117 and efficacy to improve patient outcomes while controlling costs^{4,5}. Through the years, health
118 expenditure and financing has increased substantially in developed countries such as the United
119 States (US) and Canada⁶⁻⁹. In 2019, Canada spent 10.8% of its gross domestic product on
120 healthcare expenses according to the Organization for Economic Cooperation and
121 Development (OECD, 2021)⁹. This ratio reached 17.7% at the same time in the US, where the
122 national health spending is projected to reach \$6.2 trillion by 2028, growing at an average
123 annual rate of 5.4%^{8,9}. However, compared with other OECD countries, the US perform poorly
124 on process, outcome, and patient experience metrics, as well as life expectancy^{10,11}. Life
125 expectancy in the US was the lowest at 78.8 years compared with a range from 80.7 to 83.9
126 years for other OECD countries¹⁰. The infant mortality rate in the US was 5.8 per 1000 live
127 births and the maternal mortality rate was 17.4 per 100 000 births in 2018, both higher than the
128 mean rates for any OECD country¹¹⁻¹⁵. Canada is another developed country performing poorly
129 in terms of infant and maternal mortality, with 4.7 fatalities out of every 1,000 live births and
130 10.2 maternal deaths per 100 000 births^{11,16}.

131 The lack of control in processes used to deliver medical care is clearly a major problem in the
132 context of preventable medical errors with lethal damages and high economic costs in many
133 hospitals¹⁷⁻¹⁹. Since the released *Crossing the Quality Chasm*^{20,21} by the Institute of Medicine
134 (US), numerous national and international organizations including the Academies of
135 Sciences²² and the World Health Organization^{23,24} have made repeated calls to develop a
136 framework for advancing the quality of care, ensuring that care is safe, effective, efficient,
137 patient-centred, timely, and equitable²⁰. To do this, healthcare organizations and systems must
138 develop solutions that enhance both efficiency and efficacy of improving healthcare
139 organization and patient outcomes while restraining costs. Efforts to improve clinical and care
140 pathways have shown such benefits²⁵⁻²⁷. Over the last decades, studies have revealed that
141 mapping healthcare trajectories allowed to decrease the variation of professional practices and
142 to standardise care processes¹⁷⁻¹⁹. This practice has many benefits such as improving the
143 accessibility, fluidity, quality, performance, and sustainability of healthcare services^{25,28}.

144 In this context, several tools have been developed to support process improvement through
145 process mapping. Among these methods, business process modelling notation (BPMN) is an
146 approach that consists of representing processes as a network of activities and tasks²⁹⁻³¹. This
147 structured approach supported by the Object Management Group since 2005 and adopted as an

1
2
3 148 international standard by the International Organization for Standardization since 2012, is in
4
5 149 its second version (BPMN 2.0)³⁰⁻³².

6 150 In recent years, a few reviews³³⁻³⁶ have been conducted to analyse whether the BPMN
7
8 151 approach can become a useful tool to improve the effectiveness and quality of healthcare
9
10 152 processes. For instance, Loya et al.³³ used a service-oriented architecture in clinical decision
11
12 153 support and provided evidence that BPMN was not commonly used for clinical decision
13
14 154 support systems, despite being the preferred standard for business process modelling in
15
16 155 healthcare. Mincarone et al.³⁴ demonstrated that BPMN provides a good level of formalisation,
17
18 156 a standardised communication framework between multiple stakeholders, good user
19
20 157 comprehensibility, and easier interprofessional analyses. Fernández et al.³⁵ suggested that
21
22 158 BPMN is useful for standardising processes that have some variability due to its possibility to
23
24 159 incorporate variations or changes. Moreover, Zarour et al.³⁶ analysed various BPMN
25
26 160 extensions (e.g., decision modelling notation) that can be used to improve its efficiency in many
27
28 161 domains, showing that healthcare was among the most targeted area. The overall conclusion of
29
30 162 these reviews³³⁻³⁶ is that BPMN seems to be increasingly used in healthcare organizations to
31
32 163 the point of becoming a standard in process improvement methods. However, these studies<sup>33-
33
34 164 36</sup> acknowledged the difficulties and challenges when implementing BPMN in the health sector.
35
36 165 Indeed, a limitation of these studies³³⁻³⁶ is that none of them put the use of BPMN to improve
37
38 166 healthcare trajectories or patient care trajectory as its primary focus. Loya et al.³³ focused on
39
40 167 the use of BPMN for supporting clinical decisions and stated that BPMN has potential to
41
42 168 optimise clinical pathways, but they did not assess this possibility. The papers of Mincarone et
43
44 169 al.³⁴ and Fernández et al.³⁵ mainly focused on clinical processes, briefly addressing healthcare
45
46 170 trajectories, resulting in a shallow analysis on this subject. Finally, Zarour et al.³⁶ targeted many
47
48 171 BPMN extensions that could improve its effectiveness, but their research was not exclusive to
49
50 172 healthcare setting.

51
52 173 Our literature review builds on these previous reviews³³⁻³⁶ by providing an in-depth analysis
53
54 174 of the ability of BPMN to effectively improve the quality of clinical practices, the security, and
55
56 175 the fluidity of the care process and to propose tangible results on the patient experience in a
57
58 176 patient-centred care and services logic. Moreover, we will analyse the opportunities and
59
60 177 limitations related to the integration of BPMN extension.

61
62 178 Considering the above gaps in the literature, the primary aim of this scoping review is to
63
64 179 identify and map existing evidence on the main benefits and limitations associated with the use
65
66 180 of BPMN in healthcare trajectory modelling. To do so, we will assess its ability to model key
67
68 181 dimensions or concepts of the healthcare process and to meet the needs of stakeholders. The

1
2
3 182 review will also highlight the capacity of the BPMN approach and its extensions to support
4
5 183 clinical activities and decision-making processes associated with the healthcare trajectory and
6
7 184 propose a conceptual framework for improving the use of BPMN in healthcare practices.

8 185 **METHODS AND ANALYSIS**

9
10 186 We chose to undertake a scoping review as the best method to map the available evidence
11
12 187 regarding the benefits and limitations of BPMN in modelling patient healthcare trajectory³⁷⁻³⁹.
13
14 188 The present review will be conducted following the methodological frameworks described by
15
16 189 Arksey and O'Malley³⁷, and improved by Levac et al.³⁸, and further refined by the Joanna
17
18 190 Briggs Institute (JBI)⁴⁰. The standardized methodology included six stages for scoping review:
19
20 191 (1) Identifying the research question, (2) Identifying relevant studies and grey literature, (3)
21
22 192 Selecting studies, (4) Charting the data, (5) Collating, summarizing, and reporting the data, and
23
24 193 (6) Consulting with relevant stakeholders, thereby enabling knowledge translation. The
25
26 194 Preferred Reporting Items for Systematic Reviews and Meta-Analysis Extension for Scoping
27
28 195 Reviews (PRISMA-ScR)^{39,41} has also been used to guide the reporting of this protocol and will
29
30 196 also subsequently be used to structure the reporting of the full review. Furthermore, we will
31
32 197 take an iterative and reflexive approach throughout the review process, particularly to refine
33
34 198 our study selection and data extraction steps to the best target meeting our objective. This
35
36 199 protocol is registered through the Open Science Framework⁴².

34 200 **Stage 1: Identifying the Research Question**

36 201 As the focus of scoping reviews is on summarizing the breadth of evidence, the research
37
38 202 questions should be broad while keeping in mind the review's main purpose^{37,38,40,41}. Thus, we
39
40 203 started with, "What is known about the application of BPMN methodology in healthcare
41
42 204 organization?" A preliminary search was conducted through some electronic databases
43
44 205 including International Prospective Register of Systematic Reviews, JBI Database of
45
46 206 Systematic Reviews and Implementation Reports, Cochrane Database of Systematic Reviews,
47
48 207 and National Center for Biotechnology Information, which revealed three systematic reviews
49
50 208 of modelling healthcare processes using the BPMN methodology³³⁻³⁶. Although findings from
51
52 209 these reviews³³⁻³⁶ supported the use of BPMN as an effective methodology to optimise
53
54 210 healthcare processes, no conclusion on the effectiveness were drawn. The reason may be that
55
56 211 these reviews³³⁻³⁶ were not mainly focused on the use of BPMN to improve healthcare
57
58 212 trajectories.

56 213 In addition, we adopted the JBI's Population Concept and Context (PCC) framework⁴⁰ to
57
58 214 formulate the objectives and research questions, and to conceptualise the study and report
59
60

1
2
3 215 characteristics in terms of eligibility criteria (**Table 1**). We then consulted with experienced
4
5 216 colleagues³⁰ on our predefined set of questions to provide further input and feedback.

6
7 217 In line with our purpose to comprehensively map the extent, range and nature of evidence
8
9 218 examining the use or application of BPMN within the healthcare trajectory, we formulated four
10
11 219 specific research questions to guide this review.

- 12 220 1. What are the objectives for using BPMN in healthcare organization? What are the
13
14 221 expected results and what are the needs to be met?
- 15 222 2. What are the key variables, elements, concepts, and dimensions targeted by the BPMN
16
17 223 approach?
- 18
19 224 3. Can the BPMN approach meet these expectations in healthcare trajectory? Specifically,
20
21 225 a. What are the strengths (advantages) and weaknesses (limitations) of the BPMN in
22
23 226 modelling healthcare trajectory?
24
25 227 b. What are the effectiveness of using BPMN approach and its extensions in modelling
26
27 228 healthcare trajectory?
28
29 229 c. What are their opportunities and constraints in modelling healthcare processes?
- 30
31 230 4. What are the improvements or alternatives proposed to optimizing healthcare trajectory?

32
33 231 For the purposes of this review, the term healthcare trajectory focuses on the patient's care
34
35 232 pathway across the continuum of care. Thus, it can be the clinical pathway when it focuses on
36
37 233 the organizational scale, but also the care pathway when it focuses on the systemic scale. It
38
39 234 consists first of the patient's journey through the sequencing of tasks and activities at all points
40
41 235 of contact^{43,44}. It then integrates the professional actors involved in the care trajectory,^{45,46} the
42
43 236 operation management of care delivery processes^{47,48}, the coordination structures⁴⁹⁻⁵¹, the
44
45 237 structural context of the system and organizations^{52,53} as well as the information trajectory
46
47 238 along the healthcare trajectory^{54,55}. Thus, our understanding of the term healthcare trajectory is
48
49 239 not limited to the operational aspect of the care process and to the pathophysiological process
50
51 240 of a patient's disease state, but also refers to the organisation of all activities surrounding
52
53 241 interactions between health care workers and patients, as well as the effectiveness of patient
54
55 242 care processes and their effectiveness.

56
57 243 Therefore, our analysis will consider not only the operational outcomes of the application
58
59 244 BPMN, but also its societal impact by assessing its potential to improve patient outcomes and
60
245 experience. In addition, healthcare process mapping includes several different flows. On one
246
247 hand, the main process follows the patient's journey through the process steps and the decision
248
249 points guide the patient through the process⁵⁶. On the other hand, the support processes and
250
251 secondary flows include steps directly or indirectly linked to the main process such as

1
2
3 249 administrative processes, information flow, organizational processes, and examinations that do
4
5 250 not require the presence of the patient (e.g., laboratory results, pathological tests). Thus, several
6
7 251 flows can be present and impact the care process (e.g., information flow, drug flow, blood
8
9 252 flow,).

10 253 Therefore, this scoping review will focus on the potential of the BPMN and all its components
11
12 254 to impact the results of healthcare trajectories directly or indirectly. Finally, the review will
13
14 255 also consider proposals for extensions to BPMN have been put forward to integrate evidence-
15
16 256 based medicine and guidelines to support clinical decision making, including the Decision
17
18 257 Modelling Notation proposed by both the Object Management Group^{56,57} and the Computer
19
20 258 Interpretable Guidelines^{58,59}.

21 259
22 260
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

261 **Table 1:** PCC framework⁴⁰ 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.

262

263 **Stage 2: Identifying Relevant Studies**

264 A comprehensive search strategy was developed with the assistance of an experienced health
265 sciences librarian (FB). The search strategy will follow the three-step approach recommended
266 by JBI scoping review guidelines⁴⁰ and will target the retrieval of both published and
267 unpublished articles from electronic searches databases, focusing to BPMN modelling of
268 patient care trajectory. The first step of the scoping review guidelines has been completed in
269 preparation of this protocol (**Table 1**), which involved an initial limited search on PubMed and
270 ABI/Inform (ProQuest) databases, using the following selected keywords: "Healthcare
271 Process" OR "Clinical Process " OR "Process of Care" OR "Clinical Pathways" OR "Patient
272 care Process" OR "Healthcare trajectory" OR Patient Care Management" OR "Critical
273 Pathways" OR "Clinical Healthcare Pathways" AND "Business Process Model" OR "Business
274 Process Modelling Notation" OR "Business Process Model" OR "BPMN modelling" OR
275 "Workflow" OR "Clinical Decision-Making" OR "Decision Support Systems" OR "Medical
276 Process". The index words and the text words in the title and abstract of retrieved articles were
277 analysed to identify search terms and refine the search strategy for the next step.

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

289 **Stage 3: Selecting Literature for Inclusion**

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

1
2
3 297 criteria if necessary to ensure consistent interpretation and application of the criteria. The
4
5 298 researchers will discuss their selection of articles after this first round of screening, to arrive at
6
7 299 preliminary consensus on the list of eligible studies. In the second step, the two reviewers will
8
9 300 screen the full-text articles independently to determine if they meet the inclusion criteria.
10
11 301 Reasons for the exclusion of full-text articles will be noted in Covidence⁶¹ by each reviewer.
12
13 302 Reviewers will again discuss their selection of articles after this second round of screening, to
14
15 303 arrive at a final list of eligible studies. Discrepancies will again be resolved through discussion
16
17 304 between the two reviewers and where agreement could not be reached, a third reviewer will be
18
19 305 consulted. The screening process will be documented using a PRISMA flowchart for scoping
20
21 306 review^{39,41} and by calculating the inter-rater reliability between reviewers using the Cohen's
22
23 307 Kappa coefficient⁶².

