1. Medicine’s Information Flow Challenge

Written By Deepak Jeyarajan

The Hidden Bottleneck in Healthcare: Information Flow

Modern medicine’s greatest challenge isn’t necessarily the complexity of disease or the limits of treatments—it’s information flow. Every failure point in healthcare can be traced back to breakdowns in how information moves between stakeholders. This fundamental insight reframes how we should approach healthcare system design, especially as we introduce artificial intelligence.

The Omnipresent Flow Problem

Information flow problems manifest in obvious ways:

- **Clinical handovers** between shifts or departments create vulnerability points where critical details get lost
- **Referrals** between specialists fragment the patient journey
- **Patient histories** become diluted or distorted with each retelling
- **Investigation results** get lost in complex systems
- **Public health initiatives** fail when crucial information doesn’t reach target populations

But the information flow challenge extends beyond these obvious examples. Medical learning itself—the way physicians accumulate clinical wisdom—represents an information flow bottleneck. Experience-based medicine means knowledge remains trapped in individual clinicians’ minds, creating uneven quality of care.

Even our most sophisticated knowledge-sharing mechanisms—medical journals and conferences—represent imperfect attempts to facilitate information flow between physicians and statisticians. Yet these systems weren’t designed for the scale and complexity of modern healthcare.

Medicine as a Collective Intelligence Exercise

What if we viewed medicine differently? Rather than a profession of individual experts, imagine medicine as a collective intelligence exercise where the system’s emergent capabilities exceed any individual contributor.

The most effective clinical decision for any patient requires:

1. Comprehensive search through existing knowledge (published literature)
2. Thorough research of collected but undistilled information (case reports, clinical data)

3. Aggregated experience from thousands of similar cases
4. Connection to interdisciplinary perspectives

Today’s healthcare system makes this ideal nearly impossible. No single clinician can search all relevant literature, review all similar cases, or connect with every relevant specialist for each patient. The information flow bottleneck creates a ceiling on clinical excellence.

Reimagining Clinical Work with AI-Enhanced Information Flow

AI systems designed specifically to address information flow can transform healthcare delivery. The goal isn’t to replace clinicians but to create continuously-learning ambient clinical intelligence that enhances human capabilities.

Key Information Flows to Optimize

1. Patient-Doctor Information Flow

History-taking and symptom reporting represent critical but often rushed processes. AI agents could:

- Conduct thorough pre-appointment history collection
- Translate patient concerns into clinical terminology
- Identify patterns across appointments and providers
- Ensure no relevant symptoms or concerns are missed

2. Doctor-Doctor Information Flow

When physicians collaborate, outcomes improve. AI can enhance this by facilitating:

- Structured second opinions from clinical assistants
- Interdisciplinary team connection and collaboration
- International collaboration on complex cases
- Implementation of truly international standards of medicine

3. Present Doctor-Past Doctors Information Flow

Current clinicians struggle to benefit from all collective medical wisdom. AI can bridge this by:

- Synthesizing relevant journal findings for specific cases
- Surfacing similar historical cases and their outcomes
- Transforming collective medical knowledge into case-specific insights
- Enabling learning from the outcomes of all past similar cases

4. Clinical Team Information Flow

Coordination across the broader healthcare team often fails. AI can help by:

- Ensuring that nursing observations reach physicians promptly
- Coordinating allied health interventions
- Streamlining communication between departments
- Maintaining continuous awareness of patient status across the team

5. Patient-Community Services Information Flow

Patients often struggle to navigate complex healthcare systems. AI can facilitate:

- Connection to appropriate community resources
- Patient advocacy for interdisciplinary coordination
- Navigation assistance through complex healthcare journeys
- Continuity between acute and chronic care settings

Key Clinical Capabilities to Build

By optimizing these information flows, we can develop systems that enable several crucial capabilities:

1. Closing Clinical Loops

Many healthcare errors occur when follow-up actions are missed. AI systems can:

- Remind clinicians to chase up outstanding test results
- Track patients requiring outpatient follow-up
- Ensure discharge plans are implemented completely
- Monitor for medication reconciliation issues

2. Suggesting Evidence-Based Next Steps

Clinical decision support can be dramatically improved when it's based on comprehensive information flow:

