



**INTERCOOPERAR  
PARA CRESCER**

◀ **28º SUESPAR** ▶



Mineração de  
Processos aplicada na  
Jornada do Paciente

*Marcelo Rosano Dallagassa*

# Os desafios do uso da informação em saúde



Volume



Assimetria de  
informações  
(dispersão)



- Variedade de formatos
- Questões de privacidade
- Falta de qualidade
- Ausência de informações

## Histórico do uso de informações clínicas em saúde

1970 - Utilização de sistemas computacionais para processo de revisão de contas hospitalares



1980 - Surge o conceito de DRG (Diagnosis-Related Group)



1990 - Base de informações clínicas ou de conhecimento médico para suporte de decisões

2000 - Associações baseadas em diretrizes clínicas, data warehouse



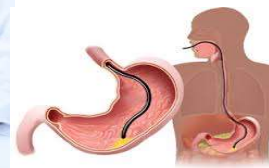
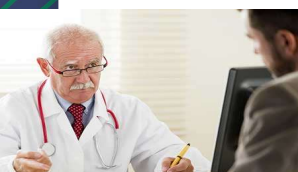
2010 - Uso da Inteligência Artificial e Data Mining



2020 - PLN, data lake, mineração de processos e gestão do conhecimento clínico

# Inteligência Artificial - Aprendizagem de máquina

## Mineração de Processos - Jornada do Paciente



Consulta  
Especialista

Psicólogo

Nutricionista

Exames  
Laboratoriais

Exames  
Imagens

Exames  
Endoscópicos

Cirurgia

# Mineração de processos na área da saúde

Diversos dados dos beneficiários são registrados...

PACIENTE

Procedimentos



Dados



Dados



Dados



Dados

10001201200CONSULTA

20/08/2017

10001201200EXAMES

30/09/2017

10001201200ENDOSCÓPICOS

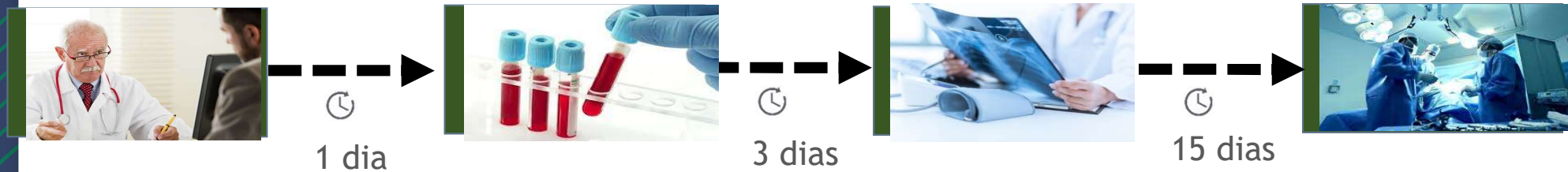
15/10/2017

10001201200INTERNAÇÃO

02/01/2018

# Mineração de processos na área da saúde

## Descoberta do Modelo de Processo



# Mineração de processos na área da saúde

## Revisão Sistemática - Mineração de Processos

### Process Mining Techniques and Applications - A Systematic Mapping Study

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Process mining is a growing and promising study area focused on understanding processes and to help capture the more significant findings during real execution rather than, those methods that, only observed idealized process model. The objective of this article is to map the active knowledge sub-areas of process mining and their main publishers by country, periodicals, and conferences. We also extract the reported application studies and classifies these by exploration domains or industry segments that are taking advantage of this technique. The applied research method was systematic mapping, which began with 3,681 articles. After applying the exclusion criteria, 1,238 articles were selected for review. In this article, an overview regarding process mining is presented, the sub-areas and related research activities are identified, followed by identification of the most applied process mining algorithms, and finally application domains among different business segments are reported on. It is possible observe that the most active sub-areas are associated with the discovery of process models, followed by conformance analysis, and architecture and tools improvements. In application domains, the segments with major case studies are healthcare followed by information technology and manufacturing.



**Process Mining**  
1238 Artigos

**Saúde**  
162  
13%

# Mineração de processos na área da saúde

Journal of Ambient Intelligence and Humanized Computing  
<https://doi.org/10.1007/s12652-021-02894-7>

ORIGINAL RESEARCH



## Opportunities and challenges for applying process mining in healthcare: a systematic mapping study

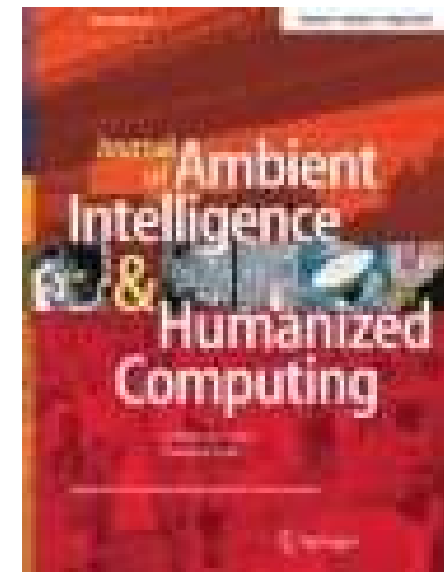
Marcelo Rosano Dallagassa<sup>1</sup> · Cleiton dos Santos Garcia<sup>2</sup> · Edson Emilio Scalabrin<sup>2</sup> · Sergio Ossamu Ioshii<sup>1</sup> · Deborah Ribeiro Carvalho<sup>1</sup>