24 308 **Stage 4: Charting of Information and Data**

25 309 Data will be extracted from every eligible article using a data extraction chart (**Charting**
26 310 **Table**) tailored to the research questions. Its aim is to maintain a manageable amount of data,
27 311 while ensuring a wide approach and breadth of coverage to obtain existing evidence on the
28 312 benefits and limitations associated with BPMN in patient care trajectory. Two researchers
29 313 (KSA and JBG or LL) will independently extract the following study information: authorship,
30 314 year of publication, country of origin, study purpose, patient care trajectory issues being
31 315 addressed (e.g., diabetes, chronic obstructive pulmonary disease, coronary heart disease,
32 316 clinical pathways for contraception), study population/target users (e.g., physicians, clinicians,
33 317 nurses, pharmacists), setting/location of intervention (e.g., primary care, acute care,
34 318 rehabilitation, home care, long-term care, community, hospital), methodological approach
35 319 (qualitative, quantitative, or mixed study), expected results study findings (e.g., decreasing
36 320 diagnostic delay, optimizing of quality care, cost, reducing medical errors, standardising the
37 321 decision-making process), type of outcomes/dimension analysed (e.g., diagnostic times,
38 322 waiting time for surgery, flexibility, improving key performance indicators, decision support
39 323 systems). We will note the objectives and benefits, as well the limitations of using BPMN and
40 324 BPMN-extension approach. The proposed Charting Table is shown in **online Supplementary**
41 325 **Appendix II**. It will be trialled on five included studies and will be iteratively refined.
42 326 Adjustments or expansions may also be made to the **Charting Table** if necessary to ensure
43 327 that the research objectives or questions are well addressed. For instance, we may add
44 328 additional categories of data deemed relevant to answer the research questions to the Charting
45 329 Table.

50 330 **Stage 5: Collating, Summarizing, and Reporting the Data**

1
2
3 331 The main findings of the included studies will be summarised in Tabular format in a manner
4
5 332 that reflects the objectives of the review. Following the PCC principles⁴⁰, a narrative summary
6
7 333 will accompany the Tabular results and link the different findings to the review objective and
8
9 334 questions and will identify any knowledge gaps in the literature. To ensure rigour in this stage,
10
11 335 two reviewers (KSA and JBG or LL) will prepare a descriptive summary table of the extracted
12
13 336 data and will highlight the key findings with input from the research team. The table will
14
15 337 include a descriptive summary of the studies and a qualitative thematic analysis of the main
16
17 338 results regarding characteristics of the BPMN approach used in each study (e.g., objective,
18
19 339 benefit, challenges, target users, redesign the clinical process), type of patient trajectory,
20
21 340 characteristics of the research designs, outcomes of interest used to measure the effectiveness
22
23 341 of BPMN (e.g., reducing work time, and challenges and potential solutions learned). We will
24
25 342 identify barriers or limitations of BPMN for achieving improvement of healthcare processes,
26
27 343 support activities and decision-making processes, and use that information to address our main
28
29 344 objectives. The consultation stage of the scoping review, described in the following section,
30
31 345 will contribute to fulfilling that objective and to establish a conceptual framework for
32
33 346 improving the use of BPMN in healthcare trajectory modelling. Finally, if the extracted data
34
35 347 allow it, a qualitative analysis will be conducted to discuss or nuance the evidence of BPMN
36
37 348 effectiveness considering potential barriers and enablers identified by the authors. We will use
38
39 349 the PRISMA-ScR to guide the final reporting of our results.

350 **Stage 6: Consultation with Stakeholders**

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

363 **ETHICS AND DISSEMINATION**

1
2
3 364 This scoping review is exempt from ethics approval because the work carried out will be based
4
5 365 on published documents. The aim of this project is to synthesise the literature about healthcare
6
7 366 trajectory using BPMN approach to enhance conceptual clarity and understanding about key
8
9 367 benefits and limitations and to extrapolate from this evidence base promising conceptual
10
11 368 framework for improving the use of BPMN in healthcare trajectory. We anticipate the research
12
13 369 will provide several key outputs including (1) a comprehensive review that will summarize
14
15 370 existing literature on the BPMN approach; (2) an evidence base demonstrating the benefits and
16
17 371 limitation of the BPMN approach in modelling patient trajectory; (3) a list of BPMN extensions
18
19 372 that can be used to improve its efficiency in many domains; (4) a conceptual framework. Our
20
21 373 findings will be disseminated in peer-reviewed journals and presentations and through
22
23 374 discussions with relevant organisations and stakeholders. Our goal will be to disseminate our
24
25 375 findings to a wide range of clinicians, leaders, and administrators in all sectors, to researchers
26
27 376 and to students entering the healthcare professions to enhance understanding about key benefits
28
29 377 and limitations of BPMN approach for optimising the patient trajectory. We believe the results
30
31 378 will benefit clinicians by guiding their decision-making throughout the patient's trajectory,
32
33 379 therefore reducing the medical error rate, optimising efficient resource management, and
34
35 380 reducing the risks of complications due to poor clinical decisions. Those improvements should
36
37 381 result in an optimisation of cost-efficiency for organisations and quality of care for patients.

382

36 383 **Contributors:** KSA, JBG and AC led the design, search strategy and conceptualisation of this
37
38 384 work and drafted the protocol. PL, FB, and CP were involved in the conceptualisation of the
39
40 385 review design, inclusion and exclusion criteria and provided feedback on the methodology and
41
42 386 the manuscript. KSA and LL were involved in data extraction forms. All authors provided
43
44 387 feedback on the manuscript and approval to the publishing of this protocol manuscript.

44 388 **Funding** None.

46 389 **Competing interests:** The authors declare no potential conflict of interest

48 390 **Patient consent:** Not required.

50 391 **Ethics approval: Research** ethics approval is not required for a scoping review.

51 392 **Provenance and peer review:** Not commissioned; externally peer reviewed.

53 393

54 394

55 395

57 396 **Reference**

- 1
2
3 397 1. McMahon M, Nadigel J, Thompson E, Glazier RH. Informing Canada's health system
4 398 response to COVID-19: priorities for health services and policy research. *Healthcare*
5 399 *Policy*. 2020;16(1):112.
- 6 400 2. Smylie J, Anderson M. Understanding the health of Indigenous peoples in Canada:
7 401 key methodological and conceptual challenges. *Cmaj*. 2006;175(6):602-602.
- 8 402 3. Smylie J, Firestone M. Back to the basics: Identifying and addressing underlying
9 403 challenges in achieving high quality and relevant health statistics for indigenous
10 404 populations in Canada. *Statistical Journal of the IAOS*. 2015;31(1):67-87.
- 11 405 4. Cortada J, Gordon D, Lenihan B. The value of analytics in healthcare: From insights
12 406 to outcomes. *IBM Global Business Services, Executive Report*. 2012.
- 13 407 5. Contandriopoulos D, Brousselle A, Larouche C, et al. Healthcare reforms, inertia
14 408 polarization and group influence. *Health Policy*. 2018;122(9):1018-1027.
- 15 409 6. Himmelstein DU, Campbell T, Woolhandler S. Health care administrative costs in the
16 410 United States and Canada, 2017. *Annals of internal medicine*. 2020;172(2):134-142.
- 17 411 7. Liu C, Tsugawa Y, Weiser TG, Scott JW, Spain DA, Maggard-Gibbons M.
18 412 Association of the US Affordable Care Act with out-of-pocket spending and
19 413 catastrophic health expenditures among adult patients with traumatic injury. *JAMA*
20 414 *network open*. 2020;3(2):e200157-e200157.
- 21 415 8. Keehan SP, Cuckler GA, Poisal JA, et al. National Health Expenditure Projections,
22 416 2019–28: Expected Rebound In Prices Drives Rising Spending Growth: National
23 417 health expenditure projections for the period 2019–2028. *Health Affairs*.
24 418 2020;39(4):704-714.
- 25 419 9. OCDE. *Health at a Glance 2021*. 2021.
- 26 420 10. Papanicolas I, Woskie LR, Jha AK. Health Care Spending in the United States and
27 421 Other High-Income Countries. *JAMA*. 2018;319(10):1024-1039.
- 28 422 11. Emanuel EJ, Gudbranson E, Van Parys J, Gørtz M, Helgeland J, Skinner J.
29 423 Comparing health outcomes of privileged US citizens with those of average residents
30 424 of other developed countries. *JAMA internal medicine*. 2021;181(3):339-344.
- 31 425 12. Singh GK, Stella MY. Infant mortality in the United States, 1915-2017: large social
32 426 inequalities have persisted for over a century. *International Journal of Maternal and*
33 427 *Child Health and AIDS*. 2019;8(1):19.
- 34 428 13. Declercq E, Zephyrin L. Maternal mortality in the United States: a primer.
35 429 *Commonwealth Fund*. 2020.
- 36 430 14. Hoyert DL. Maternal mortality rates in the United States, 2019. 2020.
- 37 431 15. Singh GK. Trends and social inequalities in maternal mortality in the United States,
38 432 1969-2018. *International Journal of Maternal and Child Health and AIDS*.
39 433 2021;10(1):29.
- 40 434 16. Cook JL, Majd M, Blake J, et al. Measuring Maternal Mortality and Morbidity in
41 435 Canada. *J Obstet Gynaecol Can*. 2017;39(11):1028-1037.
- 42 436 17. Gauld R, Burgers J, Dobrow M, et al. Healthcare system performance improvement: a
43 437 comparison of key policies in seven high-income countries. *Journal of health*
44 438 *organization and management*. 2014.
- 45 439 18. Lee SE, Scott LD, Dahinten VS, Vincent C, Lopez KD, Park CG. Safety culture,
46 440 patient safety, and quality of care outcomes: a literature review. *Western journal of*
47 441 *nursing research*. 2019;41(2):279-304.
- 48 442 19. Kruk ME, Gage AD, Arsenault C, et al. High-quality health systems in the
49 443 Sustainable Development Goals era: time for a revolution. *The Lancet global health*.
50 444 2018;6(11):e1196-e1252.
- 51 445 20. Baker A. *Crossing the quality chasm: a new health system for the 21st century*. Vol
52 446 323: British Medical Journal Publishing Group; 2001.

- 1
2
3 447 21. Wolfe A. Institute of Medicine report: crossing the quality chasm: a new health care
4 448 system for the 21st century. *Policy, Politics, & Nursing Practice*. 2001;2(3):233-235.
5 449 22. National Academies of Sciences E, Medicine. Crossing the global quality chasm:
6 450 Improving health care worldwide. 2018.
7 451 23. Organization WH. Framework on integrated, people-centred health services. *Geneva:*
8 452 *World Health Organization*. 2016:2019.
9 453 24. Organization WH. WHO report on cancer: setting priorities, investing wisely and
10 454 providing care for all. 2020.
11 455 25. Bergin RJ, Whitfield K, White V, et al. Optimal care pathways: A national policy to
12 456 improve quality of cancer care and address inequalities in cancer outcomes. *Journal*
13 457 *of cancer policy*. 2020;25:100245.
14 458 26. Allen D, Gillen E, Rixson L. Systematic review of the effectiveness of integrated care
15 459 pathways: what works, for whom, in which circumstances? *International Journal of*
16 460 *Evidence-Based Healthcare*. 2009;7(2):61-74.
17 461 27. Lodewijckx C, Sermeus W, Panella M, et al. Impact of care pathways for in-hospital
18 462 management of COPD exacerbation: a systematic review. *International journal of*
19 463 *nursing studies*. 2011;48(11):1445-1456.
20 464 28. Alkandari M, Ryan K, Hollywood A. The experiences of people living with
21 465 peripheral neuropathy in Kuwait—a process map of the patient journey. *Pharmacy*.
22 466 2019;7(3):127.
23 467 29. Ferreira AS, Oliveira GR. Business process modeling: A webibliomining perspective
24 468 of architecture frameworks. *Independent Journal of Management & Production*.
25 469 2019;10(3):1159-1183.
26 470 30. Ramudhin A, Bulgak AA, Fowler JG. A business process improvement study in a
27 471 specialized North American hospital. Paper presented at: PICMET 2010
28 472 TECHNOLOGY MANAGEMENT FOR GLOBAL ECONOMIC GROWTH2010.
29 473 31. Ramudhin A, Chan E, Mokadem A. A framework for the modelling, analysis and
30 474 optimization of pathways in healthcare. Paper presented at: 2006 International
31 475 Conference on Service Systems and Service Management2006.
32 476 32. Ramudhin A, Chan E, Benziane R, Mokadem A. Modeling and optimization of health
33 477 care processes. Paper presented at: IIE Annual Conference. Proceedings2006.
34 478 33. Loya SR, Kawamoto K, Chatwin C, Huser V. Service oriented architecture for
35 479 clinical decision support: A systematic review and future directions. *Journal of*
36 480 *medical systems*. 2014;38(12):1-22.
37 481 34. Mincarone P, Leo CG, Trujillo-Martín MdM, et al. Standardized languages and
38 482 notations for graphical modelling of patient care processes: a systematic review.
39 483 *International Journal for Quality in Health Care*. 2018;30(3):169-177.
40 484 35. De Ramon Fernandez A, Ruiz Fernandez D, Sabuco Garcia Y. Business Process
41 485 Management for optimizing clinical processes: A systematic literature review. *Health*
42 486 *informatics journal*. 2020;26(2):1305-1320.
43 487 36. Zarour K, Benmerzoug D, Guermouche N, Drira K. A systematic literature review on
44 488 BPMN extensions. *Business Process Management Journal*. 2019.
45 489 37. Arksey H, O'Malley L. Scoping studies: towards a methodological framework.
46 490 *International journal of social research methodology*. 2005;8(1):19-32.
47 491 38. Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology.
48 492 *Implementation science*. 2010;5(1):1-9.
49 493 39. Tricco AC, Lillie E, Zarin W, et al. A scoping review on the conduct and reporting of
50 494 scoping reviews. *BMC medical research methodology*. 2016;16(1):1-10.
51 495 40. Peters MD, Godfrey C, McInerney P, Munn Z, Tricco AC, Khalil H. Chapter 11:
52 496 scoping reviews (2020 version). *JBIM manual for evidence synthesis, JBI*. 2020;2020.