- Provide key clinical insights based on all available data
- Suggest investigations or examinations that might be overlooked
- Offer management suggestions with multiple levels of evidence:
    - General evidence-based guidelines
    - Institution-specific protocols
    - Team-specific preferences and patterns
- Present options with clear rationales and supporting evidence

3. Streamlining Administrative Documentation

Significant clinician time is wasted on documentation that poorly serves its information flow purpose:

- Generate structured handover summaries from clinical notes
- Prepare comprehensive referrals for specialist consultation
- Develop patient-centered discharge documentation
- Create actionable plans that can be implemented by clinical teams

4. Enabling Advanced Reasoning and Prediction

With robust information flow, more sophisticated clinical capabilities become possible:

- Counterfactual reasoning about treatment options
- Digital twinning to simulate intervention outcomes
- Predictive analytics for clinical deterioration
- Personalized treatment response projection

Designing for Human-AI Collaboration in Medicine

For these systems to succeed, they must be designed with clear principles for human-AI interaction. Drawing from aviation, human-computer interaction, and emerging human-centered AI literature, three key tensions must be addressed:

1. Automation vs. Human Agency

AI systems must enhance rather than replace clinician judgment. This requires:

- Providing the right “window” into AI reasoning
- Presenting information that matches clinician cognitive processes
- Supporting situation awareness at perception, comprehension, and projection levels
- Ensuring AI complements rather than undermines human expertise

2. System Uncertainty vs. User Confidence

Healthcare AI must acknowledge limitations without undermining clinical confidence:

- Explicitly communicate known knowledge gaps
- Present confidence levels with appropriate context
- Allow clinicians to explore alternative diagnostic pathways
- Support rather than override clinical intuition and judgment

3. System Complexity vs. Perceived Complexity

The interface between complex AI systems and busy clinicians requires careful design:

- Adapt information density based on case complexity and urgency
- Present simplified interfaces for routine cases
- Allow deeper exploration for atypical presentations
- Ensure critical information remains accessible without cognitive overload

The End Game: Ambient Clinical Intelligence

The ultimate vision is a system that transforms how medicine is practiced:

- **Resident Agent Systems** that function like a clinical “Jarvis” - allowing clinicians to use natural voice commands, automatically navigating EMRs, answering questions, and reducing cognitive burden

- **Research Acceleration** that enables 10x research output by creating research-ready data flows
- **Natural Pattern Discovery** in areas like chronobiology through large-scale data analysis
- **Automated Research Pipelines** for real-world evidence generation

By focusing on information flow as the fundamental challenge, we can build systems that genuinely transform healthcare delivery rather than merely digitizing existing workflows.

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What Medicine needs to get right about AI

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2. What Medicine needs to get right about AI

Written By Deepak Jeyarajan

1 The AI Revolution in Medicine: Beyond the Hype

The transformer architecture has revolutionized AI, enabling systems to capture complex non-linear relationships in vast datasets. In medicine, this has led to remarkable capabilities:

ℹ️ Current Applications

- **Clinical Communication:** When applied to medical language, AI systems now understand medical context and can answer patient questions at a level comparable to or exceeding doctors
- **Administrative Efficiency:** When applied to human conversations, we can now automate clinical scribing and writing medical letters
- **Workflow Enhancement:** When applied to the EMR, with text-to-action & computer use, you could even automate tedious EMR navigations.

- **Research Advancement:** When applied to massive multi-omic biological data in data-rich fields like oncology, the next biomedical breakthroughs will be aided by AI foundation models.

2 The Implementation Challenge

We clinicians will, or already are, using AI tools at work. It's crucial that we, as a field, speak the same language as those implementing these tools. This is to ensure patient safety (Epic's Sepsis cautionary tale) and to use the tools properly. They are quite good, and we should make the most of them.

2.1 Understanding AI: Models vs Products

A crucial distinction often missed is that an AI model itself is not a product. Take OpenAI as an example - while they excel at building powerful models, their success with ChatGPT comes from transforming that model into a helpful assistant. As highlighted in this brilliant Stanford talk, considering the specific context and software surrounding the model allows us to be imaginative and practical.

2.2 The Clinical Decision Support Dilemma

Consider clinical decision support in radiology. While companies focus on creating high-performance diagnostic models, the implementation pathway remains unclear. There is practical use in screening and translating reports for patient understanding, but clinical practice implementation remains murky.