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### Abstract

Process mining applies robust methodologies using data mining and machine learning for pattern recognition, using models that represent the process flow identified by the sequence of events, their timing, and the assessment of resources used. To evaluate the use of process mining in health care, with emphasis on the identification of characteristics, health care studies were selected based on a systematic review of the literature, well-defined eligibility criteria, and guided research questions. Such questions address the strategy and algorithm adopted, the location used, and the main contributions for the identified application. A total of 270 articles were selected. Among the identified applications, the discovery of process models was the most frequent, followed by resource analysis and evaluation. The most adopted algorithms were identified, the Fuzzy Miner and Heuristic Miner. One may highlight, among the main contributions, the analysis and discovery of process models for the evaluation of patient care and the evaluation of process conformity, focused on medical protocols and clinical guidelines. This review highlighted the significant use of process models discovery in their evaluation, thus supporting the proposal of changing the health care model so that it favors resources evaluation and care quality. There is also an important challenge regarding the use of such technique; on the one hand, concerning data integration and a more automatic recognition of standards and, on the other hand, concerning the application of standards focused on needs for compliance evaluation between discovered models, medical protocols and clinical guidelines.



Process Mining  
1949 Artigos

Saúde  
270  
14%



# Onde é possível utilizar a mineração de processos na área da saúde?



Avaliação de Tecnologias em Saúde (ATS)



Controles de fraudes e anormalidades



Classificação e elegibilidade de indivíduos à programas de doenças crônicas



Auditoria de contas médicas



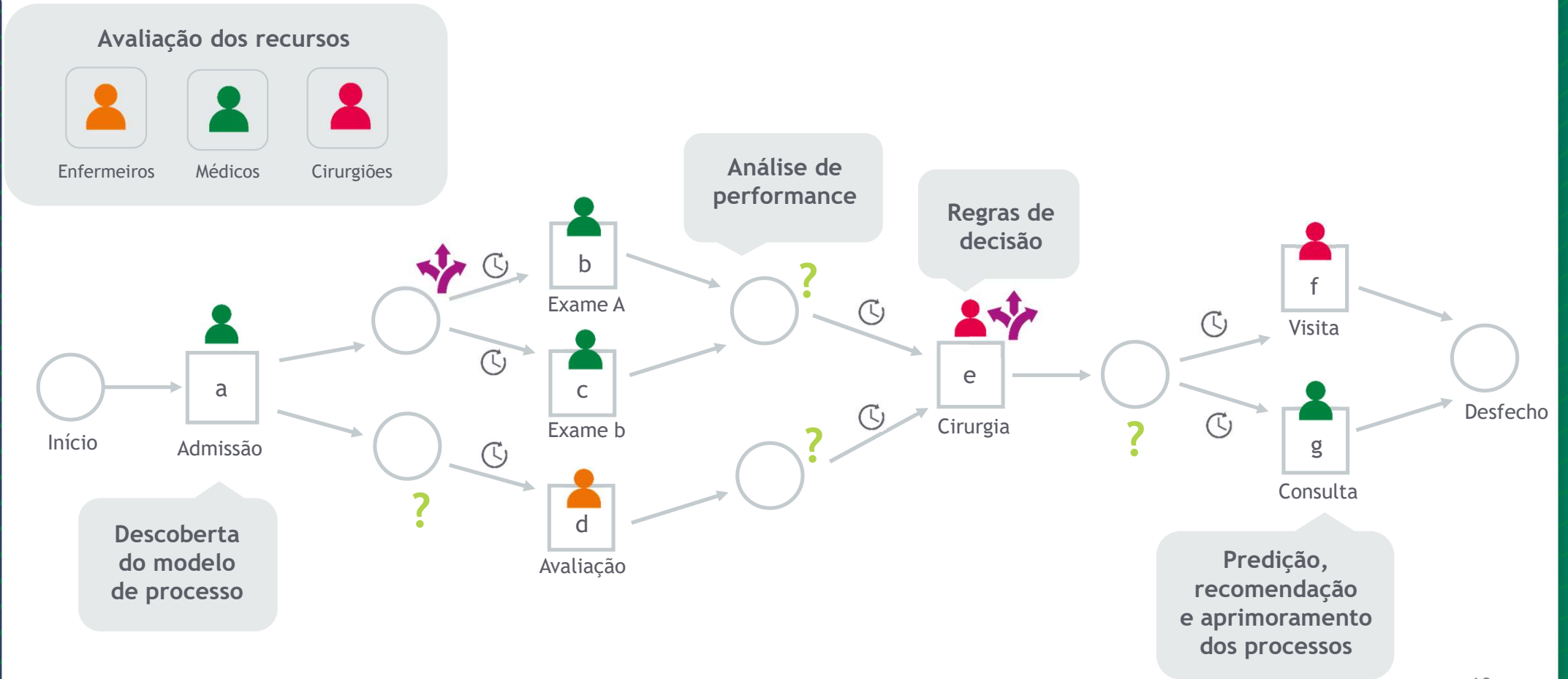
Avaliação de especialidades médicas - vinculadas a diretrizes e protocolos



Jornada do Paciente e Avaliação da Qualidade e Efetividade



# Uso da Mineração de Processos na Jornada do Paciente



Fonte: Mineração de processos aplicado na saúde - fonte: adaptado de (MANS; VAN DER AALST; VANWERSCH, 2015).



