National Aeronautics and Space Administration

ARTIFICIAL INTELLIGENCE (AI) METHODS FOR AUGMENTING THE IMPACT TOOL EVIDENCE LIBRARY

Human Research Program
Exploration Medical Capability Element

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"Expanding the Boundaries of Space Medicine and Technology"

Agenda

- Objective
- CliFF Process Overview
- Medical Information Mining and Processing
- Knowledge Base Construction
- AI Output Generation

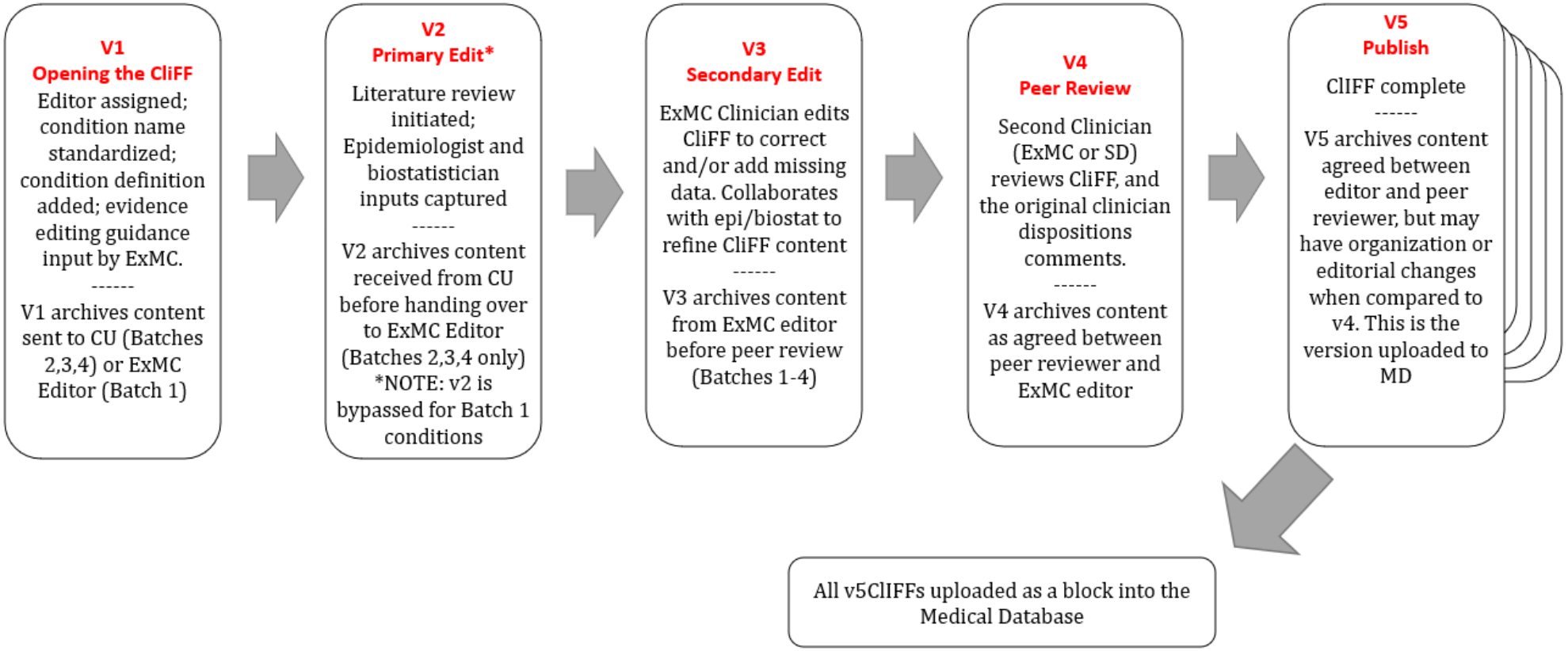
Objective

- Explore the use of AI to automate and improve the Clinical Finding Form (CliFF) creation process.
- Develop an AI-assisted automated pipeline to streamline the curation of scientific research publications.
- Leverage AI and Natural Language Processing (NLP) tools to efficiently search, retrieve, process, and summarize data for CliFF development.