- 1
2
3 497 41. Tricco AC, Lillie E, Zarin W, et al. PRISMA extension for scoping reviews
4 498 (PRISMA-ScR): checklist and explanation. *Annals of internal medicine*.
5 499 2018;169(7):467-473.
6
7 500 42. Abasse KS, Gartner J-B, Labbé L, et al. Benefits and Limitations of Business Process
8 501 Model Notation in Modeling Patient Healthcare Trajectory: A Scoping Review
9 502 Protocol. 2021.
10 503 43. Ponsignon F, Smart A, Phillips L. A customer journey perspective on service delivery
11 504 system design: insights from healthcare. *International Journal of Quality &*
12 505 *Reliability Management*. 2018.
13 506 44. Alexander GL. The nurse—patient trajectory framework. *Studies in health technology*
14 507 *and informatics*. 2007;129(Pt 2):910.
15 508 45. Beauséjour M, Goulet L, Feldman DE, et al. Pathways of healthcare utilisation in
16 509 patients with suspected adolescent idiopathic scoliosis: a cross-sectional study. *BMC*
17 510 *health services research*. 2015;15(1):1-12.
18 511 46. Louis CJ, Clark JR, Gray B, Brannon D, Parker V. Service line structure and
19 512 decision-maker attention in three health systems: Implications for patient-centered
20 513 care. *Health care management review*. 2019;44(1):41-56.
21 514 47. Yang H, Li W, Liu K, Zhang J. Knowledge-based clinical pathway for medical
22 515 quality improvement. *Information systems frontiers*. 2012;14(1):105-117.
23 516 48. De Bleser L, Depreitere R, WAELE KD, Vanhaecht K, Vlayen J, Sermeus W.
24 517 Defining pathways. *Journal of nursing management*. 2006;14(7):553-563.
25 518 49. Aziz AFA, Nordin NAM, Ali MF, Abd Aziz NA, Sulong S, Aljunid SM. The
26 519 integrated care pathway for post stroke patients (iCaPPS): a shared care approach
27 520 between stakeholders in areas with limited access to specialist stroke care services.
28 521 *BMC health services research*. 2017;17(1):1-11.
29 522 50. Busari JO, Yaldiz H, Gans RO, Duits AJ. Clinical Leadership as an Agent for
30 523 Change: A Health System Improvement Intervention in Curaçao. *Journal of*
31 524 *multidisciplinary healthcare*. 2020;13:787.
32 525 51. Seguin ML, Rangnekar A, Renedo A, Palafox B, McKee M, Balabanova D.
33 526 Systematic review of frameworks used to conceptualise health pathways of
34 527 individuals diagnosed with cardiovascular diseases. *BMJ global health*.
35 528 2020;5(9):e002464.
36 529 52. Valentijn PP, Biermann C, Bruijnzeels MA. Value-based integrated (renal) care:
37 530 setting a development agenda for research and implementation strategies. *BMC health*
38 531 *services research*. 2016;16(1):1-11.
39 532 53. Elkhuzen SG, Vissers JM, Mahdavi M, Van De Klundert JJ. Modeling Patient
40 533 Journeys for Demand Segments in Chronic Care, With an Illustration to Type 2
41 534 Diabetes. *Frontiers in Public Health*. 2020;8.
42 535 54. Fung-Kee-Fung M, Maziak D, Pantarotto J, et al. Regional process redesign of lung
43 536 cancer care: a learning health system pilot project. *Current Oncology*. 2018;25(1):59-
44 537 66.
45 538 55. Mohr P, Galderisi S, Boyer P, et al. Value of schizophrenia treatment I: The patient
46 539 journey. *European Psychiatry*. 2018;53:107-115.
47 540 56. Combi C, Oliboni B, Zardiniy A, Zerbato F. Seamless design of decision-intensive
48 541 care pathways. Paper presented at: 2016 IEEE International Conference on Healthcare
49 542 Informatics (ICHI)2016.
50 543 57. Cánovas-Segura B, Zerbato F, Oliboni B, et al. A process-oriented approach for
51 544 supporting clinical decisions for infection management. Paper presented at: 2017
52 545 IEEE International Conference on Healthcare Informatics (ICHI)2017.
53
54
55
56
57
58
59
60

- 1
2
3 546 58. Hewelt M, Kunde A, Weske M, Meinel C. Recommendations for medical treatment
4 547 processes: the PIGS approach. Paper presented at: International Conference on
5 548 Business Process Management2014.
6 549 59. de Bruin JS, Adlassnig K-P, Leitich H, Rappelsberger A. Separating business logic
7 550 from medical knowledge in digital clinical workflows using business process model
8 551 and notation and arden syntax. In: *Health Informatics Meets eHealth*. IOS Press;
9 552 2018:17-24.
10 553 60. Babineau J. Product review: covidence (systematic review software). *Journal of the*
11 554 *Canadian Health Libraries Association/Journal de l'Association des bibliothèques de*
12 555 *la santé du Canada*. 2014;35(2):68-71.
13 556 61. Kellermeyer L, Harnke B, Knight S. Covidence and Rayyan. *Journal of the Medical*
14 557 *Library Association: JMLA*. 2018;106(4):580.
15 558 62. McHugh ML. Interrater reliability: the kappa statistic. *Biochemia medica*.
16 559 2012;22(3):276-282.
17 560

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	<i>Peer review publications only limit</i>	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

For peer review only - <http://bmjopen.bmj.com/site/about/guidelines.xhtml>

1	"Business Process management") AND "clinical pathways"	
2	3 ("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR	20
3	"Business Process management") AND "critical pathways"	
4	4 ("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR	20
5	"Business Process management") AND "healthcare pathways"	
6	5 ("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR	20
7	"Business Process management") AND "clinical process"	
8	6 ("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR	20
9	"Business Process management") AND "medical process"	
10	7 ("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR	20
11	"Business Process management") AND "healthcare process"	
12	8 ("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR	20
13	"Business Process management") AND "health care process"	
14	9 ("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR	20
15	"Business Process management") AND guideline	
16	10 ("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR	20
17	"Business Process management") AND guidelines	
18	11 ("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR	20
19	"Business Process management") AND "decision support"	
20	12 ("Business Process Model" OR "Business Process Modelling" OR "Business Process Modeling" OR	1
21	"Business Process management") AND "Healthcare trajectory"	
22	Total number of results	221

BMJ Open

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

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2021-060357.R1
Article Type:	Protocol
Date Submitted by the Author:	09-Apr-2022
Complete List of Authors:	Kassim, Said; Universite Laval; Laval University Department of Management, Gartner, Jean-Baptiste; Université Laval, Département de management Labbé, Laurence; Laval University, Management Landa, Paolo; Laval University, Operations and Decision Systems Department; Centre de recherche du CHU de Québec, Université Laval Paquet, Catherine; Université Laval Département de management Bergeron, Frédéric; Université Laval Lemaire, Célia; EM Strasbourg Business School Côté, André; Universite Laval Departement de management, Département de management
Primary Subject Heading:	Health informatics
Secondary Subject Heading:	Medical management, Health services research
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

SCHOLARONE™
Manuscripts

1 Benefits and Limitations of Business Process Model Notation in Modelling

2 Patient Healthcare Trajectory: A Scoping Review Protocol

3 Running title: Modelling Patient Healthcare Trajectory using BPMN

4 Kassim Said Abasse^{1,2,3,4,5}, Jean-Baptiste Gartner^{1,2,3,5}, Laurence Labbé^{1,2}, Paolo Landa^{3,6*},

5 Catherine Paquet^{3,8,9}, Frédéric Bergeron¹⁰, Célia Lemaire¹¹, André Côté^{1,2,3,4,5}.

6 ¹Département de management, Faculté des sciences de l'administration, Université Laval,
7 Québec, G1V 0A6, Canada.

8 ²Centre de recherche en gestion des services de santé, Université Laval, Québec, G1V 0A6,
9 Canada.

10 ³Centre de recherche du CHU de Québec, Université Laval, Québec, G1V 0A6, Canada

11 ⁴VITAM, Centre de recherche en santé durable, Université Laval, Québec, G1V 0A6, Canada.

12 ⁵Centre de recherche du CISSS de Chaudière-Appalaches, Québec, G1V 0A6, Canada.

13 ⁶Département d'opérations et systèmes de décision, Faculté des sciences de l'administration
14 Université Laval, Québec, G1K 7P4, Canada

15 ⁸Département de marketing, Faculté des sciences de l'administration, Université Laval,
16 Québec, G1V 0A6, Canada.

17 ⁹Centre NUTRISS-Nutrition, Santé et société Université Laval, Québec, G1V 0A6, Canada.

18 ¹⁰Bibliothèque, Direction des services-conseils, Université Laval, Québec, G1V 0A6, Canada

19 ¹¹Université de Strasbourg, EM Strasbourg-Business School, HuManiS, Strasbourg, France.

20 *Corresponding Author

21 Paolo Landa, Ph.D

22 Professeur Adjoint

23 Département d'opérations et systèmes de décision

24 Faculté des sciences de l'administration

25 Université Laval, Québec, QC, G1V 0A6, Canada

26 Local 2421, Tel :(+1)418-656-2131 (Ext. 413389)

27 Email: Paolo.Landa@fsa.ulaval.ca.

46 **Abstract**

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

58 **Methods and Analysis:** This study will be performed in accordance with the methodological
59 framework suggested by Arksey and O'Malley. A wide range of electronic databases and grey
60 literature sources will be systematically searched using predefined keywords. The review will
61 include any study design focusing on the application of the BPMN approach for optimising
62 healthcare trajectories, published in either English or French from January 2004 to December
63 2021. Two reviewers will independently screen titles, abstracts, and full-text articles and select
64 articles meeting the inclusion criteria. A customised data extraction form will be used to extract
65 data. The results will be presented using descriptive statistics and thematic analysis on
66 qualitative data.

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

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

75

76

77

78

79

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.

114 INTRODUCTION

115 With the continuous challenges facing healthcare organizations in the past few years¹⁻³, many
116 strategies have focused on process improvements with the objective of enhancing efficiency
117 and efficacy to improve patient outcomes while controlling costs^{4,5}. Through the years, health
118 expenditure and financing has increased substantially in developed countries such as the United
119 States (US) and Canada⁶⁻⁹. In 2019, Canada spent 10.8% of its gross domestic product on
120 healthcare expenses according to the Organization for Economic Cooperation and
121 Development (OECD, 2021)⁹. This ratio reached 17.7% at the same time in the US, where the
122 national health spending is projected to reach \$6.2 trillion by 2028, growing at an average
123 annual rate of 5.4%^{8,9}. However, compared with other OECD countries, the US perform poorly
124 on process, outcome, and patient experience metrics, as well as life expectancy^{10,11}. Life
125 expectancy in the US was the lowest at 78.8 years compared with a range from 80.7 to 83.9
126 years for other OECD countries¹⁰. The infant mortality rate in the US was 5.8 per 1000 live
127 births and the maternal mortality rate was 17.4 per 100 000 births in 2018, both higher than the
128 mean rates for any OECD country¹¹⁻¹⁵. Canada is another developed country performing poorly
129 in terms of infant and maternal mortality, with 4.7 fatalities out of every 1,000 live births and
130 10.2 maternal deaths per 100 000 births^{11,16}.

131 The lack of control in processes used to deliver medical care is clearly a major problem in the
132 context of preventable medical errors with lethal damages and high economic costs in many
133 hospitals¹⁷⁻¹⁹. Since the released *Crossing the Quality Chasm*^{20,21} by the Institute of Medicine
134 (US), numerous national and international organizations including the Academies of
135 Sciences²² and the World Health Organization^{23,24} have made repeated calls to develop a
136 framework for advancing the quality of care, ensuring that care is safe, effective, efficient,
137 patient-centred, timely, and equitable²⁰. To do this, healthcare organizations and systems must
138 develop solutions that enhance both efficiency and efficacy of improving healthcare
139 organization and patient outcomes while restraining costs. Efforts to improve clinical and care
140 pathways have shown such benefits²⁵⁻²⁷. Over the last decades, articles have revealed that
141 mapping healthcare trajectories allowed to decrease the variation of professional practices and
142 to standardise care processes¹⁷⁻¹⁹. This practice has many benefits such as improving the
143 accessibility, fluidity, quality, performance, and sustainability of healthcare services^{25,28}.

144 In this context, several tools have been developed to support process improvement through
145 process mapping. Among these methods, business process modelling notation (BPMN) is an
146 approach that consists of representing processes as a network of activities and tasks²⁹⁻³¹. This
147 structured approach supported by the Object Management Group since 2005 and adopted as an

1
2
3 148 international standard by the International Organization for Standardization since 2012, is in
4
5 149 its second version (BPMN 2.0)³⁰⁻³².

6 150 In recent years, a few reviews³³⁻³⁶ have been conducted to analyse whether the BPMN
7
8 151 approach can become a useful tool to improve the effectiveness and quality of healthcare
9
10 152 processes. For instance, Loya et al.³³ used a service-oriented architecture in clinical decision
11
12 153 support and provided evidence that BPMN was not commonly used for clinical decision
13
14 154 support systems, despite being the preferred standard for business process modelling in
15
16 155 healthcare. Mincarone et al.³⁴ demonstrated that BPMN provides a good level of formalisation,
17
18 156 a standardised communication framework between multiple stakeholders, good user
19
20 157 comprehensibility, and easier interprofessional analyses. Fernández et al.³⁵ suggested that
21
22 158 BPMN is useful for standardising processes that have some variability due to its possibility to
23
24 159 incorporate variations or changes. Moreover, Zarour et al.³⁶ analysed various BPMN
25
26 160 extensions (e.g., decision modelling notation) that can be used to improve its efficiency in many
27
28 161 domains, showing that healthcare was among the most targeted area. The overall conclusion of
29
30 162 these reviews³³⁻³⁶ is that BPMN seems to be increasingly used in healthcare organizations to
31
32 163 the point of becoming a standard in process improvement methods. However, these articles<sup>33-
33
34 164 36</sup> acknowledged the difficulties and challenges when implementing BPMN in the health sector.
35
36 165 Indeed, a limitation of these articles³³⁻³⁶ is that none of them put the use of BPMN to improve
37
38 166 healthcare trajectories or patient care trajectory as its primary focus. Loya et al.³³ focused on
39
40 167 the use of BPMN for supporting clinical decisions and stated that BPMN has potential to
41
42 168 optimise clinical pathways, but they did not assess this possibility. The papers of Mincarone et
43
44 169 al.³⁴ and Fernández et al.³⁵ mainly focused on clinical processes, briefly addressing healthcare
45
46 170 trajectories, resulting in a shallow analysis on this subject. Finally, Zarour et al.³⁶ targeted many
47
48 171 BPMN extensions that could improve its effectiveness, but their research was not exclusive to
49
50 172 healthcare setting.

51
52 173 Our literature review builds on these previous reviews³³⁻³⁶ by providing an in-depth analysis
53
54 174 of the ability of BPMN to effectively improve the quality of clinical practices, the security, and
55
56 175 the fluidity of the care process and to propose tangible results on the patient experience in a
57
58 176 patient-centred care and services logic. Moreover, we will analyse the opportunities and
59
60 177 limitations related to the integration of BPMN extension.

61
62 178 Considering the above gaps in the literature, the primary aim of this scoping review is to
63
64 179 identify and map existing evidence on the main benefits and limitations associated with the use
65
66 180 of BPMN in healthcare trajectory modelling. To do so, we will assess its ability to model key
67
68 181 dimensions or concepts of the healthcare process and to meet the needs of stakeholders. The

1
2
3 182 review will also highlight the capacity of the BPMN approach and its extensions to support
4
5 183 clinical activities and decision-making processes associated with the healthcare trajectory and
6
7 184 propose a conceptual framework for improving the use of BPMN in healthcare practices.