# Jornada do paciente

## Percurso orientado do paciente





# Análise de Conformidade na Jornada do Paciente

Análise de conformidade com diferentes níveis de granularidade: Um estudo de caso para cirurgia bariátrica.

2020 13th International Congress on Image and Signal Processing, BioMedical Engineering and Informatics (CISP-BMEI)

## Conformance checking with different levels of granularity

A case study on bariatric surgery



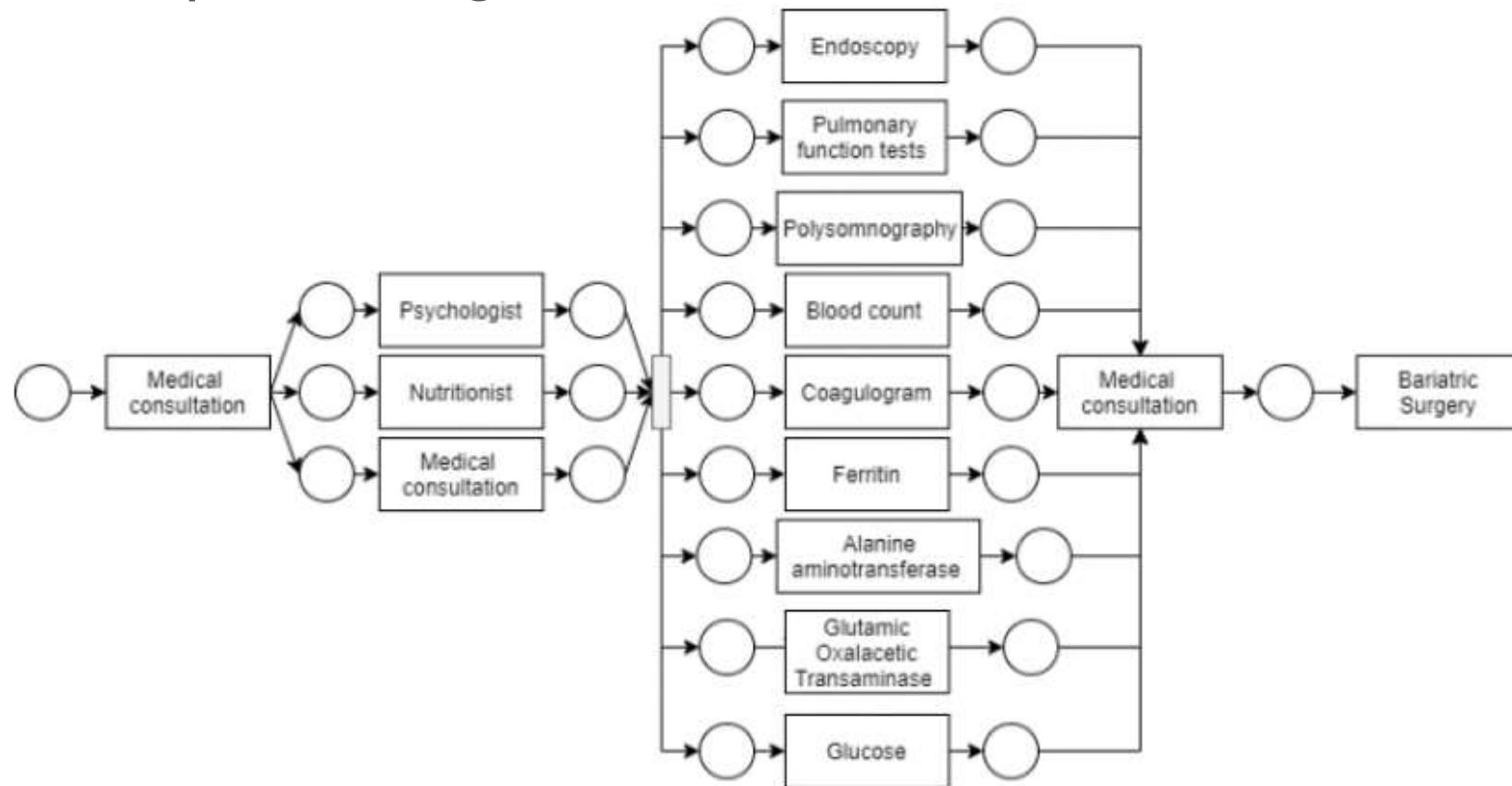
Denise M. V. Sato and Sheila C. de Freitas  
PUCPR  
IFPR  
Curitiba, Brazil

Marcelo R. Dallagassa, Edson E. Scalabrin, Eduardo  
A. P. Portela, and Deborah R. Carvalho  
PUCPR  
Curitiba, Brazil