CliFF Process Overview

CliFF Versions Overview

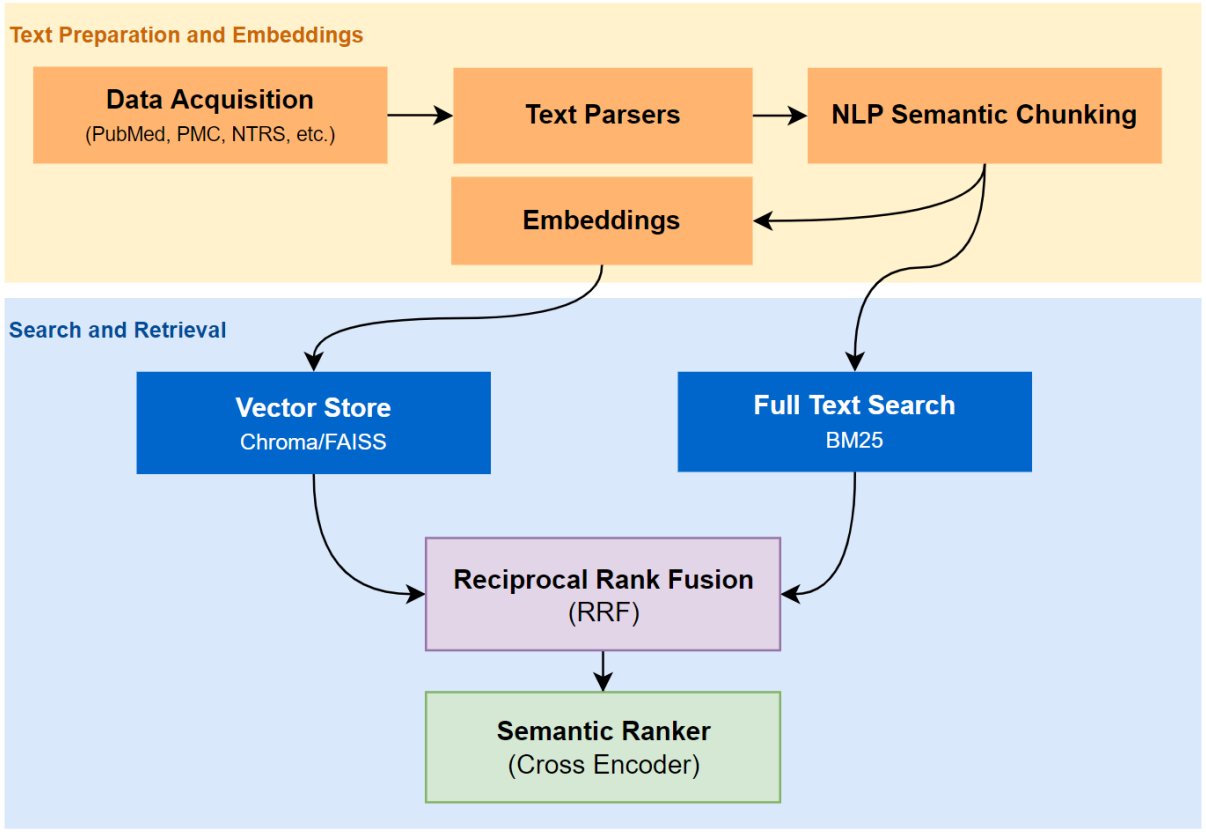
All CliFFs will be versioned in order to archive developmental stages of the CliFF product. V5 CliFFs will be uploaded to the Medical Database



REF: Exploration Medical Capability Evidence Library Methods, HRP-48036 Rev A, July 2022.