8 185 **METHODS AND ANALYSIS**

9
10 186 We chose to undertake a scoping review as the best method to map the available evidence
11
12 187 regarding the benefits and limitations of BPMN in modelling patient healthcare trajectory³⁷⁻³⁹.
13
14 188 The present review will be conducted following the methodological frameworks described by
15
16 189 Arksey and O'Malley³⁷, and improved by Levac et al.³⁸, and further refined by the Joanna
17
18 190 Briggs Institute (JBI)⁴⁰. The standardized methodology included six stages for scoping review:
19
20 191 (1) Identifying the research question, (2) Identifying relevant articles and grey literature, (3)
21
22 192 Selecting articles, (4) Charting the data, (5) Collating, summarizing, and reporting the data,
23
24 193 and (6) Consulting with relevant stakeholders, thereby enabling knowledge translation. The
25
26 194 Preferred Reporting Items for Systematic Reviews and Meta-Analysis Extension for Scoping
27
28 195 Reviews (PRISMA-ScR)^{39,41} has also been used to guide the reporting of this protocol and will
29
30 196 also subsequently be used to structure the reporting of the full review. Furthermore, we will
31
32 197 take an iterative and reflexive approach throughout the review process, particularly to refine
33
34 198 our study selection and data extraction steps to the best target meeting our objective. This
35
36 199 protocol is registered through the Open Science Framework⁴².

34 200 **Stage 1: Identifying the Research Question**

36 201 As the focus of scoping reviews is on summarizing the breadth of evidence, the research
37
38 202 questions should be broad while keeping in mind the review's main purpose^{37,38,40,41}. Thus, we
39
40 203 started with, "What is known about the application of BPMN methodology in healthcare
41
42 204 organization?" A preliminary search was conducted through some electronic databases
43
44 205 including International Prospective Register of Systematic Reviews, JBI Database of
45
46 206 Systematic Reviews and Implementation Reports, Cochrane Database of Systematic Reviews,
47
48 207 and National Center for Biotechnology Information, which revealed three systematic reviews
49
50 208 of modelling healthcare processes using the BPMN methodology³³⁻³⁶. Although findings from
51
52 209 these reviews³³⁻³⁶ supported the use of BPMN as an effective methodology to optimise
53
54 210 healthcare processes, no conclusion on the effectiveness were drawn. The reason may be that
55
56 211 these reviews³³⁻³⁶ were not mainly focused on the use of BPMN to improve healthcare
57
58 212 trajectories.

56 213 In addition, we adopted the JBI's Population Concept and Context (PCC) framework⁴⁰ to
57
58 214 formulate the objectives and research questions, and to conceptualise the study and report
59
60

1
2
3 215 characteristics in terms of eligibility criteria (**Table 1**). We then consulted with experienced
4
5 216 colleagues³⁰ on our predefined set of questions to provide further input and feedback.

6
7 217 In line with our purpose to comprehensively map the extent, range and nature of evidence
8
9 218 examining the use or application of BPMN within the healthcare trajectory, we formulated four
10
11 219 specific research questions to guide this review.

- 12 220 1. What are the objectives for using BPMN in healthcare organization? What are the
13
14 221 expected results and what are the needs to be met?
- 15 222 2. What are the key variables, elements, concepts, and dimensions targeted by the BPMN
16
17 223 approach?
- 18
19 224 3. Can the BPMN approach meet these expectations in healthcare trajectory? Specifically,
20
21 225 a. What are the strengths (advantages) and weaknesses (limitations) of the BPMN in
22
23 226 modelling healthcare trajectory?
24
25 227 b. What are the effectiveness of using BPMN approach and its extensions in modelling
26
27 228 healthcare trajectory?
28
29 229 c. What are their opportunities and constraints in modelling healthcare processes?
- 30
31 230 4. What are the improvements or alternatives proposed to optimising healthcare trajectory?

32
33 231 For the purposes of this review, the term healthcare trajectory focuses on the patient's care
34
35 232 pathway across the continuum of care. Thus, it can be the clinical pathway when it focuses on
36
37 233 the organizational scale, but also the care pathway when it focuses on the systemic scale. It
38
39 234 consists first of the patient's journey through the sequencing of tasks and activities at all points
40
41 235 of contact^{43,44}. It then integrates the professional actors involved in the care trajectory,^{45,46} the
42
43 236 operation management of care delivery processes^{47,48}, the coordination structures⁴⁹⁻⁵¹, the
44
45 237 structural context of the system and organizations^{52,53} as well as the information trajectory
46
47 238 along the healthcare trajectory^{54,55}. Thus, our understanding of the term healthcare trajectory is
48
49 239 not limited to the operational aspect of the care process and to the pathophysiological process
50
51 240 of a patient's disease state, but also refers to the organization of all activities surrounding
52
53 241 interactions between health care workers and patients, as well as the effectiveness of patient
54
55 242 care processes and their effectiveness.

56
57 243 Therefore, our analysis will consider not only the operational outcomes of the application
58
59 244 BPMN, but also its societal impact by assessing its potential to improve patient outcomes and
60
245 experience. In addition, healthcare process mapping includes several different flows. On one
246
247 hand, the main process follows the patient's journey through the process steps and the decision
248
secondary flows include steps directly or indirectly linked to the main process such as

1
2
3 249 administrative processes, information flow, organizational processes, and examinations that do
4
5 250 not require the presence of the patient (e.g., laboratory results, pathological tests). Thus, several
6
7 251 flows can be present and impact the care process (e.g., information flow, drug flow, blood
8
9 252 flow,).

10 253 Therefore, this scoping review will focus on the potential of the BPMN and all its components
11
12 254 to impact the results of healthcare trajectories directly or indirectly. Finally, the review will
13
14 255 also consider proposals for extensions to BPMN have been put forward to integrate evidence-
15
16 256 based medicine and guidelines to support clinical decision making, including the Decision
17
18 257 Modelling Notation proposed by both the Object Management Group^{56,57} and the Computer
19
20 258 Interpretable Guidelines^{58,59}.

21 259
22 260
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

261 **Table 1:** PCC framework⁴⁰ 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.

262

263 **Stage 2: Identifying Relevant Articles**

264 A comprehensive search strategy was developed with the assistance of an experienced health
265 sciences librarian (FB). The search strategy will follow the three-step approach recommended
266 by JBI scoping review guidelines⁴⁰ and will target the retrieval of both published and
267 unpublished articles from electronic searches databases, focusing to BPMN modelling of
268 patient care trajectory. The first step of the scoping review guidelines has been completed in
269 preparation of this protocol (**Table 1**), which involved an initial limited search on PubMed and
270 ABI/Inform (ProQuest) databases, using the following selected keywords: "Healthcare
271 Process" OR "Clinical Process " OR "Process of Care" OR "Clinical Pathways" OR "Patient
272 care Process" OR "Healthcare trajectory" OR Patient Care Management" OR "Critical
273 Pathways" OR "Clinical Healthcare Pathways" AND "Business Process Model" OR "Business
274 Process Modelling Notation" OR "Business Process Model" OR "BPMN modelling" OR
275 "Workflow" OR "Clinical Decision-Making" OR "Decision Support Systems" OR "Medical
276 Process". The index words and the text words in the title and abstract of retrieved articles were
277 analysed to identify search terms and refine the search strategy for the next step.

278 In the second step, the search strategy will be adapted and implemented for each included
279 information source (PubMed, Embase (Embase.com), CINAHL(EBSCO), Web of Science,
280 ABI/Inform (ProQuest), Academic Search Premier (EBSCO), and Google Scholar) for
281 potential eligible articles published in either English or French language, from 2004, year when
282 BPMN was initially developed by the Business Process Management Institute, until December
283 2021. In addition to the electronic database search, we will undertake a backward snowballing⁶⁰
284 search that will involve hand-searching the reference lists of the identified reviews^{33-36,61} in
285 order to find other relevant articles. We will also perform a hand search of some relevant
286 journals (e.g. Institute of Electrical and Electronics Engineers, Health Informatics Journal, IOS
287 Press - Studies in Health Technology and Informatics, Journal of Digital Imaging, Lecture
288 Notes in Artificial Intelligence, Springer Procedia Computer Science, Recent Advances in
289 Computer Engineering, Information Systems Journal , European Journal of Information
290 System, Lecture Notes in Business Information Processing), search citations of relevant papers
291 and scan the reference lists of relevant papers. The final search results will be exported to the
292 Covidence systematic review software^{62,63} where duplicates will be removed. The full detailed
293 search strategy for peer review and grey literature sources is included in **online**
294 **Supplementary Appendix I.**

295 **Stage 3: Selecting Literature for Inclusion**

1
2
3 296 All retrieved articles will undertake two levels of screening. First, two reviewers (KSA and
4 297 JBG or LL) will independently screen titles and abstracts of each article against the established
5 298 inclusion and exclusion criteria (**Table 1**). To increase the reliability of screening by the two
6 299 reviewers (KSA and JBG or LL), a pilot test will be conducted on 50 titles and abstracts to
7 300 evaluate reviewer agreement in the screening process. Discrepancies will be resolved through
8 301 discussion between the two reviewers and where agreement could not be reached, a third
9 302 reviewer (PL, CP, CL, or AC) will be consulted. Adjustments may also be made to the inclusion
10 303 criteria if necessary to ensure consistent interpretation and application of the criteria. The
11 304 researchers will discuss their selection of articles after this first round of screening, to arrive at
12 305 preliminary consensus on the list of eligible articles. In the second step, the two reviewers will
13 306 screen the full-text articles independently to determine if they meet the inclusion criteria.
14 307 Reasons for the exclusion of full-text articles will be noted in Covidence⁶³ by each reviewer.
15 308 Reviewers will again discuss their selection of articles after this second round of screening, to
16 309 arrive at a final list of eligible articles. Discrepancies will again be resolved through discussion
17 310 between the two reviewers and where agreement could not be reached, a third reviewer will be
18 311 consulted. The screening process will be documented using a PRISMA flowchart for scoping
19 312 review^{39,41} and by calculating the inter-rater reliability between reviewers using the Cohen's
20 313 Kappa coefficient⁶⁴.

314 **Stage 4: Charting of Information and Data**

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

1
2
3 330 BPMN-extension approach. The proposed Charting Table is shown in **online Supplementary**
4 **Appendix II**. It will be trialled on five included articles and will be iteratively refined.
5 331
6 332 Adjustments or expansions may also be made to the **Charting Table** if necessary to ensure
7
8 333 that the research objectives or questions are well addressed. For instance, we may add
9
10 334 additional categories of data deemed relevant to answer the research questions to the Charting
11
12 335 Table.

13 336 **Stage 5: Collating, Summarizing, and Reporting the Data**

14
15 337 The main findings of the included articles will be summarised in Tabular format in a manner
16
17 338 that reflects the objectives of the review. Following the PCC principles⁴⁰, a narrative summary
18
19 339 will accompany the Tabular results and link the different findings to the review objective and
20
21 340 questions and will identify any knowledge gaps in the literature. To ensure rigour in this stage,
22
23 341 two reviewers (KSA and JBG or LL) will prepare a descriptive summary table of the extracted
24
25 342 data and will highlight the key findings with input from the research team. The table will
26
27 343 include a descriptive summary of the articles and a qualitative thematic analysis of the main
28
29 344 results regarding characteristics of the BPMN approach used in each study (e.g., objective,
30
31 345 benefit, challenges, target users, redesign the clinical process), type of patient trajectory,
32
33 346 characteristics of the research designs, outcomes of interest used to measure the effectiveness
34
35 347 of BPMN (e.g., reducing work time, and challenges and potential solutions learned). We will
36
37 348 identify barriers or limitations of BPMN for achieving improvement of healthcare processes,
38
39 349 support activities and decision-making processes, and use that information to address our main
40
41 350 objectives. The consultation stage of the scoping review, described in the following section,
42
43 351 will contribute to fulfilling that objective and to establish a conceptual framework for
44
45 352 improving the use of BPMN in healthcare trajectory modelling. Finally, if the extracted data
46
47 353 allow it, a qualitative analysis will be conducted to discuss or nuance the evidence of BPMN
48
49 354 effectiveness considering potential barriers and enablers identified by the authors. We will use
50
51 355 the PRISMA-ScR to guide the final reporting of our results.

52 356 **Stage 6: Consultation**

53
54 357 The final consultation stage offers an ideal mechanism to enhance the validity of the study
55
56 358 outcome while translating findings with the stakeholders or health professionals and patients³⁸.
57
58 359 Preliminary findings from this review will provide the background for workshop with the
59
60 360 research team and stakeholders/knowledge users (e.g., healthcare professionals, patients,
61
62 361 decision-makers, administrators). The objectives of the workshop are to present and discuss
63
64 362 the interim results of the synthesis. The meeting will generate a list of key practice
65
66 363 recommendations, dissemination strategy and research priority areas to inform future research.

1
2
3 364 The workshop will be conducted with the research team with a focus on reviewing the results
4
5 365 following feedback from the previous meeting, reviewing the final report, necessary
6
7 366 modifications to findings and recommendations for precision and clarity. These consultations
8
9 367 with all stakeholders, including clinicians, technicians, and patients, aim to materialise the
10
11 368 findings of this review by discussing their applications in specific contexts. Therefore, despite
12
13 369 Arksey and O'Malley³⁷ stated that consultation is optional, we find that our study is a
14
15 370 fundamental step. Consequently, we plan to organise a workshop with all stakeholders in order
16
17 371 to get their feedback on the findings and to develop next steps in research and practice. The
18
19 372 feedback from the stakeholder workshop and the results of the scoping review will be combined
20
21 373 to clearly indicate the available evidence, gaps in research and future research priorities for
22
23 374 improving the use of BPMN in healthcare trajectory modelling.

24 375 **Patient and public involvement**

25 376 In this study, patient and public involvement will be performed at the consultation stage and
26
27 377 dissemination. Patients will be recruited from the Institut Universitaire de Cardiologie et de
28
29 378 Pneumologie de Québec - Université Laval (IUCPQ-UL). We will work together with the
30
31 379 IUCPQ-UL patient office for the recruitment and consultation of patient partners. Our
32
33 380 consultation strategy comprises involving not only patients with specific health trajectory but
34
35 381 also caregivers, healthcare and social professionals, and policymakers at different levels. It is
36
37 382 expected that their contribution in the discussion of the scoping review results will inform the
38
39 383 next steps of the project regarding the ability of BPMN to effectively improve the quality of
40
41 384 clinical practices, the security, and the fluidity of the care process. Therefore, our analysis will
42
43 385 consider not only the operational outcomes of the application BPMN, but also its societal
44
45 386 impact by considering the patient's health trajectory in healthcare organization.