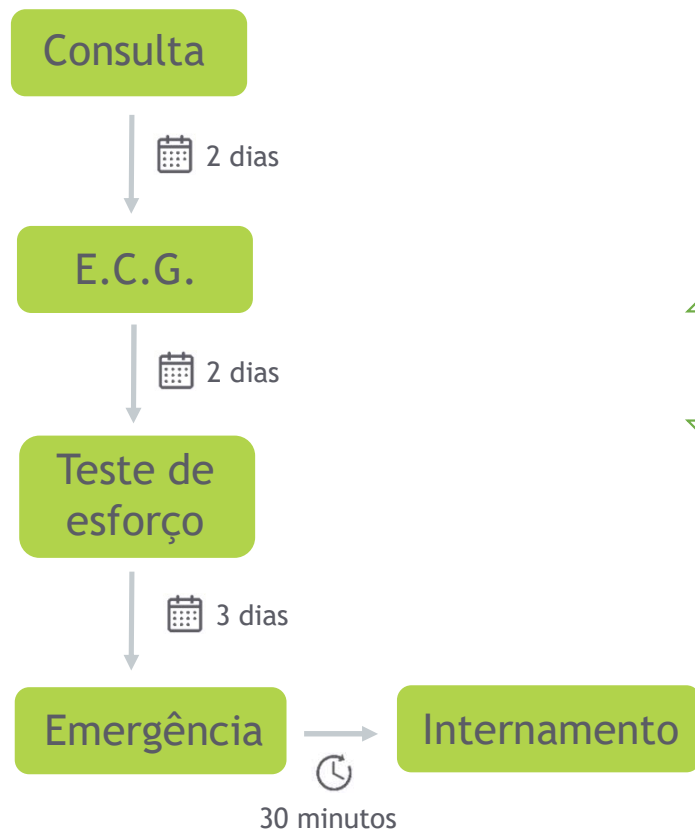
# Análise de Conformidade na Jornada do Paciente

Análise de conformidade com diferentes níveis de granularidade: Um estudo de caso para cirurgia bariátrica.

