Large Language Model: A Methodology Proposal for an Assisted Meta-Analysis to Catalog Medical Devices Used in Preoperative Progressive Pneumoperitoneum for the Management of Complex Ventral Hernias

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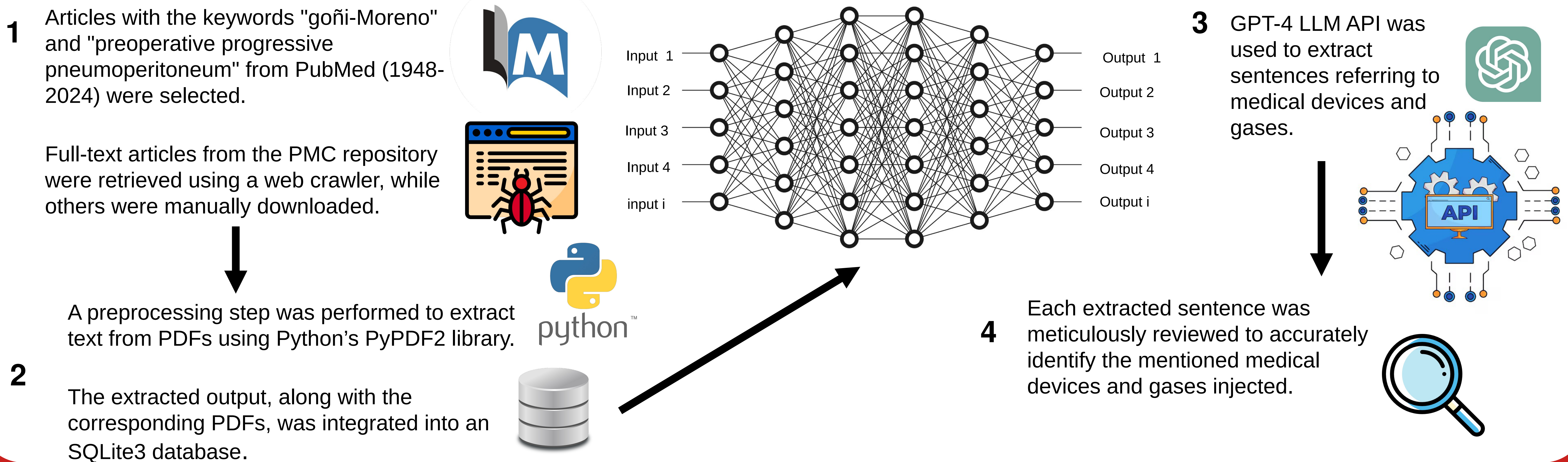[3] University of Burgundy, Dijon, France
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Background and Importance