Medical Information Mining and Processing

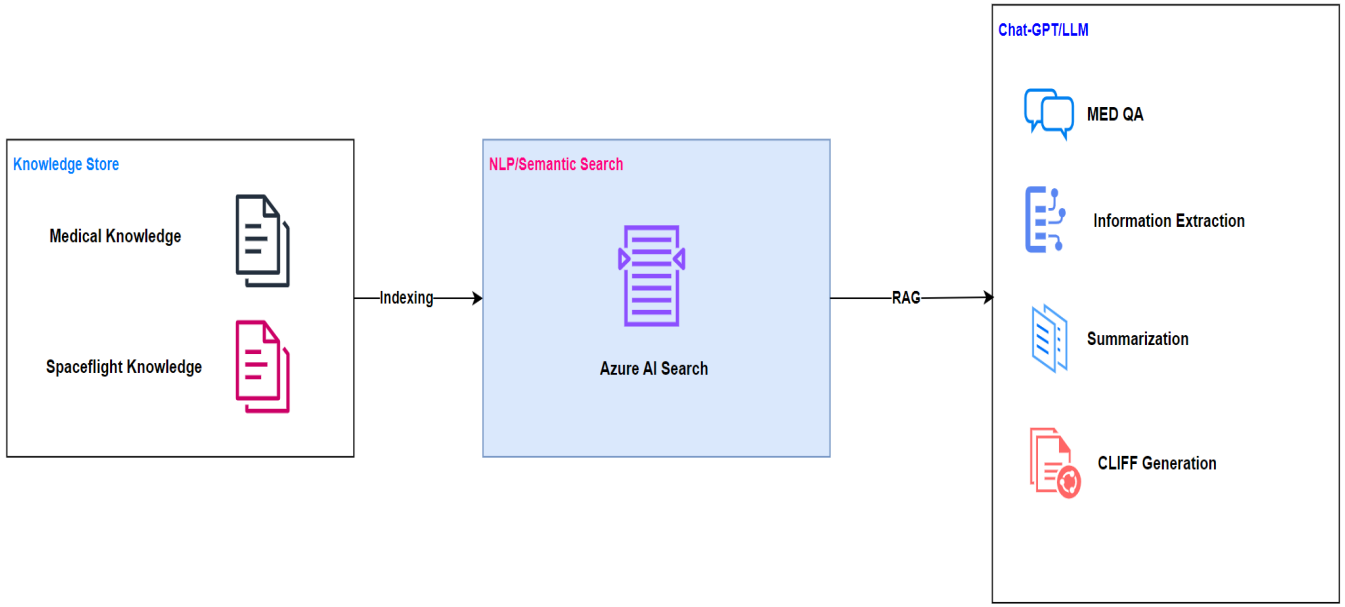
- **Data Acquisition:** Medical texts are collected from diverse sources, including PubMed, PMC, and NTRS.
- **Semantic Chunking:** The parsed text is divided into meaningful chunks using NLP-based semantic sentence splitting.
- **Vector Storage:** Embeddings are stored in a vector database (e.g., FAISS, Chroma DB) for efficient similarity searching.
- **BM25 Storage:** Text chunks are also indexed and stored in a BM25 store for full text and keyword-based retrieval.
- **Reciprocal Rank Fusion:** Results from the vector and BM25 searches are combined using reciprocal rank fusion to improve recall.
- **Semantic Ranker:** The combined results are passed through a final semantic ranker to precisely match the relevance of text to the original queries.



Knowledge Base Construction

- **Intelligent Query Generation:** AI Large Language Model (LLM) crafts specific search queries from user instructions, targeting diverse aspects of medical evidence.
- **Semantic Search & Ranking:** Semantic search identifies relevant documents, which are then ranked based on relevance to the generated queries.
- **Focused Result Set:** The top ***k*** most relevant results are selected from the search output.
- **Indexed for Access:** These top results are stored in an Azure AI Search index for efficient future retrieval.

AI Output Generation



- Leveraging Azure OpenAI and AI Search for intelligent data processing.
- Custom application and UI enable seamless user interaction.
- Capabilities include medical Q&A, information extraction, and literature summarization.
- Supports text generation, enhancing research and automated generation workflows.
- Multi agent design for complex reasoning and report generation

Example AI Output

Generate Page

Instructions | Agents Tasks | Search Results | Report

Incidence of Appendicitis: Evidence Synthesis Report

Spaceflight Incidence Overview

Currently, there is limited direct data on the incidence of appendicitis during spaceflight. The primary literature available focuses on the risk assessment and potential preventive measures, such as prophylactic surgery, to mitigate the risk[1]. Given the confined environment and limited medical resources, understanding and preventing appendicitis in space is critical for mission planning and astronaut safety.

Analog Literature Overview

Studies analogous to spaceflight conditions, such as those involving remote, harsh environments or deployed military personnel, provide indirect evidence that can be extrapolated. These environments share constraints similar to those in space, such as limited immediate medical care and the need for preventive health measures[2].