46 387 **ETHICS AND DISSEMINATION**

47 388 This scoping review is exempt from ethics approval because the work carried out will be based
48
49 389 on published documents. The involvement of relevant study participants does not imply
50
51 390 personal data collection, rather, we seek to have the key persons feedback on the information
52
53 391 gathered through the bibliographic review. The aim of this project is to synthesise the literature
54
55 392 about healthcare trajectory using BPMN approach to enhance conceptual clarity and
56
57 393 understanding about key benefits and limitations and to extrapolate from this evidence base
58
59 394 promising conceptual framework for improving the use of BPMN in healthcare trajectory.
60
395 During the development of the scoping review a patient-partner will be engaged as a consultant
396 and knowledge user. We anticipate the research will provide several key outputs including (1)
397 a comprehensive review that will summarize existing literature on the BPMN approach; (2) an

1
2
3 398 evidence base demonstrating the benefits and limitation of the BPMN approach in modelling
4
5 399 patient trajectory; (3) a list of BPMN extensions that can be used to improve its efficiency in
6
7 400 many domains; (4) a conceptual framework. Our findings will be disseminated in peer-
8
9 401 reviewed journals, workshop, seminars, and presentations and through discussions with
10
11 402 relevant organizations, study participants and stakeholders. Our goal will be to disseminate our
12
13 403 findings to a wide range of clinicians, leaders, and administrators in all sectors, to researchers
14
15 404 and to students entering the healthcare professions to enhance understanding about key benefits
16
17 405 and limitations of BPMN approach for optimising the patient trajectory. We believe the results
18
19 406 will benefit clinicians by guiding their decision-making throughout the patient's trajectory,
20
21 407 therefore reducing the medical error rate, optimising efficient resource management, and
22
23 408 reducing the risks of complications due to poor clinical decisions. Those improvements should
24
25 409 result in an optimisation of cost-efficiency for organizations and quality of care for patients.

26 410 **Contributors:** KSA, JBG and AC led the design, search strategy and conceptualisation of this
27
28 411 work and drafted the protocol. PL, FB, CL and CP were involved in the conceptualisation of
29
30 412 the review design, inclusion and exclusion criteria and provided feedback on the methodology
31
32 413 and the manuscript. KSA and LL were involved in data extraction forms. All authors provided
33
34 414 feedback on the manuscript and approval to the publishing of this protocol manuscript.

35 415 **Funding** None.

36 416 **Competing interests:** The authors declare no potential conflict of interest

37 417 **Patient and public involvement:** A patient-partner will be engaged throughout the study
38
39 418 acting as a consultant and knowledge user.

40 419 **Patient consent for publication:** Not required.

41 420 **Ethics approval: Research** ethics approval is not required for a scoping review.

42 421 **Provenance and peer review:** Not commissioned; externally peer reviewed.

43 422 **Acknowledgements:** The authors thank the IUCPQ-UL for the future collaboration with the
44
45 423 patient's groups. We also thank Nathalie Thibault, Director of Nurse care at IUCPQ-UL, and
46
47 424 Sophie Bellavance, Director of multidisciplinary services at IUCPQ-UL, for the availability in
48
49 425 the collaboration within this project.

50 426

51 427

52 428

53 429

Reference

- 54 430 1. McMahan M, Nadigel J, Thompson E, Glazier RH. Informing Canada's health system
55 431 response to COVID-19: priorities for health services and policy research. *Healthcare*
56 432 *Policy*. 2020;16(1):112.

- 1
2
3 433 2. Smylie J, Anderson M. Understanding the health of Indigenous peoples in Canada:
4 434 key methodological and conceptual challenges. *Cmaj*. 2006;175(6):602-602.
- 5 435 3. Smylie J, Firestone M. Back to the basics: Identifying and addressing underlying
6 436 challenges in achieving high quality and relevant health statistics for indigenous
7 437 populations in Canada. *Statistical Journal of the IAOS*. 2015;31(1):67-87.
- 8 438 4. Cortada J, Gordon D, Lenihan B. The value of analytics in healthcare: From insights
9 439 to outcomes. *IBM Global Business Services, Executive Report*. 2012.
- 10 440 5. Contandriopoulos D, Brousselle A, Larouche C, et al. Healthcare reforms, inertia
11 441 polarization and group influence. *Health Policy*. 2018;122(9):1018-1027.
- 12 442 6. Himmelstein DU, Campbell T, Woolhandler S. Health care administrative costs in the
13 443 United States and Canada, 2017. *Annals of internal medicine*. 2020;172(2):134-142.
- 14 444 7. Liu C, Tsugawa Y, Weiser TG, Scott JW, Spain DA, Maggard-Gibbons M.
15 445 Association of the US Affordable Care Act with out-of-pocket spending and
16 446 catastrophic health expenditures among adult patients with traumatic injury. *JAMA*
17 447 *network open*. 2020;3(2):e200157-e200157.
- 18 448 8. Keehan SP, Cuckler GA, Poisal JA, et al. National Health Expenditure Projections,
19 449 2019–28: Expected Rebound In Prices Drives Rising Spending Growth: National
20 450 health expenditure projections for the period 2019–2028. *Health Affairs*.
21 451 2020;39(4):704-714.
- 22 452 9. OCDE. *Health at a Glance 2021*. 2021.
- 23 453 10. Papanicolas I, Woskie LR, Jha AK. Health Care Spending in the United States and
24 454 Other High-Income Countries. *JAMA*. 2018;319(10):1024-1039.
- 25 455 11. Emanuel EJ, Gudbranson E, Van Parys J, Gørtz M, Helgeland J, Skinner J.
26 456 Comparing health outcomes of privileged US citizens with those of average residents
27 457 of other developed countries. *JAMA internal medicine*. 2021;181(3):339-344.
- 28 458 12. Singh GK, Stella MY. Infant mortality in the United States, 1915-2017: large social
29 459 inequalities have persisted for over a century. *International Journal of Maternal and*
30 460 *Child Health and AIDS*. 2019;8(1):19.
- 31 461 13. Declercq E, Zephyrin L. Maternal mortality in the United States: a primer.
32 462 *Commonwealth Fund*. 2020.
- 33 463 14. Hoyert DL. Maternal mortality rates in the United States, 2019. 2020.
- 34 464 15. Singh GK. Trends and social inequalities in maternal mortality in the United States,
35 465 1969-2018. *International Journal of Maternal and Child Health and AIDS*.
36 466 2021;10(1):29.
- 37 467 16. Cook JL, Majd M, Blake J, et al. Measuring Maternal Mortality and Morbidity in
38 468 Canada. *J Obstet Gynaecol Can*. 2017;39(11):1028-1037.
- 39 469 17. Gauld R, Burgers J, Dobrow M, et al. Healthcare system performance improvement: a
40 470 comparison of key policies in seven high-income countries. *Journal of health*
41 471 *organization and management*. 2014.
- 42 472 18. Lee SE, Scott LD, Dahinten VS, Vincent C, Lopez KD, Park CG. Safety culture,
43 473 patient safety, and quality of care outcomes: a literature review. *Western journal of*
44 474 *nursing research*. 2019;41(2):279-304.
- 45 475 19. Kruk ME, Gage AD, Arsenaault C, et al. High-quality health systems in the
46 476 Sustainable Development Goals era: time for a revolution. *The Lancet global health*.
47 477 2018;6(11):e1196-e1252.
- 48 478 20. Baker A. *Crossing the quality chasm: a new health system for the 21st century*. Vol
49 479 323: British Medical Journal Publishing Group; 2001.
- 50 480 21. Wolfe A. Institute of Medicine report: crossing the quality chasm: a new health care
51 481 system for the 21st century. *Policy, Politics, & Nursing Practice*. 2001;2(3):233-235.

- 1
2
3 482 22. National Academies of Sciences E, Medicine. Crossing the global quality chasm:
4 483 Improving health care worldwide. 2018.
5 484 23. Organization WH. Framework on integrated, people-centred health services. *Geneva:*
6 485 *World Health Organization*. 2016:2019.
7 486 24. Organization WH. WHO report on cancer: setting priorities, investing wisely and
8 487 providing care for all. 2020.
9 488 25. Bergin RJ, Whitfield K, White V, et al. Optimal care pathways: A national policy to
10 489 improve quality of cancer care and address inequalities in cancer outcomes. *Journal*
11 490 *of cancer policy*. 2020;25:100245.
12 491 26. Allen D, Gillen E, Rixson L. Systematic review of the effectiveness of integrated care
13 492 pathways: what works, for whom, in which circumstances? *International Journal of*
14 493 *Evidence-Based Healthcare*. 2009;7(2):61-74.
15 494 27. Lodewijckx C, Sermeus W, Panella M, et al. Impact of care pathways for in-hospital
16 495 management of COPD exacerbation: a systematic review. *International journal of*
17 496 *nursing studies*. 2011;48(11):1445-1456.
18 497 28. Alkandari M, Ryan K, Hollywood A. The experiences of people living with
19 498 peripheral neuropathy in Kuwait—a process map of the patient journey. *Pharmacy*.
20 499 2019;7(3):127.
21 500 29. Ferreira AS, Oliveira GR. Business process modeling: A webibliomining perspective
22 501 of architecture frameworks. *Independent Journal of Management & Production*.
23 502 2019;10(3):1159-1183.
24 503 30. Ramudhin A, Bulgak AA, Fowler JG. A business process improvement study in a
25 504 specialized North American hospital. Paper presented at: PICMET 2010
26 505 TECHNOLOGY MANAGEMENT FOR GLOBAL ECONOMIC GROWTH2010.
27 506 31. Ramudhin A, Chan E, Mokadem A. A framework for the modelling, analysis and
28 507 optimization of pathways in healthcare. Paper presented at: 2006 International
29 508 Conference on Service Systems and Service Management2006.
30 509 32. Ramudhin A, Chan E, Benziane R, Mokadem A. Modeling and optimization of health
31 510 care processes. Paper presented at: IIE Annual Conference. Proceedings2006.
32 511 33. Loya SR, Kawamoto K, Chatwin C, Huser V. Service oriented architecture for
33 512 clinical decision support: A systematic review and future directions. *Journal of*
34 513 *medical systems*. 2014;38(12):1-22.
35 514 34. Mincarone P, Leo CG, Trujillo-Martín MdM, et al. Standardized languages and
36 515 notations for graphical modelling of patient care processes: a systematic review.
37 516 *International Journal for Quality in Health Care*. 2018;30(3):169-177.
38 517 35. De Ramon Fernandez A, Ruiz Fernandez D, Sabuco Garcia Y. Business Process
39 518 Management for optimizing clinical processes: A systematic literature review. *Health*
40 519 *informatics journal*. 2020;26(2):1305-1320.
41 520 36. Zarour K, Benmerzoug D, Guermouche N, Drira K. A systematic literature review on
42 521 BPMN extensions. *Business Process Management Journal*. 2019.
43 522 37. Arksey H, O'Malley L. Scoping studies: towards a methodological framework.
44 523 *International journal of social research methodology*. 2005;8(1):19-32.
45 524 38. Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology.
46 525 *Implementation science*. 2010;5(1):1-9.
47 526 39. Tricco AC, Lillie E, Zarin W, et al. A scoping review on the conduct and reporting of
48 527 scoping reviews. *BMC medical research methodology*. 2016;16(1):1-10.
49 528 40. Peters MD, Godfrey C, McInerney P, Munn Z, Tricco AC, Khalil H. Chapter 11:
50 529 scoping reviews (2020 version). *JBIM manual for evidence synthesis, JBI*. 2020;2020.

- 1
2
3 530 41. Tricco AC, Lillie E, Zarin W, et al. PRISMA extension for scoping reviews
4 531 (PRISMA-ScR): checklist and explanation. *Annals of internal medicine*.
5 532 2018;169(7):467-473.
- 6 533 42. Abasse KS, Gartner J-B, Labbé L, et al. Benefits and Limitations of Business Process
7 534 Model Notation in Modeling Patient Healthcare Trajectory: A Scoping Review
8 535 Protocol. 2021.
- 9 536 43. Ponsignon F, Smart A, Phillips L. A customer journey perspective on service delivery
10 537 system design: insights from healthcare. *International Journal of Quality &*
11 538 *Reliability Management*. 2018.
- 12 539 44. Alexander GL. The nurse—patient trajectory framework. *Studies in health technology*
13 540 *and informatics*. 2007;129(Pt 2):910.
- 14 541 45. Beauséjour M, Goulet L, Feldman DE, et al. Pathways of healthcare utilisation in
15 542 patients with suspected adolescent idiopathic scoliosis: a cross-sectional study. *BMC*
16 543 *health services research*. 2015;15(1):1-12.
- 17 544 46. Louis CJ, Clark JR, Gray B, Brannon D, Parker V. Service line structure and
18 545 decision-maker attention in three health systems: Implications for patient-centered
19 546 care. *Health care management review*. 2019;44(1):41-56.
- 20 547 47. Yang H, Li W, Liu K, Zhang J. Knowledge-based clinical pathway for medical
21 548 quality improvement. *Information systems frontiers*. 2012;14(1):105-117.
- 22 549 48. De Bleser L, Depreitere R, WAELE KD, Vanhaecht K, Vlayen J, Sermeus W.
23 550 Defining pathways. *Journal of nursing management*. 2006;14(7):553-563.
- 24 551 49. Aziz AFA, Nordin NAM, Ali MF, Abd Aziz NA, Sulong S, Aljunid SM. The
25 552 integrated care pathway for post stroke patients (iCaPPS): a shared care approach
26 553 between stakeholders in areas with limited access to specialist stroke care services.
27 554 *BMC health services research*. 2017;17(1):1-11.
- 28 555 50. Busari JO, Yaldiz H, Gans RO, Duits AJ. Clinical Leadership as an Agent for
29 556 Change: A Health System Improvement Intervention in Curaçao. *Journal of*
30 557 *multidisciplinary healthcare*. 2020;13:787.
- 31 558 51. Seguin ML, Rangnekar A, Renedo A, Palafox B, McKee M, Balabanova D.
32 559 Systematic review of frameworks used to conceptualise health pathways of
33 560 individuals diagnosed with cardiovascular diseases. *BMJ global health*.
34 561 2020;5(9):e002464.
- 35 562 52. Valentijn PP, Biermann C, Bruijnzeels MA. Value-based integrated (renal) care:
36 563 setting a development agenda for research and implementation strategies. *BMC health*
37 564 *services research*. 2016;16(1):1-11.
- 38 565 53. Elkhuzen SG, Vissers JM, Mahdavi M, Van De Klundert JJ. Modeling Patient
39 566 Journeys for Demand Segments in Chronic Care, With an Illustration to Type 2
40 567 Diabetes. *Frontiers in Public Health*. 2020;8.
- 41 568 54. Fung-Kee-Fung M, Maziak D, Pantarotto J, et al. Regional process redesign of lung
42 569 cancer care: a learning health system pilot project. *Current Oncology*. 2018;25(1):59-
43 570 66.
- 44 571 55. Mohr P, Galderisi S, Boyer P, et al. Value of schizophrenia treatment I: The patient
45 572 journey. *European Psychiatry*. 2018;53:107-115.
- 46 573 56. Combi C, Oliboni B, Zardiniy A, Zerbato F. Seamless design of decision-intensive
47 574 care pathways. Paper presented at: 2016 IEEE International Conference on Healthcare
48 575 Informatics (ICHI)2016.
- 49 576 57. Cánovas-Segura B, Zerbato F, Oliboni B, et al. A process-oriented approach for
50 577 supporting clinical decisions for infection management. Paper presented at: 2017
51 578 IEEE International Conference on Healthcare Informatics (ICHI)2017.
- 52
53
54
55
56
57
58
59
60