Currently, using the model, the main product being created is one that generates imaging reports. Here are some options:

2.3 Implementation Models

1. *Human & AI Case Collaboration*
   - Clinician works on the case at the same time as the AI
   - The AI report is visible for the clinician to use as desired
2. *AI-First Verification*
   - AI generates initial report
   - Clinician reviews and validates
3. *Human-First Verification*
   - Clinician writes initial report
   - AI system performs error check
   - Discrepancies trigger senior clinician review
4. *AI as a Co-Worker*
   - AI handles routine cases & calculates confidence/complexity metrics
   - Complex cases routed to senior clinician where appropriate

Without sufficient thought to human-computer interaction, it's looking pretty bleak.

Options 1, 2 and likely 3 cause time-poor and stressed out radiologists. Option 1's 'helpful' reporter product is like a genius who sometimes gets the hardest question right and sometimes the easiest question wrong. In a healthcare setting, there is limited value - more time will be spent on all discordant cases (which may not even result in better clinical performance). Option 2 is option 1 in disguise - you risk over-reliance or ignoring useful outputs. Option 3 is more useful; it sets clear boundaries on the human-AI relationship. By only making the AI visible in discordant cases, it may serve as a good tool to 'triage' scans up the chain of experience. However, you run into the same 'Who is right?' dilemma.

Financially, only option 4 makes sense to radiology practices and hospitals. Ide & Talamas describe this as an autonomous agent replacing routine work, displacing humans to more specialised problem-solving. If this leads to better patient outcomes, we must choose this option. However, we also need to face significant restructuring of training programs and retrain displaced early-career specialists.

3 Breaking Free from False Assumptions

Our limited options stem from several unfortunate assumptions/starting points:

- Our best way to help radiologists is to diagnose for them
- The best way to help radiologists is to write reports for them
- AI is a black box that cannot truly reason, so we can't truly understand it
- This means that as long as we have high-quality training data of prior reports, we can generate high-quality reports and trust them

Reading medical imaging itself is a process. Why can't we have asked questions like:

- How can we automatically identify and show the radiologist the key references (Radiopaedia/StatDx) they would need to look at to solve this case?
- Can we automatically show the patient's last 5 CXRs, process them and identify exactly where changes have evolved?
- Considering the speed of system 1 thinking, how can we best display anomaly detection with attached tree-of-thought reasoning traces while enabling a clinician's systematic read of an image?
- During dictation, can we let the radiologist think out in a very unstructured manner, offering real-time reasoning feedback as well as scribing a high quality radiology report?
- Can we automate and adapt reporting for specific protocolised research guidelines?
- Can we use LLMs to enhance inter-radiologist communication to get rapid second opinions from leading experts?

4 Why are we here?

Outside of a resource-poor setting, there is little unmet clinical need for an autonomous radiologist agent. The explosion of AI, the abundance of radiology reports and the monetary value in creating a high-quality autonomous agent all culminates in these foundation models that can perform exceptionally well.

However, given its training with human-labelled reports and diagnoses, I question if we can truly grow in medicine with these types of models. Can we get closer to 'perfect medicine' by having models that talk and breathe our biases?

Here is a direction I think would be more fruitful, we already have high-quality intelligent staff, why can't we empower them to perform efficiently and improve to be their best? All of those 6 questions I've posed that aim to directly augment a radiologist's work are tractable now. Note that they are useful products, not necessarily new models.

Unsupervised data-driven approaches can teach us so much about biomedicine - medicine will look incredibly different in the upcoming decades. We need nimble well-supported staff, with both autonomous AI and better non-autonomous copilots to maximise their clinical impact.

We'll explore non-autonomous copilots and autonomous AI in more detail here including specifics of how we can think about human-AI interaction.

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AI Agents in Medicine: A Glimpse Into the Future

3. AI Agents in Medicine: A Glimpse Into the Future

Written By Paula Chen

With the increasing capabilities of AI in the last couple of years, many have speculated that its contribution to the field of medicine will be revolutionary. This began as excitement over discrete, individual tools that aid clinicians in their tasks, such as a program that helps radiologists identify cancerous lung lesions or an app that flags suspicious skin moles for patients.