Terrestrial Literature Overview

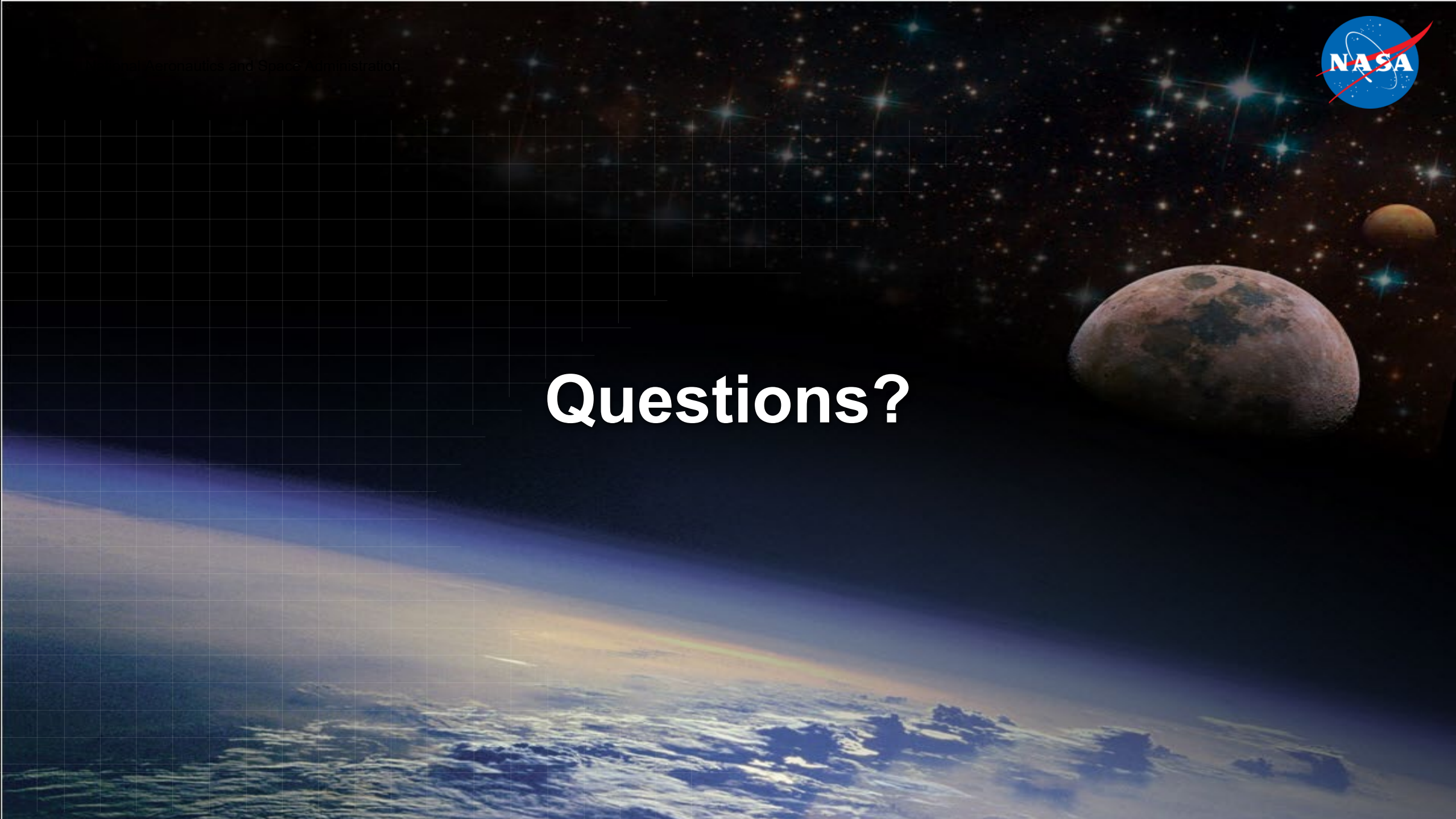
Incidence data from the general population provides a baseline understanding of appendicitis rates. Population-based studies from various countries and retrospective cohort studies offer insights into the prevalence and incidence trends over time. These data are crucial for modeling the potential risk during space missions[3].

Ranked Articles and Probability Data Table

Study Citation	Article Type	Article Publication Year or Years Included Report	Incidence or Prevalence Rate or Proportion	Comments	Relevant Probability Data
Ferris, 2017	Systematic Review	2017	Varies by region; e.g., 100-150 cases per 100,000 person-years	Comprehensive review of global incidence trends	x
de Wijkerslooth, 2020	Population-based Cohort Study	2020	Incidence not specified; focus on burden and outcomes	Large-scale epidemiologic data from the Netherlands	
Bass, 2023	Observational Cohort Study	2023	Not specified; focus on guideline adherence and complications	Data from ESTES SnapAppy study on acute appendicitis	

DISCLAIMER:

The IMPACT Probabilistic Risk Assessment (PRA) tool is under active development. All results are preliminary, subject to change, and must not be used for mission planning, operational decisions, or formal analysis. These results are provided solely for feedback and discussion purposes to support tool improvement.



Questions?