

Solstice: Automated Fact-Checking for Medical Documentation

A Multi-Agent System for Evidence Extraction and Verification

1 Overview

Solstice is an automated system for fact-checking medical claims against scientific literature. It processes PDFs through a pipeline that combines layout detection, content extraction, and multi-agent verification to produce comprehensive evidence reports.

2 System Architecture

The Solstice pipeline consists of five main stages:

1. **PDF Input:** Medical documents including clinical trials, package inserts, and marketing materials
2. **Layout Detection:** Computer vision models identify document structure (text blocks, tables, figures)
3. **Content Extraction:** Structured extraction of text and visual elements
4. **Multi-Agent Analysis:** LLM-based agents extract and verify evidence
5. **Report Generation:** Consolidated evidence reports with confidence assessments

3 How It Works

3.1 Step 1: Understanding Document Structure

Medical documents are complex—they mix narrative text with data tables, clinical figures, and regulatory disclaimers. Solstice first “sees” the document using computer vision to identify each element:

This visual understanding is crucial because:

- Key efficacy data often appears in tables
- Safety information may be in figure captions
- Important disclaimers hide in footnotes
- Marketing materials use visual hierarchy to emphasize claims

3.2 Step 2: Multi-Agent Verification

Once documents are structured, four specialized agents collaborate to verify claims:

The agent pipeline processes claims through multiple stages:

1. **Evidence Extractor:** Searches documents for passages related to the claim

Total elements: 15
Reading order: 15 elements

Vaccine 29 (2011) 7733–7739



3. Title: Protective efficacy of a trivalent recombinant hemagglutinin protein vaccine (FluBlok®) against influenza in healthy adults: A randomized, placebo-controlled trial^A

4. Text: John Treanor^{a,*}, Hana El Sahly^b, James King^c, Irene Graham^d, Ruvim Izikson^e, Robert Kohberger^f, Peter Patriarca^g, Manon Cox^e

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6. Figure: ARTICLE INFO

Article history:
Received 20 May 2011
Received in revised form 27 July 2011
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Available online 9 August 2011

Keywords:
Influenza vaccine
Baculovirus expression
Recombinant protein
Clinical trials

7. Title: ABSTRACT

8. Text: **Background:** Development of influenza vaccines that do not use embryonated eggs as the substrate for vaccine production is a high priority. We conducted this study to determine the protective efficacy a recombinant, baculovirus-expressed seasonal trivalent influenza virus hemagglutinin (rHA0) vaccine (FluBlok®). **Methods:** Healthy adult subjects at 24 centers across the US were randomly assigned to receive a single injection of saline placebo (2304 subjects), or trivalent FluBlok containing 45 mcg of each rHA0 component (2344 subjects). Serum samples for assessment of immune responses by hemagglutination-inhibition (HAI) were taken from a subset of subjects before and 28 days after immunization. Subjects were followed during the 2007–2008 influenza season and combined nasal and throat swabs for virus isolation were obtained from subjects reporting influenza-like illness. **Results:** Rates of local and systemic side effects were low, and the rates of systemic side effects were similar in the vaccine and placebo groups. HAI antibody responses were seen in 78%, 81%, and 52% of FluBlok recipients to the H1, H3, and B components, respectively. FluBlok was 44.6% (95% CI, 18.8%, 62.6%) effective in preventing culture-confirmed influenza meeting the CDC influenza-like illness case definition despite significant antigenic mismatch between the vaccine antigens and circulating viruses. **Conclusions:** Trivalent rHA0 vaccine was safe, immunogenic and effective in the prevention of culture confirmed influenza illness, including protection against drift variants.

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9. Title: Introduction

10. Text: Though embryonated hen's eggs have been used to generate effective influenza vaccines for many years, this system does have several important drawbacks. Vaccine manufacturing using eggs requires specialized facilities, and the ability to scale up egg production rapidly in response to an emergency is limited. In addition, poultry are potentially vulnerable to the same subtypes of influenza

14. Text: that might also be responsible for pandemic influenza. It is usually necessary to adapt candidate vaccine viruses for high yield growth in eggs, a process that can be time consuming, is not always successful, and which can select receptor variants that may not be optimally representative of circulating influenza strains [1,2].