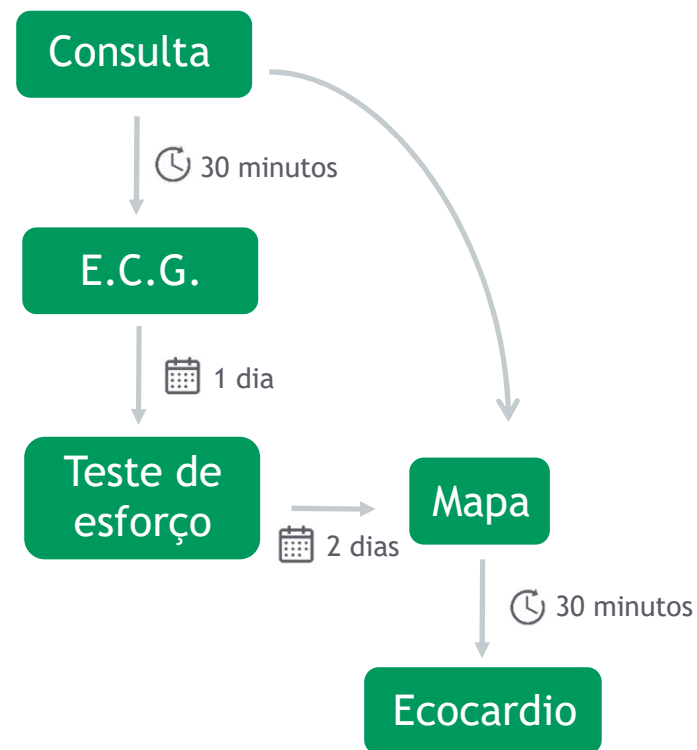




## Jornada do paciente



## Modelo de referência



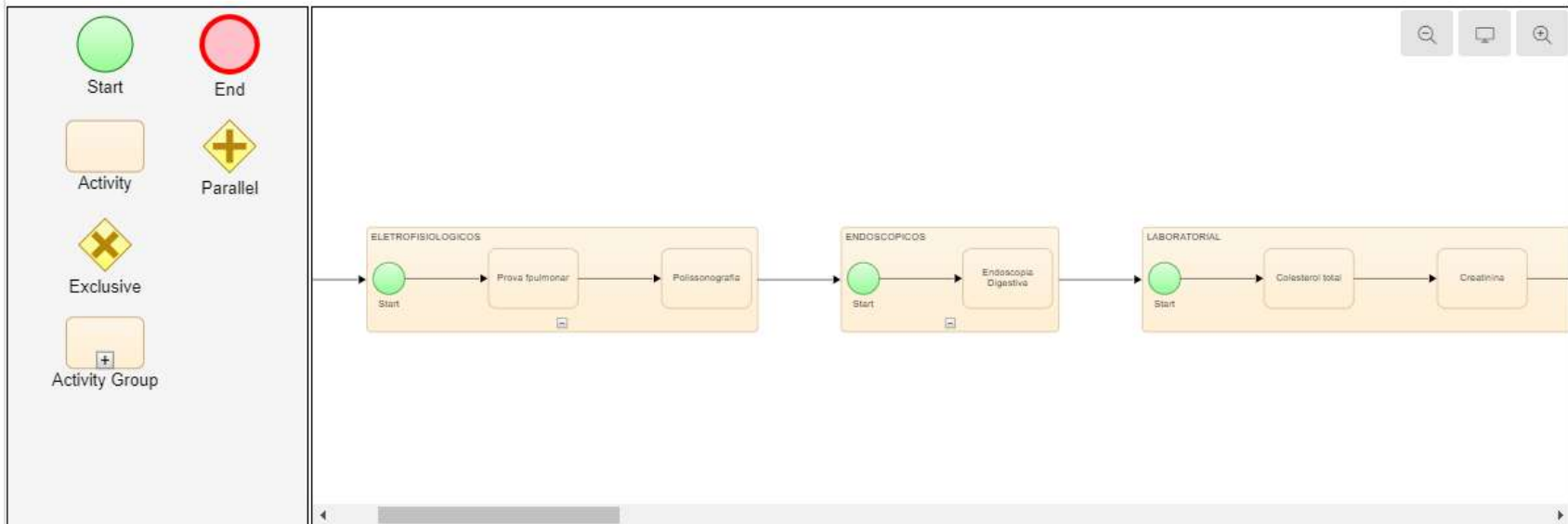


# Jornada do Paciente

## Salvar o modelo de referência

### 🔍 Modelo de referência

Informação Modelo





# Mineração de processos na Avaliação de Tecnologia em Saúde (ATS)


Health and Technology

<https://doi.org/10.1007/s12553-022-00692-5>

ORIGINAL PAPER



## Applying process mining in health technology assessment

Marcelo Rosano Dallagassa<sup>1,2</sup>  · Franciele Iachecen<sup>1,2</sup> · Luiz Henrique Picolo Furlan<sup>1</sup> · Sérgio Ossamu Ioshii<sup>1</sup> · Deborah Ribeiro Carvalho<sup>1</sup>

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### Abstract

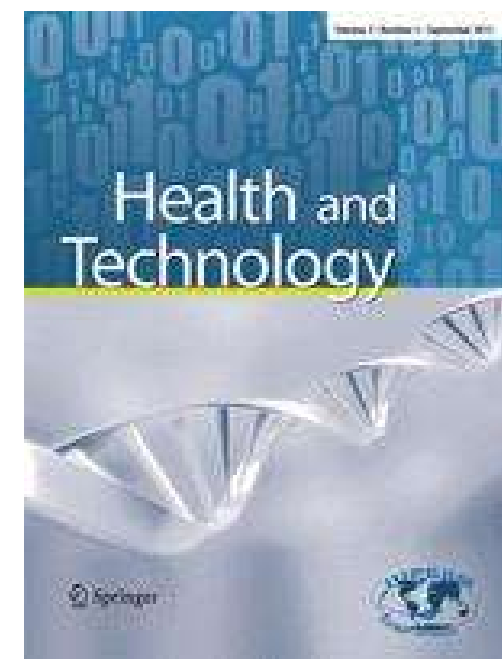
**Objective** Propose a process mining-based method for Health Technology Assessment.

**Methods** Articles dealing with prior studies in Health Technology Assessment using Process Mining were identified. Five research questions were defined to investigate these studies and present important points and desirable characteristics to be addressed in a proposal. The was defined method with five steps and was submitted to a case study for evaluation.

**Results** The Literature search identified six main characteristics. As a result, the five-step method proposed was applied in the radical prostatectomy surgical procedure between the robot assisted technique and laparoscopy.

**Conclusion** It was demonstrated in this article the creation of the proposal of an efficient method with its replication for other health technologies, coupled with the good interpretation of the specialists in terms of comprehensibility of the discovered patterns and their correlation with clinical protocols and guidelines.

**Keywords** Process mining · Health Technology Assessment · Cost analysis · Value-base health care · Real-world evidence