- 1
2
3 579 58. Hewelt M, Kunde A, Weske M, Meinel C. Recommendations for medical treatment
4 580 processes: the PIGS approach. Paper presented at: International Conference on
5 581 Business Process Management2014.
6 582 59. de Bruin JS, Adlassnig K-P, Leitich H, Rappelsberger A. Separating business logic
7 583 from medical knowledge in digital clinical workflows using business process model
8 584 and notation and arden syntax. In: *Health Informatics Meets eHealth*. IOS Press;
9 585 2018:17-24.
10 586 60. Wohlin C. Guidelines for snowballing in systematic literature studies and a replication
11 587 in software engineering. Paper presented at: Proceedings of the 18th international
12 588 conference on evaluation and assessment in software engineering2014.
13 589 61. Tomaskova H, Kopecky M. Specialization of Business Process Model and Notation
14 590 Applications in Medicine—A Review. *Data*. 2020;5(4):99.
15 591 62. Babineau J. Product review: covidence (systematic review software). *Journal of the*
16 592 *Canadian Health Libraries Association/Journal de l'Association des bibliothèques de*
17 593 *la santé du Canada*. 2014;35(2):68-71.
18 594 63. Kellermeyer L, Harnke B, Knight S. Covidence and Rayyan. *Journal of the Medical*
19 595 *Library Association: JMLA*. 2018;106(4):580.
20 596 64. McHugh ML. Interrater reliability: the kappa statistic. *Biochemia medica*.
21 597 2012;22(3):276-282.
22 598
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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

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

BMJ Open

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

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2021-060357.R2
Article Type:	Protocol
Date Submitted by the Author:	22-Apr-2022
Complete List of Authors:	Kassim, Said; Universite Laval; Laval University Department of Management, Gartner, Jean-Baptiste; Université Laval, Département de management Labbé, Laurence; Laval University, Management Landa, Paolo; Laval University, Operations and Decision Systems Department; Centre de recherche du CHU de Québec, Université Laval Paquet, Catherine; Université Laval Département de management Bergeron, Frédéric; Université Laval Lemaire, Célia; EM Strasbourg Business School Côté, André; Universite Laval Departement de management, Département de management
Primary Subject Heading:	Health informatics
Secondary Subject Heading:	Medical management, Health services research
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

SCHOLARONE™
Manuscripts

1 Benefits and Limitations of Business Process Model Notation in Modelling

2 Patient Healthcare Trajectory: A Scoping Review Protocol

3 Running title: Modelling Patient Healthcare Trajectory using BPMN

4 Kassim Said Abasse^{1,2,3,4,5}, Jean-Baptiste Gartner^{1,2,3,5}, Laurence Labbé^{1,2}, Paolo Landa^{3,6*},
5 Catherine Paquet^{3,8,9}, Frédéric Bergeron¹⁰, Célia Lemaire¹¹, André Côté^{1,2,3,4,5}.

6 ¹Département de management, Faculté des sciences de l'administration, Université Laval,
7 Québec, G1V 0A6, Canada.

8 ²Centre de recherche en gestion des services de santé, Université Laval, Québec, G1V 0A6,
9 Canada.

10 ³Centre de recherche du CHU de Québec, Université Laval, Québec, G1V 0A6, Canada

11 ⁴VITAM, Centre de recherche en santé durable, Université Laval, Québec, G1V 0A6, Canada.

12 ⁵Centre de recherche du CISSS de Chaudière-Appalaches, Québec, G1V 0A6, Canada.

13 ⁶Département d'opérations et systèmes de décision, Faculté des sciences de l'administration
14 Université Laval, Québec, G1K 7P4, Canada

15 ⁸Département de marketing, Faculté des sciences de l'administration, Université Laval,
16 Québec, G1V 0A6, Canada.

17 ⁹Centre NUTRISS-Nutrition, Santé et société Université Laval, Québec, G1V 0A6, Canada.

18 ¹⁰Bibliothèque, Direction des services-conseils, Université Laval, Québec, G1V 0A6, Canada

19 ¹¹Université de Strasbourg, EM Strasbourg-Business School, HuManiS, Strasbourg, France.

20 *Corresponding Author

21 Paolo Landa, Ph.D

22 Professeur Adjoint

23 Département d'opérations et systèmes de décision

24 Faculté des sciences de l'administration

25 Université Laval, Québec, QC, G1V 0A6, Canada

26 Local 2421, Tel :(+1)418-656-2131 (Ext. 413389)

27 Email: Paolo.Landa@fsa.ulaval.ca.

46 **Abstract**

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

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

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

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

75

76

77

78

79

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.

114

115 INTRODUCTION

116 With the continuous challenges facing healthcare organizations in the past few years¹⁻³, many
117 strategies have focused on process improvements with the objective of enhancing efficiency
118 and efficacy to improve patient outcomes while controlling costs^{4,5}. Through the years, health
119 expenditure and financing have increased substantially in developed countries such as the
120 United States (US) and Canada⁶⁻⁹. In 2019, Canada spent 10.8% of its gross domestic product
121 on healthcare expenses according to the Organization for Economic Cooperation and
122 Development (OECD, 2021)⁹. This ratio reached 17.7% at the same time in the US, where the
123 national health spending is projected to reach \$6.2 trillion by 2028, growing at an average
124 annual rate of 5.4%^{8,9}. However, compared with other OECD countries, the US perform poorly
125 on process, outcome, and patient experience metrics, as well as life expectancy^{10,11}. Life
126 expectancy in the US was the lowest at 78.8 years compared with a range from 80.7 to 83.9
127 years for other OECD countries¹⁰. The infant mortality rate in the US was 5.8 per 1000 live
128 births and the maternal mortality rate was 17.4 per 100 000 births in 2018, both higher than the
129 mean rates for any OECD country¹¹⁻¹⁵. Canada is another developed country performing poorly
130 in terms of infant and maternal mortality, with 4.7 fatalities out of every 1,000 live births and
131 10.2 maternal deaths per 100 000 births^{11,16}.

132 The lack of control in processes used to deliver medical care is clearly a major problem in the
133 context of preventable medical errors with lethal damages and high economic costs in many
134 hospitals¹⁷⁻¹⁹. Since the released Crossing the Quality Chasm^{20,21} by the Institute of Medicine
135 (US), numerous national and international organizations including the Academies of
136 Sciences²² and the World Health Organization^{23,24} have made repeated calls to develop a
137 framework for advancing the quality of care, ensuring that care is safe, effective, efficient,
138 patient-centred, timely, and equitable²⁰. To do this, healthcare organizations and systems must
139 develop solutions that enhance both efficiency and efficacy of improving healthcare
140 organization and patient outcomes while restraining costs. Efforts to improve clinical and care
141 pathways have shown such benefits²⁵⁻²⁷. Over the last decades, articles have revealed that
142 mapping healthcare trajectories allowed to decrease the variation of professional practices and
143 to standardise care processes¹⁷⁻¹⁹. This practice has many benefits such as improving the
144 accessibility, fluidity, quality, performance, and sustainability of healthcare services^{25,28}.

145 In this context, several tools have been developed to support process improvement through
146 process mapping. Among these methods, business process modelling notation (BPMN) is an
147 approach that consists of representing processes as a network of activities and tasks²⁹⁻³¹. This

1
2
3 148 structured approach supported by the Object Management Group since 2005 and adopted as an
4
5 149 international standard by the International Organization for Standardization since 2012, is in
6
7 150 its second version (BPMN 2.0) ³⁰⁻³².

8 151 In recent years, a few reviews ³³⁻³⁶ have been conducted to analyse whether the BPMN
9
10 152 approach can become a useful tool to improve the effectiveness and quality of healthcare
11
12 153 processes. For instance, Loya et al.³³ used a service-oriented architecture in clinical decision
13
14 154 support and provided evidence that BPMN was not commonly used for clinical decision
15
16 155 support systems, despite being the preferred standard for business process modelling in
17
18 156 healthcare. Mincarone et al.³⁴ demonstrated that BPMN provides a good level of formalisation,
19
20 157 a standardised communication framework between multiple stakeholders, good user
21
22 158 comprehensibility, and easier interprofessional analyses. Fernández et al.³⁵ suggested that
23
24 159 BPMN is useful for standardising processes that have some variability due to its possibility to
25
26 160 incorporate variations or changes. Moreover, Zarour et al.³⁶ analysed various BPMN
27
28 161 extensions (e.g., decision modelling notation) that can be used to improve its efficiency in many
29
30 162 domains, showing that healthcare was among the most targeted area. The overall conclusion of
31
32 163 these reviews ³³⁻³⁶ is that BPMN seems to be increasingly used in healthcare organizations to
33
34 164 the point of becoming a standard in process improvement methods. However, these articles<sup>33-
35
36 165 ³⁶ acknowledged the difficulties and challenges when implementing BPMN in the health sector.
37
38 166 Indeed, a limitation of these articles³³⁻³⁶ is that none of them put the use of BPMN to improve
39
40 167 healthcare trajectories or patient care trajectory as its primary focus. Loya et al.³³ focused on
41
42 168 the use of BPMN for supporting clinical decisions and stated that BPMN has potential to
43
44 169 optimise clinical pathways, but they did not assess this possibility. The papers of Mincarone et
45
46 170 al.³⁴ and Fernández et al.³⁵ mainly focused on clinical processes, briefly addressing healthcare
47
48 171 trajectories, resulting in a shallow analysis on this subject. Finally, Zarour et al.³⁶ targeted many
49
50 172 BPMN extensions that could improve its effectiveness, but their research was not exclusive to
51
52 173 healthcare setting.</sup>

53
54 174 Our literature review builds on these previous reviews³³⁻³⁶ by providing an in-depth analysis
55
56 175 of the ability of BPMN to effectively improve the quality of clinical practices, the security, and
57
58 176 the fluidity of the care process and to propose tangible results on the patient experience in a
59
60 177 patient-centred care and services logic. Moreover, we will analyse the opportunities and
61
62 178 limitations related to the integration of BPMN extension.

63
64 179 Considering the above gaps in the literature, the primary aim of this scoping review is to
65
66 180 identify and map existing evidence on the main benefits and limitations associated with the use
67
68 181 of BPMN in healthcare trajectory modelling. To do so, we will assess its ability to model key

1
2
3 182 dimensions or concepts of the healthcare process and to meet the needs of stakeholders. The
4
5 183 review will also highlight the capacity of the BPMN approach and its extensions to support
6
7 184 clinical activities and decision-making processes associated with the healthcare trajectory and
8
9 185 propose a conceptual framework for improving the use of BPMN in healthcare practices.

10 186 **METHODS AND ANALYSIS**

11
12 187 We chose to undertake a scoping review as the best method to map the available evidence
13
14 188 regarding the benefits and limitations of BPMN in modelling patient healthcare trajectory³⁷⁻³⁹.
15
16 189 The present review will be conducted following the methodological frameworks described by
17
18 190 Arksey and O'Malley³⁷, and improved by Levac et al.³⁸, and further refined by the Joanna
19
20 191 Briggs Institute (JBI)⁴⁰. The standardized methodology included six stages for scoping review:
21
22 192 (1) Identifying the research question, (2) Identifying relevant articles and grey literature, (3)
23
24 193 Selecting articles, (4) Charting the data, (5) Collating, summarizing, and reporting the data,
25
26 194 and (6) Consulting with relevant stakeholders, thereby enabling knowledge translation. The
27
28 195 Preferred Reporting Items for Systematic Reviews and Meta-Analysis Extension for Scoping
29
30 196 Reviews (PRISMA-ScR)^{39,41} has also been used to guide the reporting of this protocol and will
31
32 197 also subsequently be used to structure the reporting of the full review. Furthermore, we will
33
34 198 take an iterative and reflexive approach throughout the review process, particularly to refine
35
36 199 our study selection and data extraction steps to the best target meeting our objective. This
37
38 200 protocol is registered through the Open Science Framework⁴². The development of the scoping
39
40 201 review will start in May 2022 and it should be finalised in September 2022.

41 202 **Stage 1: Identifying the Research Question**

42
43 203 As the focus of scoping reviews is on summarizing the breadth of evidence, the research
44
45 204 questions should be broad while keeping in mind the review's main purpose^{37,38,40,41}. Thus, we
46
47 205 started with, "What is known about the application of BPMN methodology in healthcare
48
49 206 organization?" A preliminary search was conducted through some electronic databases
50
51 207 including International Prospective Register of Systematic Reviews, JBI Database of
52
53 208 Systematic Reviews and Implementation Reports, Cochrane Database of Systematic Reviews,
54
55 209 and National Center for Biotechnology Information, which revealed three systematic reviews
56
57 210 of modelling healthcare processes using the BPMN methodology³³⁻³⁶. Although findings from
58
59 211 these reviews³³⁻³⁶ supported the use of BPMN as an effective methodology to optimise
60
212 healthcare processes, no conclusions on the effectiveness were drawn. The reason may be that
213 these reviews³³⁻³⁶ were not mainly focused on the use of BPMN to improve healthcare
214 trajectories.

1
2
3 215 In addition, we adopted the JBI's Population Concept and Context (PCC) framework⁴⁰ to
4 216 formulate the objectives and research questions, and to conceptualise the study and report
5 217 characteristics in terms of eligibility criteria (**Table 1**). We then consulted with experienced
6 218 colleagues³⁰ on our predefined set of questions to provide further input and feedback.

7 219 In line with our purpose to comprehensively map the extent, range and nature of evidence
8 220 examining the use or application of BPMN within the healthcare trajectory, we formulated four
9 221 specific research questions to guide this review.