15. Text: Expression of proteins in insect cells using recombinant baculovirus has emerged as a promising technology for vaccine production. New recombinant baculoviruses can be generated quickly from sequence data, protein expression is very efficient under the control of the baculovirus polyhedrin promoter, and post-translational modifications of the protein are generally similar to other eukaryotic systems. In previous studies, we have evaluated baculovirus-expressed recombinant influenza virus hemagglutinins (rHA0s) as influenza vaccines in humans. Monovalent and bivalent rHA0s have been well tolerated and immunogenic in

11. Text: ^ATrials.gov Identifier: NCT00539981.

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12. Text:

13. Text: X/S – see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.vaccine.2011.07.128

Figure 1: Layout detection on a clinical trial paper identifies distinct regions: title, abstract, body text, tables, and figures. Each element is extracted separately for targeted analysis.

2. **Evidence Verifier:** Confirms quotes are accurate and truly support the claim
3. **Completeness Checker:** Identifies missing evidence and triggers additional searches
4. **Visual Analyzer:** Examines tables and figures for data supporting or contradicting claims

Agents communicate through structured JSON outputs, with feedback loops allowing the Completeness Checker to request additional extraction when gaps are identified.

3.3 Step 3: Comprehensive Reporting

The system produces detailed reports showing:

- Exact quotes supporting each claim
- Visual evidence from tables and figures
- Conflicting information if found
- Confidence assessment based on evidence strength
- Missing evidence that couldn't be located

4 Real-World Applications

4.1 Clinical Trial Verification

When pharmaceutical companies publish trial results, Solstice can verify that marketing claims accurately reflect the scientific data. The system catches discrepancies like selective reporting or overgeneralization of results.

4.2 Regulatory Compliance

Medical device manufacturers must ensure their promotional materials align with FDA-approved indications. Solstice automatically cross-references marketing claims against regulatory documents.

4.3 Marketing Material Review

Marketing materials require special attention due to their persuasive nature:

5 Key Innovations

5.1 Multimodal Understanding

Unlike text-only systems, Solstice analyzes tables, graphs, and figures—critical for medical evidence where key data often appears visually.

5.2 Intelligent Orchestration

Agents work together with feedback loops, ensuring thorough verification. If gaps are found, the system automatically searches for additional evidence.

5.3 Traceable Verification

Every claim links back to its source evidence, maintaining transparency and allowing human review of the automated findings.

Total elements: 19

Reading order: 19 elements

2. Separator

3. Figure

4. Text

5. Text

6. Figure

7. Text

8. Text

9. Text

10. Text

11. Text

12. Text

13. Figure

14. Text

15. Text

16. Text

17. Text

18. Text

19. Text

Figure 2: Marketing materials use visual design to emphasize benefits. Solstice identifies promotional claims and verifies them against clinical evidence.

4

5.4 Scalable Architecture

The system processes multiple claims in parallel while managing computational resources efficiently.

6 Impact and Benefits

- **Speed:** Reduces verification time from days to minutes
- **Accuracy:** Systematic analysis eliminates human oversight errors
- **Completeness:** Examines entire documents, not just keyword matches
- **Transparency:** Provides traceable evidence for every verification
- **Scalability:** Handles large document sets that would overwhelm human reviewers

7 Future Directions

Solstice continues to evolve with planned enhancements:

- Cross-document reasoning to synthesize evidence from multiple sources
- Temporal analysis to track how claims change over time
- Contradiction detection between related documents
- Integration with regulatory databases for real-time compliance checking

8 Conclusion

Solstice represents a paradigm shift in medical document verification. By combining visual document understanding with intelligent agent orchestration, it transforms a manual, error-prone process into an automated, reliable system. This enables faster drug development, more accurate marketing, and ultimately, better-informed healthcare decisions.