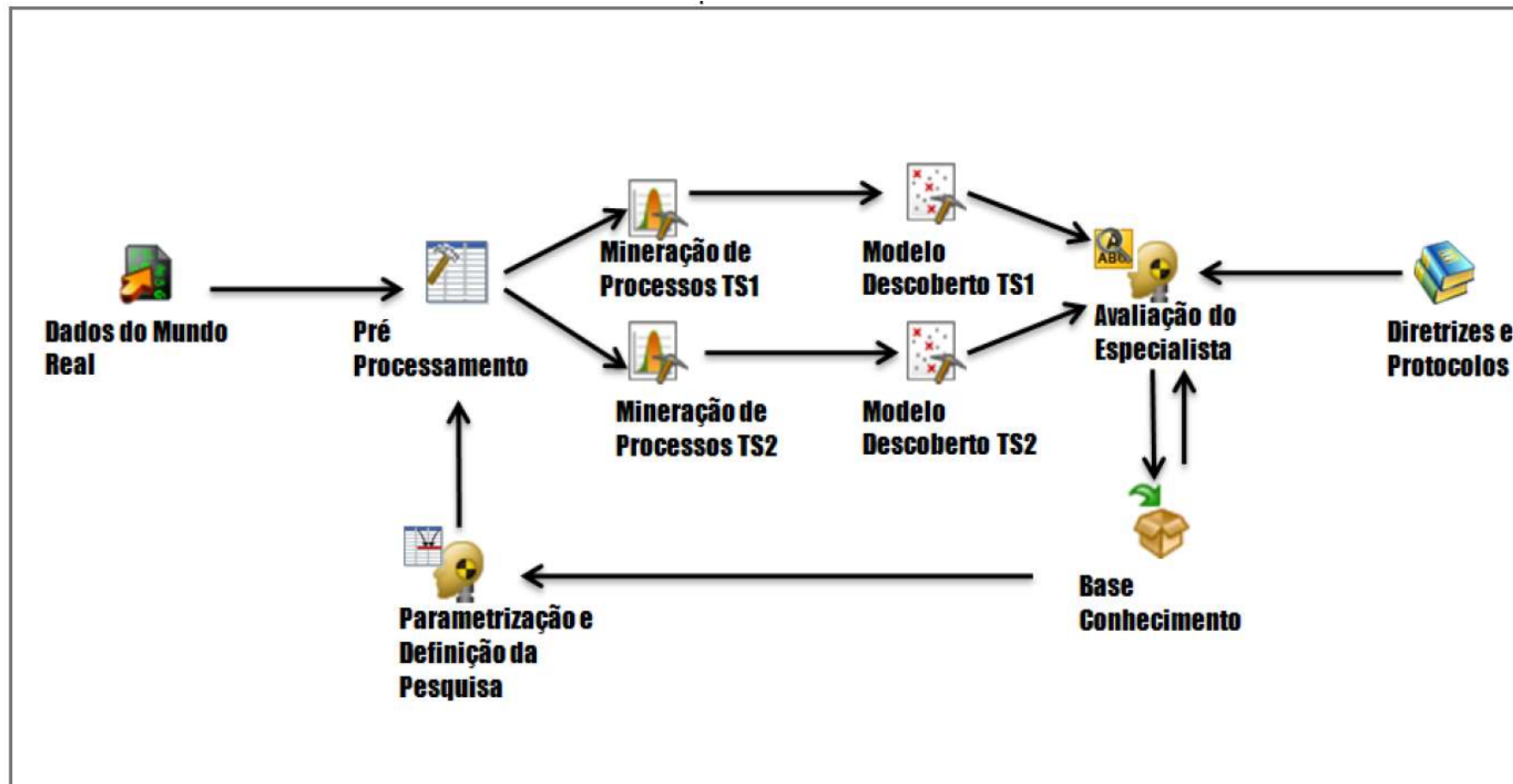






# Avaliação de Tecnologia em Saúde

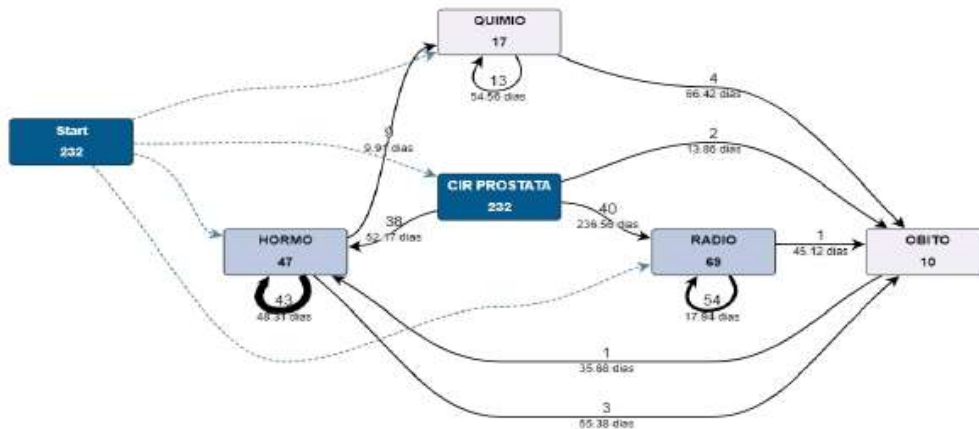
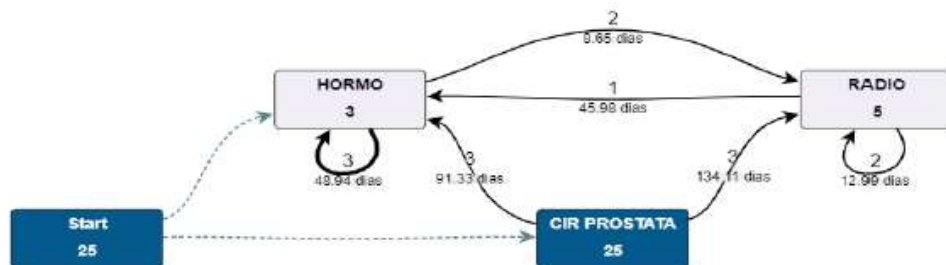
## Método Proposto