But while these early tools offered isolated support, a new class of AI—capable of autonomous, goal-driven behavior—is starting to emerge. The rise of AI agents unlocks a whole new realm of possibilities within the medical sphere: tools that thrive in the chaos of multidisciplinary coordination, high-uncertainty situations, and patient variability.

What is Agentic AI?

Agentic AI is a type of artificial intelligence that can work independently to achieve complex goals, without requiring constant human supervision or feedback. Unlike traditional systems that follow pre-programmed rules or respond to simple commands, agentic AI can take an abstract, often open-ended goal—like "help diagnose this patient" or "plan a treatment course"—and determine a logical sequence of steps to accomplish it.

These agents don’t just give one-off answers. Instead, they break tasks down into smaller substeps, working through each one to arrive at a final solution. For instance, to diagnose a patient, an AI agent might analyze symptoms, suggest investigations, interpret the results, and generate a cohesive answer.

Through capabilities like "text-to-action" and “multi-agent collaboration”, these agents can also interact with external systems like hospital tools or databases, and collaborate with other AI agents to complete complex real-world tasks. For instance, after reasoning through a patient diagnosis, it would be possible for an AI agent to notify the doctor of a critical condition and book the patient in for a follow-up appointment on the hospital website.

What Agents Could Be Useful in Medicine?

The possibilities of AI agents in medicine are endless, but some possible ideas include:

Care Coordination Agent

This agent coordinates and tracks individualised care plans from admission to discharge and follow-up, advocating for the patient’s unique values and preferences. It keeps patients and families informed, translating medical terminology into plain language. Long-term, it could remain with the patient throughout their healthcare journey.

Patient Monitoring Agent

This agent continuously monitors vitals, labs, and other patient data to detect early signs of deterioration. It processes large volumes of real-time data, identifies subtle patterns, and alerts teams to emerging risks before they become critical. It operates on evidence-based protocols and helps doctors by providing updates on specific test results, ensuring continuous, high-quality care.

Clinical Support Agent

The Clinical Support Agent assists doctors by automating administrative tasks, including patient progress notes and ordering investigations. It synthesizes medical literature, guidelines and patient context to offer useful, timely recommendations, thereby streamlining workflows and reducing decision fatigue.

Multidisciplinary Team Management Agent

This agent coordinates the efforts of various healthcare professionals involved in patient care. It schedules meetings, integrates input from different specialists, and ensures smooth communication across disciplines. During team discussions, it presents concise patient summaries, highlights key issues, and suggests solutions to potential conflicts. It tracks action items and ensures all team members have up-to-date information, promoting informed decision-making and improving patient outcomes.

Rapid Responder Agent

Built for emergencies, this agent processes data in real-time to support triage and decision-making. It supports emergency procedures by displaying critical care guidelines, tracking interventions, and assisting in the prioritisation of tests and consultations. It integrates verbal updates, imaging, and vital signs to assist clinicians in making fast, accurate decisions.

Procedural Planning Agent

This agent seeks to provide guidance throughout medical procedures to improve safety and efficiency. Before a procedure, it assesses patient suitability. During the procedure, it offers real-time, step-by-step intraoperative guidance and helps navigate each procedural step. Post-procedure, it monitors for complications and ensures continuous care

Quality Management Agent

Operating at an institutional level, this agent continuously audits performance, flags adverse outcomes, and identifies systemic issues. It promotes quality improvement by tracking trends and unmet needs, enabling proactive resource allocation and equity in healthcare.

Conclusion

As the nascent field of agentic AI continues to evolve, much remains unanswered about where such a powerful reasoning tool would best be implemented in medicine. Nonetheless, its sole existence raises questions about how we as a society think about healthcare delivery – both as it currently is, and as it could be.

Questions for your consideration

- The predicted usefulness of AI in medicine is founded on the notion that medicine is a verifiable problem. A verifiable problem is one where the truth or correctness of a solution can be objectively checked using available evidence, criteria, or procedures. Do you believe medicine is entirely a verifiable problem?
- What other agents do you think would be useful in medicine?
- How should we test and validate agentic AI in medicine before deploying them widely?
- Are there certain tasks in medicine that should never be handed over to AI agents, no matter how advanced they become?
- What are some challenges and drawbacks in introducing AI agents in healthcare? (stay tuned for next time!)

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