- With the rise of artificial intelligence (AI) tools, especially Deep-Learning models, meta-analyses are likely to evolve. However, it is necessary to provide a framework for this purpose. This study focused on the goñi-Moreno technique, which aims to increases abdominal cavity volume prior to a complex ventral hernia surgery in order to reduce postoperative respiratory issues. Subcutaneous emphysema, caused by multi-perforated catheters, is a common complication [1,2]. The choice of medical devices depends on the practitioners. Here we conducted a meta-analysis to explore medical devices mentioned in literature related to this technique, using AI.
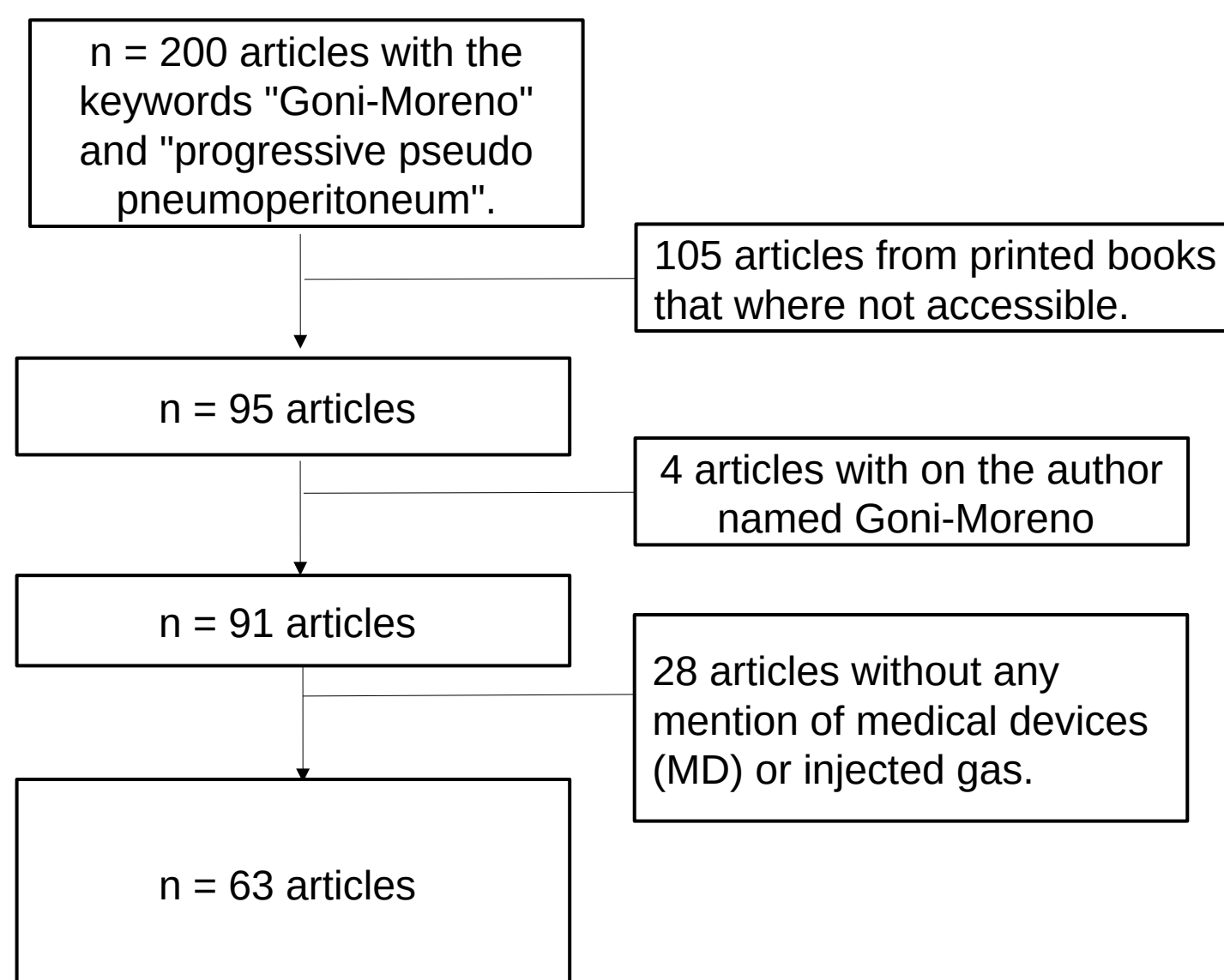
Aim and Objectives

- The objective of this study was to develop a state-of-the-art meta-analysis technique, assisted by a large language model (LLM), to identify an exhaustive list of medical devices and gases employed in the Goñi-Moreno technique worldwide. And to compare theses findings with our practices.

Materials and Methods

1 Articles with the keywords "goñi-Moreno" and "preoperative progressive pneumoperitoneum" from PubMed (1948-2024) were selected.

Full-text articles from the PMC repository were retrieved using a web crawler, while others were manually downloaded.

A preprocessing step was performed to extract text from PDFs using Python's PyPDF2 library.

2 The extracted output, along with the corresponding PDFs, was integrated into an SQLite3 database.

Input 1, Input 2, Input 3, Input 4, input i → Output 1, Output 2, Output 3, Output 4, Output i

3 GPT-4 LLM API was used to extract sentences referring to medical devices and gases.

4 Each extracted sentence was meticulously reviewed to accurately identify the mentioned medical devices and gases injected.

Results

Meta-analysis Flowchart

n = 200 articles with the keywords "Goni-Moreno" and "progressive pseudo pneumoperitoneum".