- 10 222 1. What are the objectives for using BPMN in healthcare organization? What are the
11 223 expected results and what are the needs to be met?
- 12 224 2. What are the key variables, elements, concepts, and dimensions targeted by the BPMN
13 225 approach?
- 14 226 3. Can the BPMN approach meet these expectations in healthcare trajectory? Specifically,
15 227 a. What are the strengths (advantages) and weaknesses (limitations) of the BPMN in
16 228 modelling healthcare trajectory?
17 229 b. What are the effectiveness of using BPMN approach and its extensions in modelling
18 230 healthcare trajectory?
19 231 c. What are their opportunities and constraints in modelling healthcare processes?
- 20 232 4. What are the improvements or alternatives proposed to optimising healthcare trajectory?

21 233 For the purposes of this review, the term healthcare trajectory focuses on the patient's care
22 234 pathway across the continuum of care. Thus, it can be the clinical pathway when it focuses on
23 235 the organizational scale, but also the care pathway when it focuses on the systemic scale. It
24 236 consists first of the patient's journey through the sequencing of tasks and activities at all points
25 237 of contact^{43,44}. It then integrates the professional actors involved in the care trajectory,^{45,46} the
26 238 operation management of care delivery processes^{47,48}, the coordination structures⁴⁹⁻⁵¹, the
27 239 structural context of the system and organizations^{52,53} as well as the information trajectory
28 240 along the healthcare trajectory^{54,55}. Thus, our understanding of the term healthcare trajectory is
29 241 not limited to the operational aspect of the care process and to the pathophysiological process
30 242 of a patient's disease state, but also refers to the organization of all activities surrounding
31 243 interactions between health care workers and patients, as well as the effectiveness of patient
32 244 care processes and their effectiveness.

33 245 Therefore, our analysis will consider not only the operational outcomes of the application
34 246 BPMN, but also its societal impact by assessing its potential to improve patient outcomes and
35 247 experience. In addition, healthcare process mapping includes several different flows. On one
36 248 hand, the main process follows the patient's journey through the process steps and the decision

1
2
3 249 points guide the patient through the process⁵⁶. On the other hand, the support processes and
4
5 250 secondary flows include steps directly or indirectly linked to the main process such as
6
7 251 administrative processes, information flow, organizational processes, and examinations that do
8
9 252 not require the presence of the patient (e.g., laboratory results, pathological tests). Thus, several
10
11 253 flows can be present and impact the care process (e.g., information flow, drug flow, blood
12
13 254 flow,).

14 255 Therefore, this scoping review will focus on the potential of the BPMN and all its components
15
16 256 to impact the results of healthcare trajectories directly or indirectly. Finally, the review will
17
18 257 also consider proposals for extensions to BPMN have been put forward to integrate evidence-
19
20 258 based medicine and guidelines to support clinical decision making, including the Decision
21
22 259 Modelling Notation proposed by both the Object Management Group^{56,57} and the Computer
23
24 260 Interpretable Guidelines^{58,59}.

25 261

26 262

263 **Table 1:** PCC framework⁴⁰ 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.

264

265 **Stage 2: Identifying Relevant Articles**

266 A comprehensive search strategy was developed with the assistance of an experienced health
267 sciences librarian (FB). The search strategy will follow the three-step approach recommended
268 by JBI scoping review guidelines⁴⁰ and will target the retrieval of both published and
269 unpublished articles from electronic searches databases, focusing to BPMN modelling of
270 patient care trajectory. The first step of the scoping review guidelines has been completed in
271 preparation of this protocol (**Table 1**), which involved an initial limited search on PubMed and
272 ABI/Inform (ProQuest) databases, using the following selected keywords: "Healthcare
273 Process" OR "Clinical Process " OR "Process of Care" OR "Clinical Pathways" OR "Patient
274 care Process" OR "Healthcare trajectory" OR Patient Care Management" OR "Critical
275 Pathways" OR "Clinical Healthcare Pathways" AND "Business Process Model" OR "Business
276 Process Modelling Notation" OR "Business Process Model" OR "BPMN modelling" OR
277 "Workflow" OR "Clinical Decision-Making" OR "Decision Support Systems" OR "Medical
278 Process". The index words and the text words in the title and abstract of retrieved articles were
279 analysed to identify search terms and refine the search strategy. In detail, we used an adjacency
280 operator between the expression "Business Process" and terms (Model OR Method OR
281 management) that seemed most relevant to us and consistent with previous published
282 systematic literature reviews³³⁻³⁶, as subject experts, in order to capture all potential articles
283 using synonyms and words variations of the "Business Process Model Notation" concept, in
284 addition to BPMN acronym. To find articles about patient "Healthcare Trajectory", a broad
285 concept containing several components, we used a mix of general (e.g., Practice Guidelines as
286 Topic OR Workflow OR Clinical Decision-Making) and specific terms (e.g., Patient Care
287 Management OR Critical Pathways), both from controlled vocabulary (e.g., MeSH terms) and
288 keywords to avoid missing articles. We used the Boolean operator AND to restrict our search
289 to articles specifically related to these two concepts.

290 In the second step, the search strategy will be adapted and implemented for each included
291 information source (PubMed, Embase (Embase.com), CINAHL(EBSCO), Web of Science,
292 ABI/Inform (ProQuest), Academic Search Premier (EBSCO), and Google Scholar) for
293 potential eligible articles from January 1st, 2004, year when BPMN was initially developed by
294 the Business Process Management Institute, until December 9th, 2021. In addition to the
295 electronic database search, we will undertake a backward snowballing⁶⁰ search that will involve
296 hand-searching the reference lists of the identified reviews^{33-36,61} in order to find other relevant
297 articles. We will also perform a hand search of some relevant journals (e.g. Institute of
298 Electrical and Electronics Engineers, Health Informatics Journal, IOS Press - Studies in Health

1
2
3 299 Technology and Informatics, Journal of Digital Imaging, Lecture Notes in Artificial
4
5 300 Intelligence, Springer Procedia Computer Science, Recent Advances in Computer Engineering,
6
7 301 Information Systems Journal , European Journal of Information System, Lecture Notes in
8
9 302 Business Information Processing), search citations of relevant papers and scan the reference
10
11 303 lists of relevant papers. The final search results will be exported to the Covidence® systematic
12
13 304 review software^{62,63} where duplicates will be removed. The full detailed search strategy for
14
15 305 peer review and grey literature sources is included in **online Supplementary Appendix I**.

16 306 **Stage 3: Selecting Literature for Inclusion**

17 307 All retrieved articles will undertake two levels of screening. First, two reviewers (KSA and
18
19 308 JBG or LL) will independently screen titles and abstracts of each article against the established
20
21 309 inclusion and exclusion criteria (**Table 1**). To increase the reliability of screening by the two
22
23 310 reviewers (KSA and JBG or LL), a pilot test will be conducted on 50 titles and abstracts to
24
25 311 evaluate reviewer agreement in the screening process. Discrepancies will be resolved through
26
27 312 discussion between the two reviewers and where agreement could not be reached, a third
28
29 313 reviewer (PL, CP, CL, or AC) will be consulted. Adjustments may also be made to the inclusion
30
31 314 criteria if necessary to ensure consistent interpretation and application of the criteria. The
32
33 315 researchers will discuss their selection of articles after this first round of screening, to arrive at
34
35 316 preliminary consensus on the list of eligible articles. In the second step, the two reviewers will
36
37 317 screen the full-text articles independently to determine if they meet the inclusion criteria.
38
39 318 Reasons for the exclusion of full-text articles will be noted in Covidence⁶³ by each reviewer.
40
41 319 Reviewers will again discuss their selection of articles after this second round of screening, to
42
43 320 arrive at a final list of eligible articles. Discrepancies will again be resolved through discussion
44
45 321 between the two reviewers and where agreement could not be reached, a third reviewer will be
46
47 322 consulted. The screening process will be documented using a PRISMA flowchart for scoping
48
49 323 review^{39,41} and by calculating the inter-rater reliability between reviewers using the Cohen's
50
51 324 Kappa coefficient⁶⁴.

52 325 **Stage 4: Charting of Information and Data**

53 326 Data will be extracted from every eligible article using a data extraction chart (**Charting**
54
55 327 **Table**) tailored to the research questions. Its aim is to maintain a manageable amount of data,
56
57 328 while ensuring a wide approach and breadth of coverage to obtain existing evidence on the
58
59 329 benefits and limitations associated with BPMN in patient care trajectory. Two researchers
60
61 330 (KSA and JBG or LL) will independently extract the following study information: authorship,
62
63 331 year of publication, country of origin, study purpose, patient care trajectory issues being
64
65 332 addressed (e.g., diabetes, chronic obstructive pulmonary disease, coronary heart disease,

1
2
3 333 clinical pathways for contraception), study population/target users (e.g., physicians, clinicians,
4 334 nurses, pharmacists), setting/location of intervention (e.g., primary care, acute care,
5 335 rehabilitation, home care, long-term care, community, hospital), methodological approach
6 336 (qualitative, quantitative, or mixed study), expected results study findings (e.g., decreasing
7 337 diagnostic delay, optimising of quality care, cost, reducing medical errors, standardising the
8 338 decision-making process), type of outcomes/dimension analysed (e.g., diagnostic times,
9 339 waiting time for surgery, flexibility, improving key performance indicators, decision support
10 340 systems). We will note the objectives and benefits, as well as the limitations of using BPMN
11 341 and BPMN-extension approach. The proposed Charting Table is shown in **online**
12 342 **Supplementary Appendix II**. It will be trialled on five included articles and will be iteratively
13 343 refined. Adjustments or expansions may also be made to the **Charting Table** if necessary to
14 344 ensure that the research objectives or questions are well addressed. For instance, we may add
15 345 additional categories of data deemed relevant to answer the research questions to the Charting
16 346 Table.

17 347 **Stage 5: Collating, Summarizing, and Reporting the Data**

18 348 The main findings of the included articles will be summarised in Tabular format in a manner
19 349 that reflects the objectives of the review. Following the PCC principles⁴⁰, a narrative summary
20 350 will accompany the Tabular results and link the different findings to the review objective and
21 351 questions and will identify any knowledge gaps in the literature. To ensure rigour in this stage,
22 352 two reviewers (KSA and JBG or LL) will prepare a descriptive summary table of the extracted
23 353 data and will highlight the key findings with input from the research team. The table will
24 354 include a descriptive summary of the articles and a qualitative thematic analysis of the main
25 355 results regarding characteristics of the BPMN approach used in each study (e.g., objective,
26 356 benefit, challenges, target users, redesign the clinical process), type of patient trajectory,
27 357 characteristics of the research designs, outcomes of interest used to measure the effectiveness
28 358 of BPMN (e.g., reducing work time, and challenges and potential solutions learned). We will
29 359 identify barriers or limitations of BPMN for achieving improvement of healthcare processes,
30 360 support activities and decision-making processes, and use that information to address our main
31 361 objectives. The consultation stage of the scoping review, described in the following section,
32 362 will contribute to fulfilling that objective and to establish a conceptual framework for
33 363 improving the use of BPMN in healthcare trajectory modelling. Finally, if the extracted data
34 364 allow it, a qualitative analysis will be conducted to discuss or nuance the evidence of BPMN
35 365 effectiveness considering potential barriers and enablers identified by the authors. We will use
36 366 the PRISMA-ScR to guide the final reporting of our results.

367 **Stage 6: Consultation**

368 The final consultation stage offers an ideal mechanism to enhance the validity of the study
369 outcome while translating findings with the stakeholders or health professionals and patients³⁸.
370 Preliminary findings from this review will provide the background for workshop with the
371 research team and stakeholders/knowledge users (e.g., healthcare professionals, patients,
372 decision-makers, administrators). The objectives of the workshop are to present and discuss
373 the interim results of the synthesis. The meeting will generate a list of key practice
374 recommendations, dissemination strategy and research priority areas to inform future research.

375 The workshop will be conducted with the research team with a focus on reviewing the results
376 following feedback from the previous meeting, reviewing the final report, necessary
377 modifications to findings and recommendations for precision and clarity. These consultations
378 with all stakeholders, including clinicians, technicians, and patients, aim to materialise the
379 findings of this review by discussing their applications in specific contexts. Therefore, despite
380 Arksey and O'Malley³⁷ stated that consultation is optional, we find that our study is a
381 fundamental step. Consequently, we plan to organise a workshop with all stakeholders in order
382 to get their feedback on the findings and to develop next steps in research and practice. The
383 feedback from the stakeholder workshop and the results of the scoping review will be combined
384 to clearly indicate the available evidence, gaps in research and future research priorities for
385 improving the use of BPMN in healthcare trajectory modelling.

386 **Patient and public involvement**

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

398 **ETHICS AND DISSEMINATION**

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

1
2
3 401 personal data collection, rather, we seek to have the key persons feedback on the information
4
5 402 gathered through the bibliographic review. The aim of this project is to synthesise the literature
6
7 403 about healthcare trajectory using BPMN approach to enhance conceptual clarity and
8
9 404 understanding about key benefits and limitations and to extrapolate from this evidence base
10
11 405 promising conceptual framework for improving the use of BPMN in healthcare trajectory.
12
13 406 During the development of the scoping review a patient-partner will be engaged as a consultant
14
15 407 and knowledge user. We anticipate the research will provide several key outputs including (1)
16
17 408 a comprehensive review that will summarize existing literature on the BPMN approach; (2) an
18
19 409 evidence base demonstrating the benefits and limitation of the BPMN approach in modelling
20
21 410 patient trajectory; (3) a list of BPMN extensions that can be used to improve its efficiency in
22
23 411 many domains; (4) a conceptual framework. Our findings will be disseminated in peer-
24
25 412 reviewed journals, workshop, seminars, and presentations and through discussions with
26
27 413 relevant organizations, study participants and stakeholders. Our goal will be to disseminate our
28
29 414 findings to a wide range of clinicians, leaders, and administrators in all sectors, to researchers
30
31 415 and to students entering the healthcare professions to enhance understanding about key benefits
32
33 416 and limitations of BPMN approach for optimising the patient trajectory. We believe the results
34
35 417 will benefit clinicians by guiding their decision-making throughout the patient's trajectory,
36
37 418 therefore reducing the medical error rate, optimising efficient resource management, and
38
39 419 reducing the risks of complications due to poor clinical decisions. Those improvements should
40
41 420 result in an optimisation of cost-efficiency for organizations and quality of care for patients.
42
43 421 **Contributors:** KSA, JBG and AC led the design, search strategy and conceptualisation of this
44
45 422 work and drafted the protocol. PL, FB, CL and CP were involved in the conceptualisation of
46
47 423 the review design, inclusion and exclusion criteria and provided feedback on the methodology
48
49 424 and the manuscript. KSA and LL were involved in data extraction forms. All authors provided
50
51 425 feedback on the manuscript and approval to the publishing of this protocol manuscript.
52
53 426 **Funding** None.
54
55 427 **Competing interests:** The authors declare no potential conflict of interest
56
57 428 **Patient and public involvement:** A patient-partner will be engaged throughout the study
58
59 429 acting as a consultant and knowledge user.
60
61 430 **Patient consent for publication:** Not required.
62
63 431 **Ethics approval:** Research ethics approval is not required for a scoping review.
64
65 432 **Provenance and peer review:** Not commissioned; externally peer reviewed.
66
67 433 **Acknowledgements:** The authors thank the IUCPQ-UL for the future collaboration with the
68
69 434 patient's groups. We also thank Nathalie Thibault, Director of Nurse care at IUCPQ-UL, and

3 435 Sophie Bellavance, Director of multidisciplinary services at IUCPQ-UL, for the availability in
4 the collaboration within this project.