# Avaliação de Tecnologia em Saúde

## Comparação de Modelos de Processos de ATS

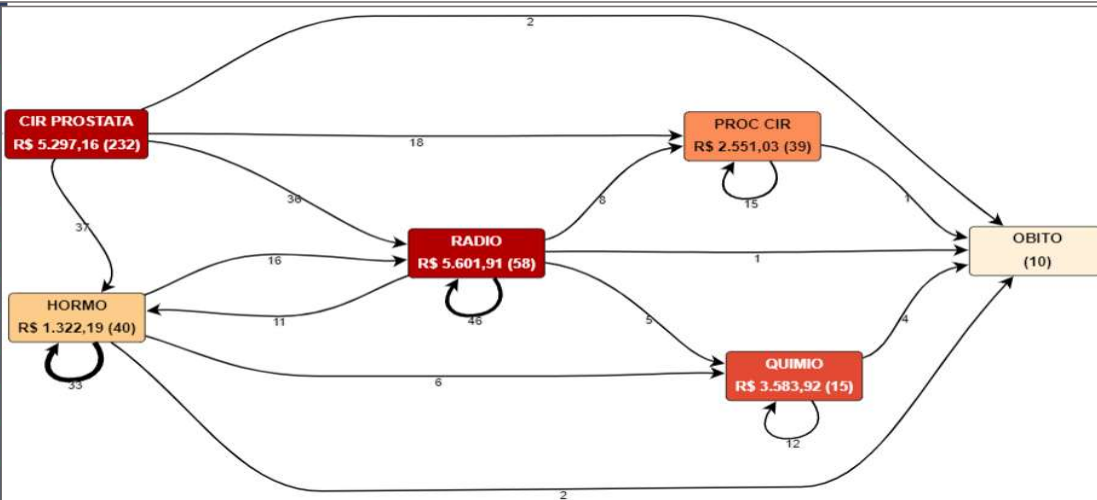
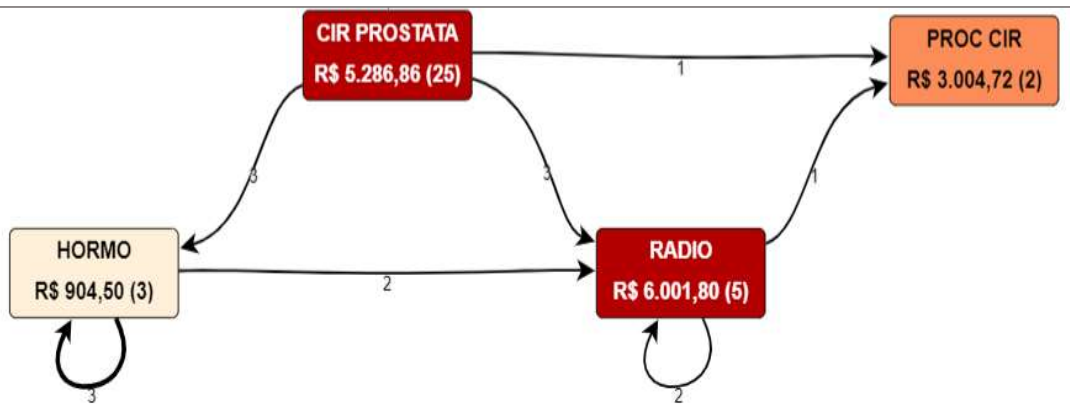


Atividade	Robô-Assistida n=25		Laparoscópica n=232	
	Qtde	%	Qtde	%
HORMONOTERAPIA	3	12,0%	47	20,0%
QUIMIOTERAPIA	0	0,0%	17	7,3%
RADIOTERAPIA	5	20,0%	69	29,7%
ÓBITO	0	0,0%	10	4,3%



# Avaliação de Tecnologia em Saúde

## Análise Custo Efetividade Incremental (ICER)



$$C_1 = \frac{\sum(\text{custo médio} \cdot \text{frequência})}{n} = \frac{(5.286,86 \cdot 25 + 904,50 \cdot 3 + 6.001,80 \cdot 5 + 3.004,72 \cdot 2)}{25} = \frac{170.903,19}{25} = 6.836,16$$

$$C_2 = \frac{\sum(\text{custo médio} \cdot \text{frequência})}{n} = \frac{(5.297,16 \cdot 232 + 1.322,19 \cdot 40 + 5.601,91 \cdot 58 + 3.583,92 \cdot 15 + 2.551,03 \cdot 39)}{25} = \frac{1.759.988,47}{232} = 7.586,16$$

$$ACM = C_1 - C_2 = 6.836,16 - 7.586,16 = - 750,02$$

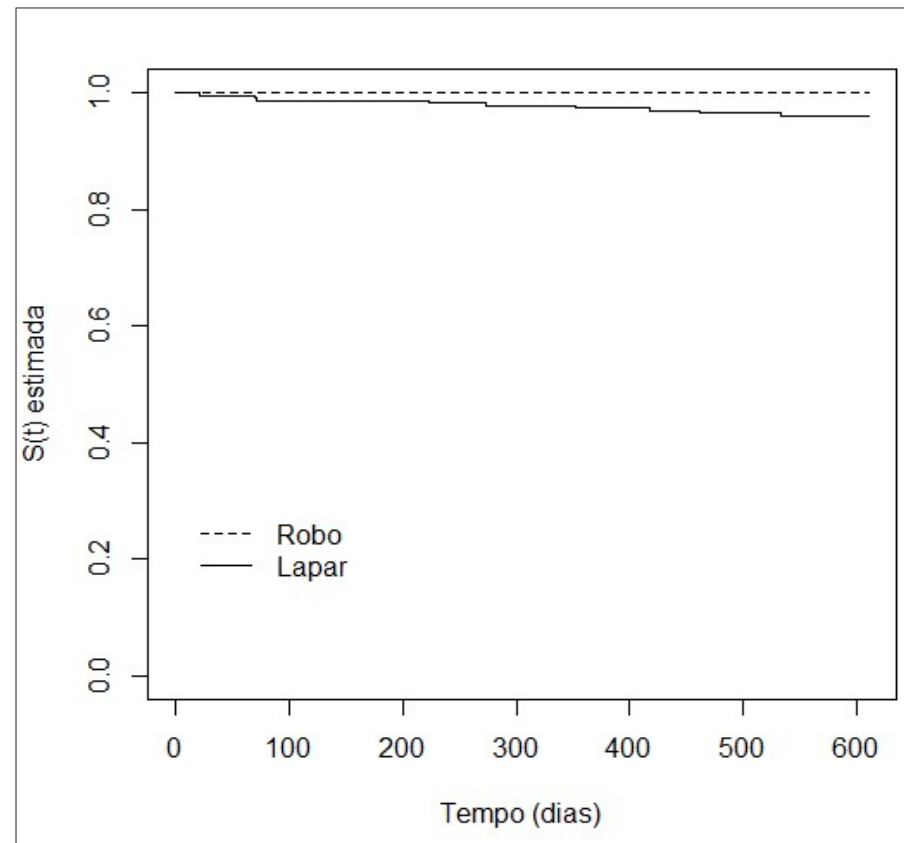
$$ACE = \frac{(C_1 - C_2)}{(E_1 - E_2)} = \frac{(6.836,16 - 7.586,16)}{(0,9200 - 0,8319)} = - 8.513,28$$