→ 105 articles from printed books that where not accessible.

n = 95 articles

→ 4 articles with on the author named Goni-Moreno

n = 91 articles

→ 28 articles without any mention of medical devices (MD) or injected gas.

n = 63 articles

Out of 200 PubMed articles (1948-2024), 63 were analyzed after exclusions:

- 105 inaccessible paper articles
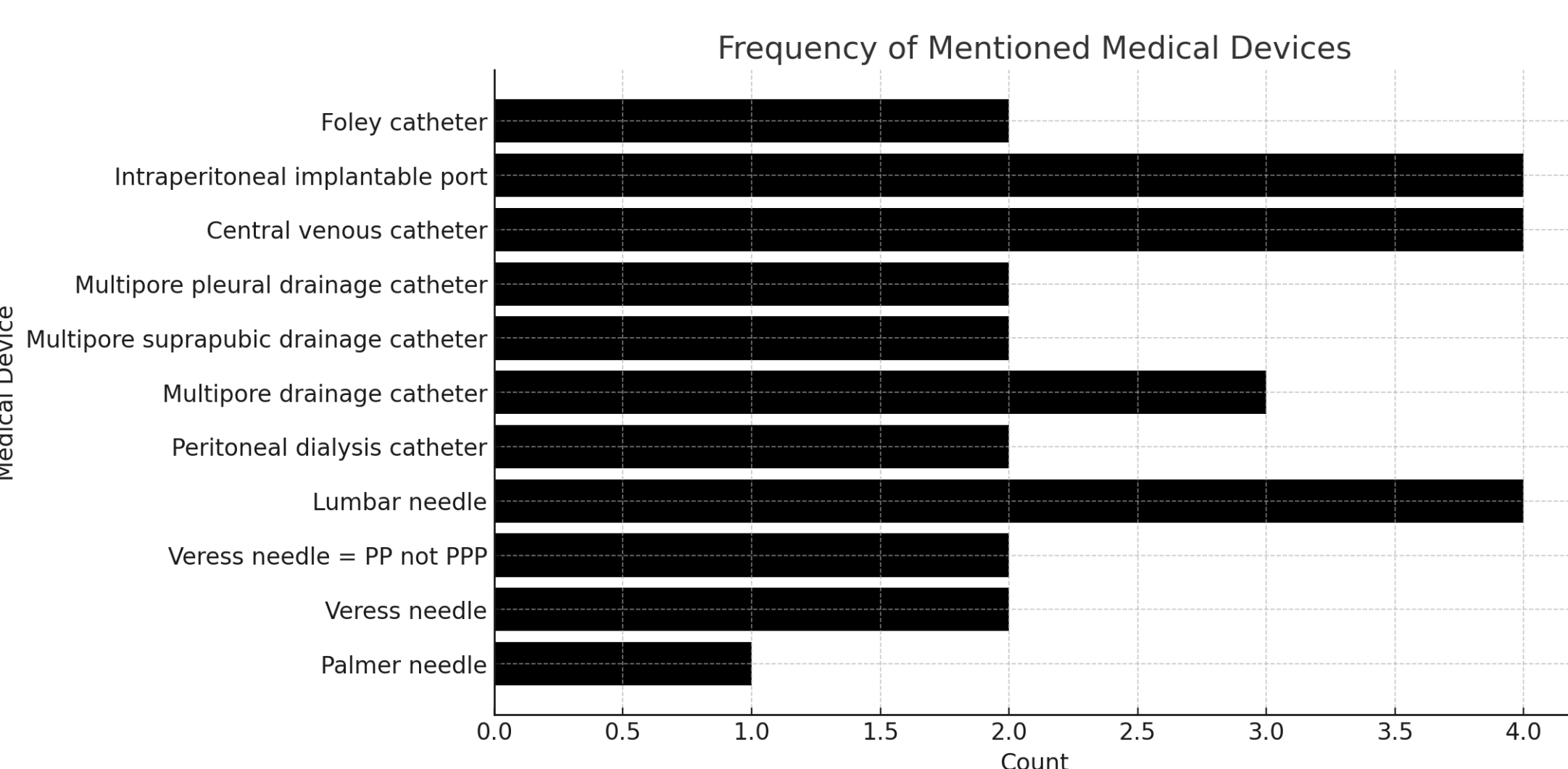- 32 irrelevant articles

Most cited medical devices:

- Intra-abdominal implantable chamber
- Central venous catheter
- Multi-perforated drainage catheter
- Lumbar needle

Most used gas:

- Air (most common)
- Some mentions of NO (nitric oxide) and CO_2 (carbon dioxide)

A comprehensive list of sterile medical devices (DMS) documented in the literature.