6 437

8 438

9 439

10 440

Reference

12 441 1. McMahan M, Nadigel J, Thompson E, Glazier RH. Informing Canada's health system
13 442 response to COVID-19: priorities for health services and policy research. *Healthcare*
14 443 *Policy*. 2020;16(1):112.

15 444 2. Smylie J, Anderson M. Understanding the health of Indigenous peoples in Canada:
16 445 key methodological and conceptual challenges. *Cmaj*. 2006;175(6):602-602.

17 446 3. Smylie J, Firestone M. Back to the basics: Identifying and addressing underlying
18 447 challenges in achieving high quality and relevant health statistics for indigenous
19 448 populations in Canada. *Statistical Journal of the IAOS*. 2015;31(1):67-87.

20 449 4. Cortada J, Gordon D, Lenihan B. The value of analytics in healthcare: From insights
21 450 to outcomes. *IBM Global Business Services, Executive Report*. 2012.

22 451 5. Contandriopoulos D, Brousselle A, Larouche C, et al. Healthcare reforms, inertia
23 452 polarization and group influence. *Health Policy*. 2018;122(9):1018-1027.

24 453 6. Himmelstein DU, Campbell T, Woolhandler S. Health care administrative costs in the
25 454 United States and Canada, 2017. *Annals of internal medicine*. 2020;172(2):134-142.

26 455 7. Liu C, Tsugawa Y, Weiser TG, Scott JW, Spain DA, Maggard-Gibbons M.
27 456 Association of the US Affordable Care Act with out-of-pocket spending and
28 457 catastrophic health expenditures among adult patients with traumatic injury. *JAMA*
29 458 *network open*. 2020;3(2):e200157-e200157.

30 459 8. Keehan SP, Cuckler GA, Poisal JA, et al. National Health Expenditure Projections,
31 460 2019–28: Expected Rebound In Prices Drives Rising Spending Growth: National
32 461 health expenditure projections for the period 2019–2028. *Health Affairs*.
33 462 2020;39(4):704-714.

34 463 9. OCDE. *Health at a Glance 2021*. 2021.

35 464 10. Papanicolas I, Woskie LR, Jha AK. Health Care Spending in the United States and
36 465 Other High-Income Countries. *JAMA*. 2018;319(10):1024-1039.

37 466 11. Emanuel EJ, Gudbranson E, Van Parys J, Gørtz M, Helgeland J, Skinner J.
38 467 Comparing health outcomes of privileged US citizens with those of average residents
39 468 of other developed countries. *JAMA internal medicine*. 2021;181(3):339-344.

40 469 12. Singh GK, Stella MY. Infant mortality in the United States, 1915-2017: large social
41 470 inequalities have persisted for over a century. *International Journal of Maternal and*
42 471 *Child Health and AIDS*. 2019;8(1):19.

43 472 13. Declercq E, Zephyrin L. Maternal mortality in the United States: a primer.
44 473 *Commonwealth Fund*. 2020.

45 474 14. Hoyert DL. Maternal mortality rates in the United States, 2019. 2020.

46 475 15. Singh GK. Trends and social inequalities in maternal mortality in the United States,
47 476 1969-2018. *International Journal of Maternal and Child Health and AIDS*.
48 477 2021;10(1):29.

49 478 16. Cook JL, Majd M, Blake J, et al. Measuring Maternal Mortality and Morbidity in
50 479 Canada. *J Obstet Gynaecol Can*. 2017;39(11):1028-1037.

51 480 17. Gauld R, Burgers J, Dobrow M, et al. Healthcare system performance improvement: a
52 481 comparison of key policies in seven high-income countries. *Journal of health*
53 482 *organization and management*. 2014.

- 1
2
3 483 18. Lee SE, Scott LD, Dahinten VS, Vincent C, Lopez KD, Park CG. Safety culture,
4 484 patient safety, and quality of care outcomes: a literature review. *Western journal of*
5 485 *nursing research*. 2019;41(2):279-304.
- 6 486 19. Kruk ME, Gage AD, Arsenault C, et al. High-quality health systems in the
7 487 Sustainable Development Goals era: time for a revolution. *The Lancet global health*.
8 488 2018;6(11):e1196-e1252.
- 9 489 20. Baker A. *Crossing the quality chasm: a new health system for the 21st century*. Vol
10 490 323: British Medical Journal Publishing Group; 2001.
- 11 491 21. Wolfe A. Institute of Medicine report: crossing the quality chasm: a new health care
12 492 system for the 21st century. *Policy, Politics, & Nursing Practice*. 2001;2(3):233-235.
- 13 493 22. National Academies of Sciences E, Medicine. Crossing the global quality chasm:
14 494 Improving health care worldwide. 2018.
- 15 495 23. Organization WH. Framework on integrated, people-centred health services. *Geneva:*
16 496 *World Health Organization*. 2016:2019.
- 17 497 24. Organization WH. WHO report on cancer: setting priorities, investing wisely and
18 498 providing care for all. 2020.
- 19 499 25. Bergin RJ, Whitfield K, White V, et al. Optimal care pathways: A national policy to
20 500 improve quality of cancer care and address inequalities in cancer outcomes. *Journal*
21 501 *of cancer policy*. 2020;25:100245.
- 22 502 26. Allen D, Gillen E, Rixson L. Systematic review of the effectiveness of integrated care
23 503 pathways: what works, for whom, in which circumstances? *International Journal of*
24 504 *Evidence-Based Healthcare*. 2009;7(2):61-74.
- 25 505 27. Lodewijckx C, Sermeus W, Panella M, et al. Impact of care pathways for in-hospital
26 506 management of COPD exacerbation: a systematic review. *International journal of*
27 507 *nursing studies*. 2011;48(11):1445-1456.
- 28 508 28. Alkandari M, Ryan K, Hollywood A. The experiences of people living with
29 509 peripheral neuropathy in Kuwait—a process map of the patient journey. *Pharmacy*.
30 510 2019;7(3):127.
- 31 511 29. Ferreira AS, Oliveira GR. Business process modeling: A webibliomining perspective
32 512 of architecture frameworks. *Independent Journal of Management & Production*.
33 513 2019;10(3):1159-1183.
- 34 514 30. Ramudhin A, Bulgak AA, Fowler JG. A business process improvement study in a
35 515 specialized North American hospital. Paper presented at: PICMET 2010
36 516 TECHNOLOGY MANAGEMENT FOR GLOBAL ECONOMIC GROWTH2010.
- 37 517 31. Ramudhin A, Chan E, Mokadem A. A framework for the modelling, analysis and
38 518 optimization of pathways in healthcare. Paper presented at: 2006 International
39 519 Conference on Service Systems and Service Management2006.
- 40 520 32. Ramudhin A, Chan E, Benziane R, Mokadem A. Modeling and optimization of health
41 521 care processes. Paper presented at: IIE Annual Conference. Proceedings2006.
- 42 522 33. Loya SR, Kawamoto K, Chatwin C, Huser V. Service oriented architecture for
43 523 clinical decision support: A systematic review and future directions. *Journal of*
44 524 *medical systems*. 2014;38(12):1-22.
- 45 525 34. Mincarone P, Leo CG, Trujillo-Martín MdM, et al. Standardized languages and
46 526 notations for graphical modelling of patient care processes: a systematic review.
47 527 *International Journal for Quality in Health Care*. 2018;30(3):169-177.
- 48 528 35. De Ramon Fernandez A, Ruiz Fernandez D, Sabuco Garcia Y. Business Process
49 529 Management for optimizing clinical processes: A systematic literature review. *Health*
50 530 *informatics journal*. 2020;26(2):1305-1320.
- 51 531 36. Zarour K, Benmerzoug D, Guermouche N, Drira K. A systematic literature review on
52 532 BPMN extensions. *Business Process Management Journal*. 2019.

- 1
2
3 533 37. Arksey H, O'Malley L. Scoping studies: towards a methodological framework.
4 534 *International journal of social research methodology*. 2005;8(1):19-32.
- 5 535 38. Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology.
6 536 *Implementation science*. 2010;5(1):1-9.
- 7 537 39. Tricco AC, Lillie E, Zarin W, et al. A scoping review on the conduct and reporting of
8 538 scoping reviews. *BMC medical research methodology*. 2016;16(1):1-10.
- 9 539 40. Peters MD, Godfrey C, McInerney P, Munn Z, Tricco AC, Khalil H. Chapter 11:
10 540 scoping reviews (2020 version). *JBIM manual for evidence synthesis, JBIM*. 2020;2020.
- 11 541 41. Tricco AC, Lillie E, Zarin W, et al. PRISMA extension for scoping reviews
12 542 (PRISMA-ScR): checklist and explanation. *Annals of internal medicine*.
13 543 2018;169(7):467-473.
- 14 544 42. Abasse KS, Gartner J-B, Labbé L, et al. Benefits and Limitations of Business Process
15 545 Model Notation in Modeling Patient Healthcare Trajectory: A Scoping Review
16 546 Protocol. 2021.
- 17 547 43. Ponsignon F, Smart A, Phillips L. A customer journey perspective on service delivery
18 548 system design: insights from healthcare. *International Journal of Quality &*
19 549 *Reliability Management*. 2018.
- 20 550 44. Alexander GL. The nurse—patient trajectory framework. *Studies in health technology*
21 551 *and informatics*. 2007;129(Pt 2):910.
- 22 552 45. Beauséjour M, Goulet L, Feldman DE, et al. Pathways of healthcare utilisation in
23 553 patients with suspected adolescent idiopathic scoliosis: a cross-sectional study. *BMC*
24 554 *health services research*. 2015;15(1):1-12.
- 25 555 46. Louis CJ, Clark JR, Gray B, Brannon D, Parker V. Service line structure and
26 556 decision-maker attention in three health systems: Implications for patient-centered
27 557 care. *Health care management review*. 2019;44(1):41-56.
- 28 558 47. Yang H, Li W, Liu K, Zhang J. Knowledge-based clinical pathway for medical
29 559 quality improvement. *Information systems frontiers*. 2012;14(1):105-117.
- 30 560 48. De Bleser L, Depreitere R, WAELE KD, Vanhaecht K, Vlayen J, Sermeus W.
31 561 Defining pathways. *Journal of nursing management*. 2006;14(7):553-563.
- 32 562 49. Aziz AFA, Nordin NAM, Ali MF, Abd Aziz NA, Sulong S, Aljunid SM. The
33 563 integrated care pathway for post stroke patients (iCaPPS): a shared care approach
34 564 between stakeholders in areas with limited access to specialist stroke care services.
35 565 *BMC health services research*. 2017;17(1):1-11.
- 36 566 50. Busari JO, Yaldiz H, Gans RO, Duits AJ. Clinical Leadership as an Agent for
37 567 Change: A Health System Improvement Intervention in Curaçao. *Journal of*
38 568 *multidisciplinary healthcare*. 2020;13:787.
- 39 569 51. Seguin ML, Rangnekar A, Renedo A, Palafox B, McKee M, Balabanova D.
40 570 Systematic review of frameworks used to conceptualise health pathways of
41 571 individuals diagnosed with cardiovascular diseases. *BMJ global health*.
42 572 2020;5(9):e002464.
- 43 573 52. Valentijn PP, Biermann C, Bruijnzeels MA. Value-based integrated (renal) care:
44 574 setting a development agenda for research and implementation strategies. *BMC health*
45 575 *services research*. 2016;16(1):1-11.
- 46 576 53. Elkhuisen SG, Vissers JM, Mahdavi M, Van De Klundert JJ. Modeling Patient
47 577 Journeys for Demand Segments in Chronic Care, With an Illustration to Type 2
48 578 Diabetes. *Frontiers in Public Health*. 2020;8.
- 49 579 54. Fung-Kee-Fung M, Maziak D, Pantarotto J, et al. Regional process redesign of lung
50 580 cancer care: a learning health system pilot project. *Current Oncology*. 2018;25(1):59-
51 581 66.

- 1
2
3 582 55. Mohr P, Galderisi S, Boyer P, et al. Value of schizophrenia treatment I: The patient
4 583 journey. *European Psychiatry*. 2018;53:107-115.
- 5 584 56. Combi C, Oliboni B, Zardiniy A, Zerbato F. Seamless design of decision-intensive
6 585 care pathways. Paper presented at: 2016 IEEE International Conference on Healthcare
7 586 Informatics (ICHI)2016.
- 8 587 57. Cánovas-Segura B, Zerbato F, Oliboni B, et al. A process-oriented approach for
9 588 supporting clinical decisions for infection management. Paper presented at: 2017
10 589 IEEE International Conference on Healthcare Informatics (ICHI)2017.
- 11 590 58. Hewelt M, Kunde A, Weske M, Meinel C. Recommendations for medical treatment
12 591 processes: the PIGS approach. Paper presented at: International Conference on
13 592 Business Process Management2014.
- 14 593 59. de Bruin JS, Adlassnig K-P, Leitich H, Rappelsberger A. Separating business logic
15 594 from medical knowledge in digital clinical workflows using business process model
16 595 and notation and arden syntax. In: *Health Informatics Meets eHealth*. IOS Press;
17 596 2018:17-24.
- 18 597 60. Wohlin C. Guidelines for snowballing in systematic literature studies and a replication
19 598 in software engineering. Paper presented at: Proceedings of the 18th international
20 599 conference on evaluation and assessment in software engineering2014.
- 21 600 61. Tomaskova H, Kopecky M. Specialization of Business Process Model and Notation
22 601 Applications in Medicine—A Review. *Data*. 2020;5(4):99.
- 23 602 62. Babineau J. Product review: covidence (systematic review software). *Journal of the*
24 603 *Canadian Health Libraries Association/Journal de l'Association des bibliothèques de*
25 604 *la santé du Canada*. 2014;35(2):68-71.
- 26 605 63. Kellermeyer L, Harnke B, Knight S. Covidence and Rayyan. *Journal of the Medical*
27 606 *Library Association: JMLA*. 2018;106(4):580.
- 28 607 64. McHugh ML. Interrater reliability: the kappa statistic. *Biochemia medica*.
29 608 2012;22(3):276-282.
30
31
32
33
34 609
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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

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