# Avaliação de Tecnologia em Saúde

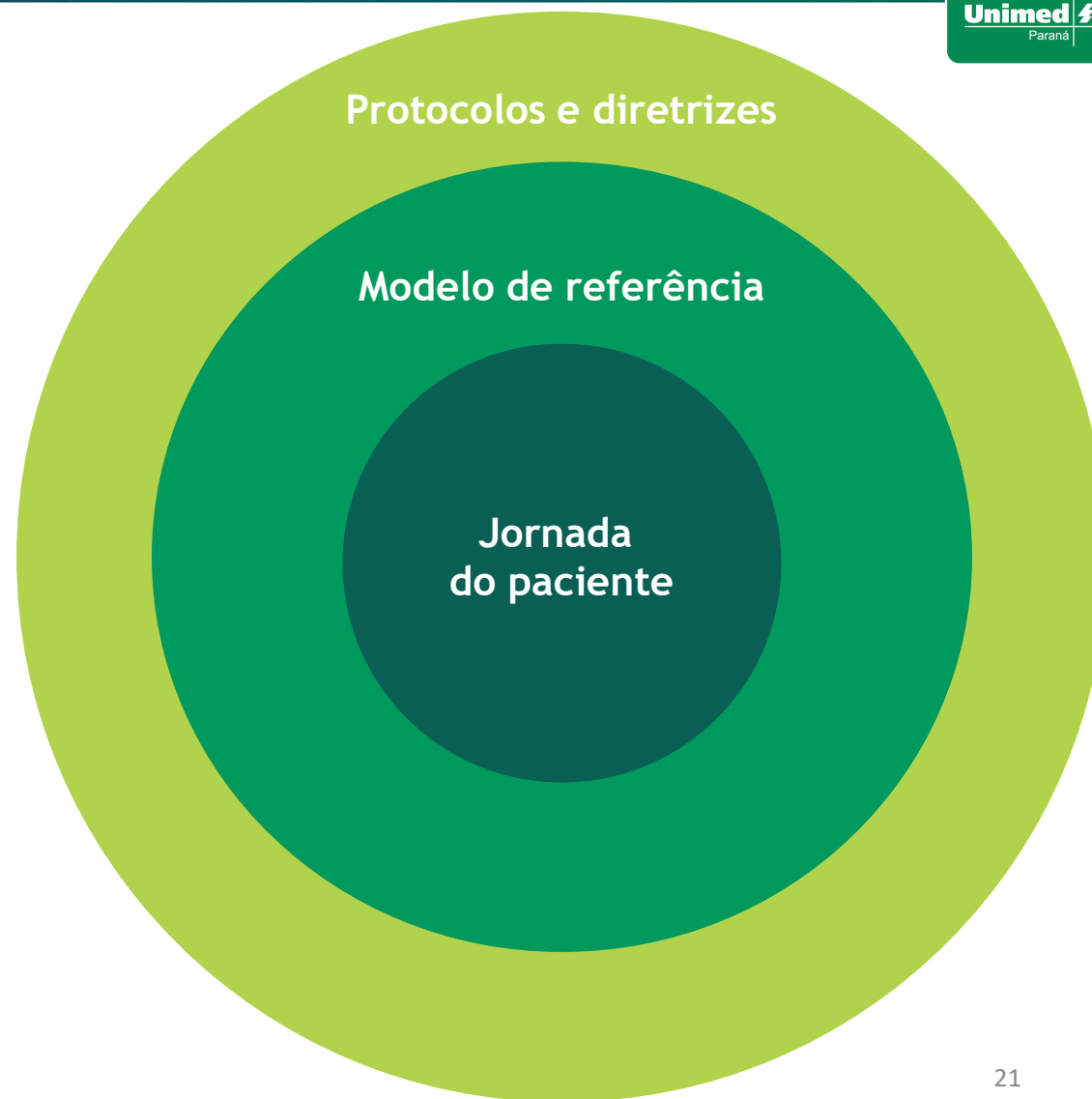
## Análise de Sobrevida - Kaplan Meier

Casos de óbito na técnica laparoscópica - n=232



## Jornada do paciente

Relações entre jornada do paciente, modelo de referência e protocolos/diretrizes



## Conclusão





Marcelo Rosano Dallagassa

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