Frequency of Mentioned Medical Devices

Foley catheter
Intraperitoneal implantable port
Central venous catheter
Multipore pleural drainage catheter
Multipore suprapubic drainage catheter
Multipore drainage catheter
Peritoneal dialysis catheter
Lumbar needle
Veress needle = PP not PPP
Veress needle
Palmer needle

Count: 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0

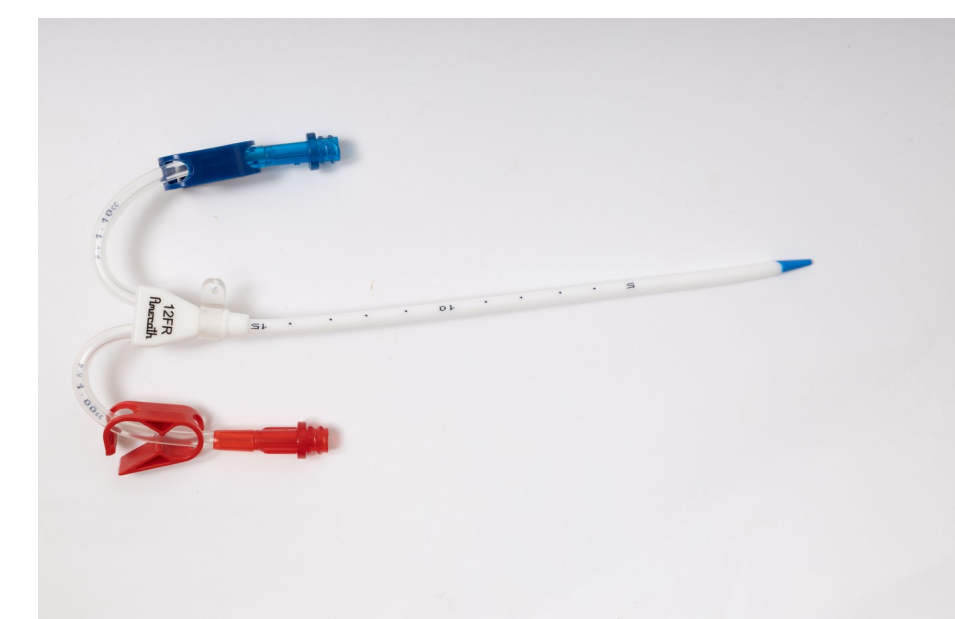Medical Device

Peritoneal dialysis catheter

Lumbar needle

Peripheral venous catheter

Central venous catheter

Veress needle

Hemodialysis catheter

Foley catheter

Intraperitoneal implantable port

Procedure at Dijon University Hospital

| Procedure: insufflation of ambient air | Medical device used: Radiopaque multiperforated drainage catheters | Insufflation method: until the patient's maximum tolerance | Gas administered: filtered ambient air | Complications encountered: subcutaneous emphysema |

Conclusion and Relevance

- Increased risk of subcutaneous emphysema associated with the use of multiperforated catheters.
- The use of multiperforated catheters results in a less technical surgical procedure.

Some studies, like Takehiko et al. (2024), showed promising results using LLMs in meta-analysis. In this study, we proposed a methodology to help practitioners quickly answer surgical questions, complementing rigorous methods that require re-evaluation. We are also providing a protocol to ensure the reproducibility of this methodology. Fine-tuning small language models for medical device research is the next step.

[1] Allart, K., Sabbagh, C., & Regimbeau, J.-M. (2020). Intraperitoneal catheter introduction for pre-operative progressive pneumoperitoneum for abdominal hernia with loss of domain (Goni-Moreno technique). Journal of Visceral Surgery, 157(4), 335–340. https://doi.org/10.1016/j.jviscsurg.2020.06.016

[2] Subirana, H., Comas, J., Crusellas, O., Robres, J., Barri, J., Domenech, A., Borlado, C., & Castellví, J. (2023). Preoperative Progressive Pneumoperitoneum in the Treatment of Hernias With Loss of Domain. Our Experience in 50 Cases. Journal of Abdominal Wall Surgery, 2, 11230. https://doi.org/10.3389/jaws.2023.11230

[3] Oami, T., Okada, Y., & Nakada, T. A. (2024). Performance of a Large Language Model in Screening Citations. JAMA network open, 7(7), e2420496.